A Comparison of Delivery Modes in Tertiary Forensic Science Education

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Faculty of Education

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THESIS DECLARATION

I, Barbara Ann Larkin, certify that:

This thesis has been substantially accomplished during enrolment in the degree.

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The research involving human data reported in this thesis was assessed and approved by The University of Western Australia Human Research Ethics Committee. Approval #: RA/4/1/2530 and the Canberra Institute of Technology. Approval #: 10/ 2009:1.

The following approvals were obtained prior to commencing the relevant work described in this thesis: All participants were provided with an information sheet and consent form.

Third party formatting assistance was provided in the preparation of the thesis by Fiona Mayne.

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ABSTRACT

The quality of tertiary forensic science education has been under review in the USA, the UK, and Australia. This study addressed one of the recommendations outlined in the *Education and Training for the Future Report*, 2005; to identify national and international best practice delivery mechanisms. The broad aim of this study was to compare different tertiary forensic science delivery modes, including face-to-face, blended and fully online modes. The research questions focused on the stakeholders’ experiences, perceptions and outcomes of these delivery modes. Three stakeholders within Australia participated; tertiary forensic science students and teachers and forensic science industry personnel. This study used a pragmatic, mixed method approach and consisted of two main parts; a national survey and a local case study conducted at the Canberra Institute of Technology. A questionnaire was used in the national survey to gather quantitative data; students (*N*=110), teachers (*N*=29) and industry personnel (*N*=31) and interviews were used in the case study to provide in-depth insight into the numeric data; students (*N*=7), teachers (*N*=7) and industry personnel (*N*=5). The majority of participant stakeholders identified blended mode as their preferred mode of delivery. The *knowledge and skill* blended model and the *flipped* blended model are the recommended models for diploma and undergraduate students respectively. Motivation factors identified by students and industry personnel impacting on participation in online delivery include high quality feedback and opportunities for social interaction. Based on the results of this study, a proposed best practice model for forensic science education is presented.
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DEDICATION

This thesis is dedicated to my daughter, Katie Ann Larkin.
CHAPTER 1: INTRODUCTION

This chapter introduces the context, nature and purpose of the study. The rationale and Research Questions of the thesis are presented followed by a description of the background and the originality and significance of the study. The chapter also includes a brief account of my employment history and personal reasons for conducting this study and concludes with an overview of the structure of this doctoral thesis.

1.1 Rationale

Forensic science involves the application of scientific knowledge to legal situations and includes a wide variety of scientific disciplines ranging from forensic investigation to forensic accounting. Forensic science is an applied science but forensic scientists also require a high level of problem solving, communication and team work skills. It is important to ensure that forensic scientists completing their qualifications have the right skills, knowledge and professional attitudes together with a solid basis for continued learning and research. Their educational outcomes will have a significant impact on the forensic science industry. This study investigated different educational delivery modes in forensic science and the impact they have on those educational outcomes.

An increase in public interest in forensic science in Australia since the early 1990s has resulted in a rise in the number of forensic science programs (Horton et al., 2012; Samarji, 2010). In 2004, there were approximately 20 tertiary institutions offering 48 forensic-related programs (Brightman, 2005). According to Horton et al. (2012), in 2012 there were 57 forensic-related programs offered by Australian tertiary providers of which 33 were bachelor programs. Other programs include generic-degree courses that include an elective in forensic science, pre-bachelor diplomas and certificates, post-bachelor diplomas, master’s degrees and doctoral degrees (Horton et al., 2012). The certificate courses offered through Technical and Further Education (TAFE) use competency-based training that has an exclusive emphasis on skills and outcomes (Chappell, Gonczi & Hager, 2000). In contrast, university courses are based on graded
performance. Brightman (2005) points to inconsistencies in terms of content and delivery within forensic science programs.

The need for this proposed research originally arose from the National Institute of Forensic Science (NIFS) Education and Training for the Future Report (Brightman, 2005). The report incorporated the results of a questionnaire to over 2080 Australian forensic practitioners. The findings presented in the NIFS report in 2005 were similar to reviews undertaken in both the USA (Education and Training in Forensic Science: A guide to Forensic Science Laboratories, Educational Institutions and Students, 2004; Addressing shortfalls in forensic science education, 2007; Strengthening forensic science in the United States; a Path Forward, 2009) and the UK (Forensic Science: Implications for Higher Education, 2004). One of the fourteen recommendations made in the NIFS Education and Training for the Future Report (Brightman, 2005) focused on identifying national and international best practice in delivery mechanisms. Despite the majority of survey responses indicating a preference for face-to-face delivery, the report suggested there are opportunities to develop online materials. Another recommendation stated that, by 2010, authorised forensic practitioners would require a relevant academic qualification, and that it is highly desirable this will be at the bachelor level. In response, Canberra Institute of Technology (CIT) developed the Bachelor of Forensic Science (Crime Scene Examination). The rationale for this research was derived from these recommendations from the NIFS Education and Training Future report (Brightman, 2005) and a major aim was to interrogate the tension between the preference for face-to-face delivery modes in forensic science and the need for online distance delivery modes.

The rationale for this study was also in keeping with the four themes presented during the NIFS Education and Training Summit held in July 2008 that focused on: 1. The need for a nationally consistent approach to forensic practitioner training and education across Australia; 2. The need to review forensic training and education programs and resources to establish best practice; 3. The need for closer liaison between employers of forensic practitioners and the providers of forensic training and education programs; and, 4. That NIFS should continue to have a key role as the national body in co-ordinating specialist forensic training programs and providing a conduit for the dissemination of forensic knowledge to practitioners. In 2009, the National Academy
of Sciences (NAS) reported that there is a need to correct educational deficiencies for current crime scene officers and suggested that this should be done at the undergraduate and graduate level. In addition to the Bachelor of Forensic science (Crime Scene Examination) the Canberra Institute of Technology offer a range of vocational courses available only to members of the police force including the Advanced Diploma of Public Safety and various specialist graduate certificates i.e. Forensic Fingerprint Investigation and Forensic Firearm Examination.

The question of suitable delivery mode is important in forensic science education. Currently the Advanced Diploma of Public Safety (to be superseded in 2017 by the Advanced Diploma of Forensic Investigation) is offered through the Canberra Institute of Technology via distance mode. For some subjects, the students, who are members of the police force, are required to attend face-to-face residential practical workshops. Often due to work commitments or personal reasons, the students are unable to attend these residential workshops. For example, during natural disasters such as the 2012-2013 Victorian bushfires or even international incidents such as a tsunami or bombing, police can be deployed at times when they are also required to complete assessment tasks. For these reasons, it is difficult to coordinate a time when all students are available for a residential workshop. Furthermore, it is not economically viable to run residential workshops for a small numbers of students. The higher education sector needs to explore all types of delivery. For example, in the Diploma of Public Safety at the Canberra Institute of Technology, the unit Forensic Microscopy was offered via distance mode where the students never met the teacher. Learning guides and resources were posted online and the students were required to submit a portfolio of photographs as part of their practical assignment. Research should be conducted to see if it is possible for such units to be delivered in virtual classrooms e.g., using low powered digital microscope connected to the computer by a universal serial bus (USB) in real-time. It is important to look at the outcomes of using delivery methods from the industry, teacher and students’ points of view. If the work presented is not up to industry standards, there is little point pursuing that method of delivery.

Furthermore, inexperienced students need to hear from expert witnesses in their discipline area. Such specialists are not often conveniently located in one place, so
there is a need to use technology to either record lectures or set-up live lectures. It would be foolish to suggest that all lessons can be delivered online. For example, when using a gas chromatograph, students need hands-on experience but all other options to complement the acquisition of such skills should be explored. With the advancement of technology there will be more analysis of forensic evidence at the crime scene itself and forensic education should reflect these changes.

Cassella (2008) stated that forensic science isn’t the necessary conclusion to a forensic science degree and like other science degrees not all graduates of forensic science degrees gain employment in the industry. Although it can be difficult to gain employment in forensic science, some graduates do gain employment within forensic science early in their careers. Forensic education impacts not only on these future forensic professionals but also on the wider community, the ‘end-users’, so it is imperative that we develop and use best practice delivery methods.

1.2 Purpose and Research Questions
The broad aim of this study was to compare and contrast key stakeholders’ perceptions of different delivery modes, including face-to-face, blended or mixed mode and online delivery, in tertiary forensic science education in Australia. The aim also was to identify key stakeholders’ perceptions of best practice delivery mechanisms in tertiary forensic science in order to share the information with the forensic science community and related industries.

The nine research questions that guided data collection are divided into three broad categories consistent with the three key stakeholders. The first set of questions is focused on student perceptions, experiences and outcomes of the different delivery modes in forensic science.

1a) What are Australian tertiary students’ experiences of delivery modes (face-to-face, blended and online) for forensic science?
1b) What are Australian tertiary students’ perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?
1c) How do student outcomes (marks/grades) correlate with delivery modes for forensic science?

The second set of research questions is focused on teachers’ perceptions and experiences of different delivery modes for forensic science.

2a) What are Australian tertiary teachers’ experiences of delivery modes (face-to-face, blended and online) for forensic science?
2b) What are Australian tertiary teachers’ perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?
2c) How do teachers perceive student outcomes as a result of different delivery modes for forensic science?

The third set of research questions refers to forensic industry personnel perceptions of different delivery modes and their outcomes for students.

3a) What are Australian industry personnel perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?
3b) What are Australian industry personnel perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?
3c) How do Australian industry personnel perceive student outcomes as a result of different delivery modes for forensic science?

The key elements of the research included:

- A survey of students and teaching staff in Australian tertiary institutions offering forensic science and Australian forensic science industry personnel; and,
A case study of the Bachelor of Forensic Science (Crime Scene Examination) implemented in 2009 at the Canberra Institute of Technology (CIT).

1.3 Background and context

1.31 Provision of training in forensic science

This study focused on higher education in forensic science including the university and the Vocational Education and Training (VET) sector. It was not within the scope of this study to research discipline specific in-house training or professional development.

Prior to the 1960’s, Australian higher education comprised of two major sectors each offering different qualifications and career opportunities. Universities offered curriculum-based qualifications such as graduate diplomas, bachelor, masters and doctoral degrees while the VET sector (formerly known as technical education) offered competency-based qualifications (Edwards, 2011). According to Wheelahan and Moodie (2008), this trend is now less distinct with a move towards a mixed model.

The Australian Qualifications Framework (AQF) http://www.aqf.edu.au/ links the learning that occurs in schools, vocational colleges and universities into one national system. The AQF outlines the hierarchy of tertiary qualifications (Figure 1). Within the AQF, it is possible to gain academic qualifications and work-based qualifications.

VET institutions can now offer degrees in addition to competency-based courses e.g., Canberra Institute of Technology offers the Bachelor of Forensic Science (Crime Scene Examination), and universities can now offer certificate courses e.g., Swinburne University offers the Certificate IV in Forensic Science. There are numerous disciplines within forensic science and forensic science courses vary in their area of focus or specialisation.
Disciplines of forensic science

Forensic science has a multitude of disciplines but can be broadly divided into three main areas: forensic pathology, crime scene/fieldwork and laboratory work. Each of these areas requires specialist skills and training. Samarji (2010) categorised forensic practice into five categories: crime scene investigation, criminalistics technical, criminalistics scientific, forensic biomedical and other forensic specialities.

1) Crime scene investigation - The crime scene is the beginning of forensic evidence and the crime scene examiner is responsible for the collection,
documentation and packaging of evidence. If evidence is mishandled at this stage, it will be impossible to rectify the problem at the later stages of analysis e.g., in the laboratory (Weston, 2004).

2) Criminalistics technical – This category encompasses many different fields including fingerprinting, document examination, firearms identification and ballistics, tool mark examination, fire and explosion investigation (Samarji, 2010).

3) Criminalistics scientific - This category includes specialists who analyse evidence in the laboratory after it has been collected. The disciplines included in this group are forensic biology, chemistry and physics (Samarji, 2010).

4) Forensic biomedical specialisations - include forensic pathology, forensic odontology, forensic entomology and forensic psychiatry (Samarji, 2010).

5) Other forensic specialities - include forensic computing and engineering (Samarji, 2010).

Part A of this research is a ‘broad sweep’ of all five categories as it includes a national survey of educational institutions (teachers and students) and forensic industry (industry personnel). Part B of this research focuses on crime scene investigation as it was conducted at the Canberra Institute of Technology, a VET institution delivering a Bachelor of Forensic Science (Crime Scene Examination) and the Advanced Diploma of Public Safety.

1.33 Duties of the forensic scientist

According to the National Institute of Forensic Science (NIFS report) (Brightman, 2005, p. 5) an authorised forensic practitioner is a person authorised to not only give evidence of fact (based on the five senses), but to draw inferences from those facts and to offer related scientific interpretation and opinion evidence in their area of expertise. Knowledge and experience, together with education and training underpin this authorisation. Therefore this category does not include practitioners whose function is the collection and recording of physical evidence and may include contextual interpretation but not the scientific interpretation thereof.
Consideration of this definition raises an interesting question. Where does the crime scene examiner fit within this definition? If a crime scene examiner holds a Bachelor of Forensic Science, is the crime scene examiner a scientist or a technician?

Weston (2004, p. 46) emphasised the importance of the crime scene examiner taking an holistic approach and refers to the contextual interpretation of evidence.

Any person involved in crime scene examination has a duty not just to record the obvious but to look beyond that and examine, observe, and take notice of what the evidence tells them.

According to the Western Australian Department of Training and Workforce Development, Career Centre (http://www.careercentre.dtwd.wa.gov.au/Occupations/Pages/forensic-scientist.aspx), the duties of a forensic scientist include the examination of evidence collected from a crime scene, providing the results of that examination in a report and then presenting the verbal evidence in a court. It is imperative for forensic educators (curriculum writers and teachers) to examine the duties of forensic scientists and tailor the content, learning approaches and delivery methods to meet the needs of the industry. Consequently, it is important for forensic educators to clearly understand forensic science but differences of opinion exist as to what forensic science is.

1.34 Forensic science: A discipline within itself?

There are two schools of thought with respect to forensic science education. One school of thought is that forensic science is not a stand-alone science but is based on the natural sciences (Kobus & Liddy, 2009). The NAS report, Strengthening Forensic Science in the United States: A Path Forward (2009) presented an argument consistent with this perspective, that a person cannot become a competent forensic scientist without first gaining competency in a specific scientific field of study. The other school of thought is that forensic science is a fundamental field of study within itself and should be viewed as an holistic discipline (Cassella, 2008; Crispino et al., 2014). Roux, Crispino and Ribaux (2012, p. 7) raised concerns that when forensics is viewed as a series of multiple specialisations, crime scene investigation “is considered as a separate police technical activity”. Whilst Casella (2008), acknowledged that forensic science is multi-faceted, he argued that forensic science is worthy of training to the
bachelor, master and doctoral levels and that it is possible to be educated as a scientist e.g., in biology and to develop forensic science skills at the same time. These conflicting views have implications for forensic science education programs.

1.35 Requirements of forensic science programs

Concerns have been raised regarding the quality of some forensic science programs (Brightman, 2005; Kobus & Liddy, 2009; Quarino & Brettell, 2009). The NIFS Education and Training review (Brightman, 2005, p. 61) identified underpinning science as an important requirement for a forensic science program and emphasised the importance of ensuring that forensic science courses have the “best blend of fundamental science and forensic specific science”. Quarino and Brettell (2009) expressed concerns over postgraduate forensic science programs that offer contextualised practical components, because such courses may lead to ‘experts’ with limited experience or practical knowledge. According to Kobus and Liddy (2009), employers depend on educational institutions such as universities to meet their recruitment requirements and to provide graduates who will be ready to move into on-the-job training. Kobus and Liddy (2009) and Fraser (2009) are not supporters of forensic degree programs that are vocational in nature and question the value of a degree in forensic science. In other words, their view is that forensic programs should be about producing graduates who are able to take on forensic science employment and training.

An argument against forensic science degrees and for general science degrees was put forward as a better option at the NIFS Education of Training Forensic Science Summit (2009). In support of this side of the argument, it was stated that general science degrees were down in demand whilst science degrees with an application such as biomedical science and forensic science were up in demand. Horton et al., (2012) also reported an increased level of public interest in forensic science in Australia based on the increase in the number of forensic science programs e.g., forensic science related programs in Australia rose from forty eight in 2004 to fifty seven in 2012. According to Samarji (2010), some universities have taken advantage of the recent increase in public interest in forensic science and rebranded their science degrees as forensic science in order to attract students to forensic science programs.
The forensic science institute at the University of Central Oklahoma (UCO) has taken an inter-disciplinary approach in order to educate forensic science professionals (Adams et al., 2012). UCO no longer offers a stand-alone Bachelor of Science in forensic science. Students are required to enrol in a dual degree; a Bachelor of Science degree in forensic science and a relevant Bachelor of Arts program (Adams et al., 2012). Students may enrol in one of a variety of disciplines including chemistry, biology, anthropology, criminal justice, psychology and accounting. The forensic science program is located in a dedicated unit, the W. Roger Webb Forensic Science Institute and a science crime laboratory is located across from the institute. The Office of the State Medical Examiner and the Board of Medicolegal Investigation are authorized to relocate immediately adjacent or in close proximity to the UCO Forensic Science Institute. A hypothetical advantage of the dual degree delivered in close proximity to industry personnel would mean the students’ career choices are not confined to forensic science alone and that they would have potential access to industry personnel / expertise and facilities.

In Australia, there has been some discussion regarding a national accreditation for forensic science degrees (Horton et al., 2012; Robertson, 2012). In some professions such as pharmacy, medicine and dentistry, there is a national accreditation board. In order to practice in these professions, graduates must have passed an accredited degree and show evidence of ongoing experience and professional development. At this stage, no decision has been made regarding a national accreditation for forensic science programs in Australia.

The increase in the number of forensic science programs (Horton et al., 2012) and rapid development of technologies used in education have led educational institutions to explore alternatives to conventional face-to-face delivery as a cost-effective educational approach (Johnson, Adams & Cummins, 2013). An overview of these delivery modes is provided in the next section.

1.36 Delivery modes

Geelan (2006) argued that educational researchers should ensure that the work they do significantly and positively affects what happens in the classroom otherwise it is essentially unproductive. This research was designed to be consistent with Geelan’s
thesis in that it was intended to be of direct use to forensic science educators in their
daily work of teaching. Forensic science educators in Australia and worldwide currently
use a range of modes of delivery for their courses. This research investigated three
modes of delivery, face-to-face, online and mixed or blended delivery mode.

1.3.6.1 Face-to-face delivery
For the past 75 years, the learning theory behind the curriculum and pedagogy of
career and technical education classrooms has been behaviourism (Doolittle & Camp,
1999). As a consequence, face-to-face delivery in the form of the traditional in-person
lecture has been the dominant mode of delivery for forensic science. Educational
reform in the USA by the National Council of Teachers of Mathematics (1989, 1991)
and the National Academy of Science (1996) embraced the principles of the theory of
constructivism. The transition between behaviourism and constructivism over the past
few decades has resulted in the current status quo where instructional methods and
strategies used in science classrooms vary from those that are primarily didactic or
teacher-centred to those that are mainly student-centred (Treagust, 2007).

As an applied science, forensic courses are usually delivered via face-to-face and use
problem-based learning (Voss, 2008). Problem-based learning allows the learner to set
and solve problems by integrating the learning which leads to understanding and
reflection. Problem-based learning is consistent with social constructivism (discussed
in Chapter Two in more depth) and is an example of constructive alignment where
there is alignment from the objectives through to the teaching methods and
assessment (Biggs, 2003). The main focus is for the student to be able to solve
professional problems. According to Biggs (2003) there are two aspects to constructive
alignment. The constructive aspect applies to what the learner does and the alignment
part refers to what the teacher does, that is, choosing learning activities that are likely
to achieve the desired learning outcomes.

1.3.6.2 Blended or mixed delivery
According to Franklin and Peat (2001), there was a small shift away from courses
comprising all face-to-face student-teacher activities to courses with a mix of face-to-
face and on-line activities earlier in the new millenium. More recently, budget cuts
(Johnson et al., 2013) and a global drive for larger numbers of students being taught in
more financially efficient ways (OECD, 2013) has led to education institutions exploring innovative teaching models as alternatives to face-to-face delivery.

Fee (2009) referred to a number of different forms of blended learning with particular emphasis on the following four types, namely the sandwich, the milestone, knowledge and skills and complementary resources. The first form of blended learning is called the *sandwich* because it contains a traditional face-to-face course as the sandwich filling while the pre and post part of the course is offered online. The second form of blended learning is known as the *milestone* because it starts with an online course and adds on face-to-face training events as milestones which help to pace the program. The third form is referred to as *knowledge and skills*. Here, the online component is used for underpinning knowledge while the face-to-face approach is used for skill development. Finally, the *complementary resources* form of blended learning is where online resources are offered as back-up for face-to-face training.

These mixed delivery classes have the potential to help students who may otherwise give up due to commitments outside their study. A research project investigating staff perceptions of online learning in a blended mode showed that staff were generally positive about their experiences and that it provided opportunities for student reflection, peer editing and tutoring feedback opportunities between staff and students (Keppell et al., 2004). A meta-analysis conducted by Means et al. (2010) found that blended mode led to higher scores than either face-to-face or online mode.

On the down-side, by using blended mode, there may be technical problems with the online component (Waldman & Smith, 2013), students may require time management skills (Napier, Dekhane & Smith, 2011) and dislike the interactive nature of working on a computer (Clark, 2011).

1.363 Online delivery

Modern instructional methods include online learning which presents educational institutions opportunities for educational delivery to students at a distance from campuses in courses largely presented via the internet. One of the advantages of online learning is that the learner has more ownership in the learning process. For example, there has been a shift from a past procedural approach, where learners followed a specified pathway of learning, to an approach where the learner can ‘jump’
from one area of interest to another (Rylatt, 2000). Mason and Kaye (1990) identified three consequences of interactive online learning. Firstly, there was an opportunity for discussion, collaboration and the potential for building a sense of community. In addition, it affects teaching, administrative and support staff in that students can now communicate with the staff via email. Lastly, online learning provides access to peers and opportunities for networking between scholars. Disadvantages to the e-learner may also include possible computer phobia, as well as lack of reliability of equipment and afterhours support (Freeman, 1997) and a lack of social interaction and motivation (Muilenberg & Berge, 2005). A further constraint of fully online delivery is the lack of face-to-face practical work: viewed by Bird (2010) as an essential component of the natural sciences. However, it is now possible to conduct virtual work simulations i.e. virtual crime scenes (Lehman & Jeffers, 2012).

A recent development in online learning has been the emergence of Massive Open Online Courses (MOOCs) but there have been reports of high attrition rates (Clow, 2013; Koutropoulos et al., 2012) and in cases where assessment is included, there are problems with authentication (Bond, 2013).

There is no doubt that online delivery offers flexibility to students. The question is whether online delivery is incorporated into forensic science courses to increase student enrolments or whether it genuinely benefits both students and the forensic industry.

**1.3.64 Online delivery of forensic science in Australia**

The NIFS Education and Training for the Future Report (Brightman, 2005) suggested there were opportunities for online delivery of forensic science in Australia. Since that time, the use of online resources in tertiary education, including forensic science, has become common. For example, The University of Western Australia, Canberra Institute of Technology and Charles Sturt University all have implemented some form of online delivery in forensic science. Murdoch University offer an online Bachelor of Science in Cyber Forensics and Information Security. The University of New England offer a combined Bachelor of Arts/ Bachelor of Science degree, majoring in forensic science that is delivered both on and off campus. The primary focus of the Centre for Forensic Science at the University of Western Australia, for example, is on postgraduate
programs, including graduate certificate, graduate diploma, master and master/PhD. Voss (2008) incorporated online learning into a traditional face-to-face entomology unit at University of Western Australia with an emphasis on problem-based learning activities. The integration of the online learning tool was positively received by the students.

The Canberra Institute of Technology (CIT) is a Technical and Further Education (TAFE) institution that offers forensic science courses ranging from an Advanced Diploma in Public Safety to a Bachelor of Forensic Science (Crime Scene Examination). The delivery of forensic science at degree level puts CIT in a unique position. Being a TAFE institution it must meet Australian Quality Training Framework (AQTF) standards including competency-based training in addition to the graded performance of an undergraduate course. In addition to the face-to-face forensic science courses, CIT offers a Massive Open Online Course (MOOC) in biometrics.

1.365 Online learning debate

Research prior to 2004, shows that the face-to-face versus online learning debate should be put to rest (McDonald, 2002; Meyer, 2002; Russell, 1999). Meyer (2002) located more than 50 studies, comparing the same course taught in the traditional format with a web-based model, posted or published in 1999, 2000 and 2001 in peer-reviewed online journals, traditional paper journals and web-based conference sites. The results of these studies indicated no significant difference in student achievement. Myer (2002, 2004) asserted that the no significant difference phenomenon was due to simple comparison studies, some of which were flawed in design. The majority of the comparison studies had not taken into account the variables such as student learning preferences, maturity, and competency with relevant technology that may be important in student learning (Meyer, 2004). According to Meyer (2004) in most cases, the studies have been a one-time comparison of two courses, where both courses were taught by the same person (often the researcher), where students selected their own mode of delivery and where the dependent variables tested were either grades or final exam scores. Specific skills or concepts learned were not taken into account. A good comparison study must attempt to identify and control intervening influences, including the pedagogy used.
Means et al. (2010) examined over a thousand empirical studies and found that students who studied through online learning mode performed moderately better than those who studied via face-to-face mode. It was also found that the effects were larger with students who experienced blended mode. Means et al. (2010) pointed to the fact that these effects could be due to factors other than just the media alone e.g., opportunities for collaboration.

The two metaanalyses, Myer (2002) and Means et al. (2010), have different findings. Myer (2002) found no significant difference between face-to-face and online learning while Means et al. (2010) showed a moderate gain for online studies. Myer (2002, p. 30) speculated that many of the studies may have been the faculties’ first foray into evaluating whether the technology works and found the majority were poorly designed. A strength of the Means et al. (2010) study was a large sample size i.e., a thousand empirical studies, and the fact that it only included studies with controlled designs that met strict quality guidelines including using studies with random assignment or controlled quasi experimental designs. Furthermore, it only examined objective measurements of student learning e.g., student outcomes and student perspectives were not included. Means et al. (2010, p. xviii), made the point that although they used studies with a controlled design, many of the studies that were screened included “weaknesses such a small sample size, failure to report retention rates for students in the conditions being contrasted; and, in many cases, potential bias stemming from the authors’ dual role as experimenters and instructors.”

Research into online learning must be rigorous and take into account different subject matter, student types and also different online learning practices (Means et al. 2010) Furthermore, the pedagogy used must be disclosed for meaningful conclusions to be made.

1.4 Originality and significance of the study

This doctoral study is original and significant because it focuses on the quality of forensic science education and contributes to our understanding of the skills of forensic industry practitioners. There have been numerous reports and studies throughout the world to assess the effectiveness of forensic science and the skills of
the forensic industry practitioner. These reports are mainly aimed at forensic professionals, however, educational institutions should also apply research into the effectiveness of forensic science programs and delivery methods to ensure the graduates are industry ready. Research into the efficiency and effectiveness of forensic science has acknowledged that skills and training of personnel are the benchmark to strengthening forensic science (Robertson, 2010).

Models of education often separate knowledge, theory and practice (Brown & Hartrick Doane, 2006). This doctoral research, however, has been designed to be consistent with Geelan’s (2006) perspective that educational researchers should ensure that the work they do significantly and positively affects what happens in the classroom. In order to address the ‘theory-practice gap’, Geelan suggested four possibilities; teaching the teachers to read and implement research, teaching researchers to write their research reports in ‘teacher language’, provide people who read research and translate it into ‘teacher language’ and transform the kinds of education research so that the results are of use to teachers in the classroom. This doctoral study is original and significant because it is aimed at addressing the theory-practice gap in forensic science education. Based on the experiences and perceptions of key stakeholders, a proposed best practice delivery model has been developed.

According to Meyer (2004), previous studies comparing online learning and face-to-face delivery modes have been limited by a lack of quality research. There is plenty of research available on face-to-face versus online learning in general education but there are gaps and discrepancies in how forensic science should be delivered. For example, the NIFS Training for the Future Report (Brightman, 2005) found the majority of respondents reported a preference for face-to-face delivery. In contrast, some Australian case studies have discussed the advantages of online learning materials (Crampton, 2008; Voss, 2008). The combination of a lack of well-designed comparative studies and a small number of case studies in forensic science delivery modes within Australia has resulted in a clear lack of direction with regard to best practice for the teaching of forensic science education. Samarji (2010), conducted a study on the complexity of forensic science and the implications for forensic education in which he acknowledged that one of the limitations of his research was the exclusion of students’ perceptions. This study will provide an original and significant contribution to forensic
science education because it will combine a broad survey of Australian tertiary forensic science teachers, students and industry personnel with an in-depth case study within one institution from the perspectives of the staff, students and industry personnel. This combination of both broad and in-depth data has the potential to tease out and explain some of the discrepancies noted above and give better direction for forensic science educators in Australia.

1.5 Research design

This study used a pragmatic approach, in which both qualitative and quantitative methods were used to investigate different delivery methods in tertiary forensic science education (Brown & Hartrick Doanne, 2006; Doyle, Brady & Byrne, 2009; Hall, 2003; Morgan, 2007). The research design consists of two major parts, Part A and Part B. Part A included broad data collected through a survey of students and teaching staff in various Australian universities together with forensic science industry personnel. Preliminary interviews were conducted with students and staff from the University of Western Australia (UWA) and the University of Canberra (UC) and local industry personnel to develop the survey. Part B of the research was a case study at the Canberra Institute of Technology (CIT) implemented in two phases utilising a number of methods of data collection. The national survey (Part A) and the case study (Part B) provided different grain sized data that were triangulated to enhance the rigour of the research.

The mixed method approach used in this study is also used extensively in nursing research (Creswell, 2013; Creswell & Plano Clark, 2011; Creswell et al., 2011); another applied science. Collecting both quantitative and qualitative data capitalizes on each of their strengths. For example, quantitative data can produce numerical objective data that shows trends across a broad spectrum of participants while qualitative data can provide descriptive examples that elaborate details. Multistage cluster sampling was used in Part A because this was the method recommended for national surveys by the Australian Council for Education Research (Murphy & Schulz, 2006). More detailed information about the research design and methods of data collection and analysis are provided in Chapter Three.
1.6 Author background

Since late 2009, I have been a part-time PhD candidate at the University of Western Australia (UWA) and throughout my tenure have been employed full-time as a teacher at the Canberra Institute of Technology (CIT). During my time at CIT, I have taught units in the Diploma/Advanced Diploma in Public Safety, Bachelor of Forensic Science (CrimeScene Examination) and the Graduate Diploma in Forensic Science.

My teaching experience amounts to 25 years and ranges from high school to postgraduate level. Prior to teaching, I worked in various medical laboratories as a technician and subsequently started teaching these skills. These two different but interconnected careers have contributed to my commitment to life-long learning and the importance of employability skills.

My hope is that this research will be of direct use to forensic science teachers by providing new knowledge that will have practical ramifications by contributing to the chances of forensic science students gaining relevant employment. On a personal level, I hope to learn more about new technologies that are available in education and improve my online teaching practices.

1.7 Thesis structure

This chapter outlined the rationale and background for this study as well as the broad aim and specific research questions. This chapter also outlined the originality and significance of the research, introduced the research design and provided a snapshot of the author’s background in the context of this research on forensic science education.

Chapters Two provides a critical review of the literature relevant to this study. It comprises two main sections: learning theory with an emphasis on social constructivist theory and delivery methods including face-to-face, blended and online modes.
Chapter Three reports on the methodology used and defends the choice of the pragmatic mixed method that was employed in this study. Both the quantitative and qualitative methods are described in terms of sampling, data collection and analysis. In addition, the limitations of the method are outlined.

Chapter Four presents the study’s findings for participating students that address Research Question 1. Firstly, the quantitative data are presented and then examples are provided through the qualitative interview responses.

Chapter Five presents the study’s findings for the participating forensic science teachers that address Research Question 2. This chapter uses a similar approach to that used in Chapter Four.

Chapter Six presents the study’s findings for the industry personnel participants that address Research Question 3. This chapter uses a similar approach to that used in Chapters Four and Five.

Chapter Seven provides a cross case analysis comparison of the findings for all three participating stakeholders of this study; forensic science students, teachers and industry personnel.

Finally, Chapter Eight summarises the findings of this study for each Research Question and discusses their meaning in light of the literature. Included in this chapter, the different stakeholder perspectives are compared and contrasted to tease out the challenges and formulate possible solutions. In addition, the study’s rigour, limitations, contribution to the literature and ideas for future research are provided. The chapter concludes with a brief account of my reflective thoughts on my doctoral research.
CHAPTER 2: LITERATURE REVIEW

DELIVERY MODES IN SCIENCE EDUCATION AND A SOCIAL CONSTRUCTIVIST FRAMEWORK

This chapter provides a critical analysis of the literature relevant to this study including learning theory and delivery modes. The first section examines the underpinning learning theories. Literature related to social constructivism is explored as it relates to science education in general followed an analysis more specifically focused on forensic science. In the second section, the literature related to different delivery methods or modes including traditional face-to-face, blended or mixed and fully online delivery is examined in order to provide a foundation to analyse the written and verbal feedback from the students, teachers and industry personnel in this study.

2.1 Learning theory

2.11 Learning theory in science

The learning theory behind the curriculum and pedagogy of career and technical education during the majority of the twentieth century was behaviourism (Doolittle & Camp, 1999). Research that supported behaviourism suggested that learning involves the formation of links between specific stimuli and responses through the application of rewards (Thorndike, 1932; Wirth, 1972). As a result of this stimuli/response/reward type research and the underpinning theory of behaviourism, ‘good’ teaching was thought to involve the teacher providing a set of stimuli and reinforcements that are likely to ensure that the students give appropriate responses. Bailey and Garratt (2002) provide an example of this stimuli/response/reward approach where the students attend a chemistry lecture and are expected to practice their knowledge/skills. Such behaviour is driven and reinforced by either rewards such as marks or positive feedback from the teacher and/or peers or punishments.

According to McRobbie and Tobin (1997), however, behaviourist-based approaches in science education resulted in rote learning, little conceptual understanding and a limited ability to apply formulae. Dolittle and Camp (1999) elaborated on the
limitations of behaviourism, stating that behaviourist theory does not address high order thinking, problem solving and collaborative work skills. There are, however, potential advantages to a behaviourist-based approach that may be beneficial to students of forensic science and other technical forms of education. For example, it is important in the introductory learning stages to rote learn in order to master the information required to solve problems (Jonassen, 1991; Voss, 2008). Voss (2008) pointed out that it is common for forensic science students in the same class to have varied scientific backgrounds and they may not have mastered the information required for further investigations. At this early stage in the learning process, rote learning may provide an anchor upon which to develop their knowledge.

Dobbins (1999) stated that behaviourism was the learning theory used in career and technical education and pointed out the links between behavioural learning theory and competency-based instruction. These links include the use of performance objectives, criterion-referenced measures to measure task completion and the use of worker task lists. Although this provides the student with specific skills and allows the student limited control over the pace of learning, the student has no control over the content (Murphy, 2008).

Competency-based learning involves “instructional systems in which skills are checked off when accomplished and assumed to be permanently held by the student” (Doolittle & Camp, 1999, paragraph 10). Kirschner, Sweller and Clark (2006), however, challenge the assumption that knowledge can best be acquired through experience. The competency-based approach to technical education model has been the main type used for many years (Finch & Crunkilton, 1999). While this approach to pre-bachelor diplomas and certificates in forensic science persists, there has been a push to reconsider the theoretical framework for career and technical education (Lynch, 1996, 1997; Osborn, 1999). Towards the end of the twentieth century, educational reform in the USA, led by the National Council of Teachers of Mathematics (1989, 1991) and the National Academy of Science (1996), embraced the principle of another type of learning theory called constructivism.

2.111 Constructivist learning theory in science
Constructivism is a theory of learning proponents of which argue that learners actively construct their own knowledge and meaning from their experiences; that for meaningful learning to take place, new knowledge must be connected with prior knowledge in appropriate ways; and, that learning is essentially a subjective process (Bodner, Klobuchar & Geelan, 2001; Fosnot, 1996; Lunenburg, 2011). This acknowledgement of the learner’s role in the creation of knowledge contrasts with the older model of behaviourism which is based on notions of learning as the transmission of a set of predetermined skills and knowledge to the student.

Jean Piaget (1896 – 1980) and Lev Vygotsky (1896 – 1934) are two historical theorists who were involved in the development of constructivism. Piaget conducted extensive research on developmental psychology and believed that teachers should be mindful of the child’s stage of development. Vygotsky believed that for learning to occur a child must be first participating in a social environment and then internalize the experience. Whether learning is developmental or social, both Piaget and Vygotsky believed classrooms should be constructivist in nature and provide opportunities for students to gather, filter, analyse and reflect on information i.e. construct their own knowledge (Fosnot, 1996).

Constructivism is often described as a continuum and there are a number of different forms which makes the field of constructivism very complex (Geelan, 2006). This literature review focuses on two constructivist writers: Doolittle and Camp (1999) and Geelan (2006). These two authors were chosen because Doolittle and Camp (1999) discuss constructivism from a technical and career education point of view which is relevant to Part B of this study and Geelan (2006) is a writer with a pragmatic classroom emphasis; the perspective taken in this study.

Doolittle and Camp (1999) divided constructivism into three broad categories: radical constructivism, cognitive constructivism and social constructivism. Radical constructivism starts from the assumption that knowledge is in the heads of people, and that thinking people construct what he or she knows on the basis of his or her own experience (von Glaserfeld, 1995, 1996). Ernest von Glaserfeld (1995, 1996) maintained that knowledge is not transferred from the environment or from other persons but must be actively constructed within the individual mind.
The second form of constructivism described by Doolittle and Camp (1999) is cognitive constructivism. Cognitive constructivism is about how the individual learner understands things in terms of developmental stages and learning styles (Piaget, 1972). According to Doolittle and Camp (1999), cognitive constructivism is the most compatible of the three types of constructivism with technical and career education. Cognitive constructivism was Doolittle and Camp’s (1999) preferred model because it emphasised the ability of the individual to construct similar, if not identical, mental models based on similar experiences. This ability of the students to construct identical models based on similar experiences supports the technical education requirement of students having a required set of knowledge and skills.

Social constructivism is based on the theory that learning is acquired through social interaction with others (Solomon, 1987; Vygotsky, 1987). Social constructivism emphasises the social nature of knowledge and that learning is the result of social interaction and language usage (Prawat & Floden, 1994). Social constructivism is not about ‘consensus=truth’. Students can sit through a lecture, read a text book or an online resource but the real learning takes place when the student is able to ask questions and challenge information. As Geelan (2006 Ch 7 p. 3) states:

What is stored in books is not knowledge, only information.

Bahar (2003) observed that students need the opportunity to validate their learning through discussion and such an exchange of ideas can often lead to a better understanding of the subject. Furthermore, team work and communication skills are necessary generic skills in many professions, particularly in the forensic science field, so it is important to encourage collaborative learning. For these reasons, it is argued that social constructivism is the learning theory most compatible with technical and further education.

Geelan (2006) described six forms of constructivism. Like Doolittle and Camp (1999), Geelan (2006) included social and radical constructivism in his classification system but differentiated between two types of social constructivism; Solomon, 1987 and Gergen (1995) who described a more extreme form where knowledge arises within societies rather than within individuals. Geelan (2006) also included personal, contextual and critical constructivism. Personal constructivism is based on the theory that individuals
construct knowledge for themselves through the repetition of events and stress the adaptive nature of cognition (Kelly, 1955; Piaget, 1972). As Geelan (2006) pointed out, students have different histories/experiences and no two people can have identical knowledge or have the ability to construct new knowledge identically. Although it is important for teachers to take the prior knowledge of their students into account and to provide opportunities to practice, personal constructivism does not take into account the social aspects of learning. For this reason, personal constructivism is not an optimal learning model to use in technical and further education such as the forensic science discipline that is the context of this research.

Another form of constructivism in Geelan’s (2006) classification system is contextual constructivism. Cobern (1993) proposed that social interactions influenced learning but could not account for the context of human cognition. In order for learning to take place, Cobern (1993) asserted that cultural differences also need to be taken into account. This is an important and interesting perspective from a historical point of view, but nowadays there is legislation in place to ensure that all students, regardless of cultural background, are provided with equal resources and time allocation. For example, the Equal Opportunity Act, 1987; Equity and Diversity Framework for ACT public servants, 2003; http://www.business.gov.au/business-topics/employing-people/Pages/equal-employment-opportunity-and-anti-discrimination.aspx

Furthermore, most universities have policies in place to prevent any discrimination of a particular group of people and often have an office of diversity and equality that students can access. While this may not always be effective, there is now more consideration of context and culture in the current education system compared to historical context.

Critical constructivism recognises not only that learning occurs within a social and cultural environment but also advocates the use of supportive environments (Underhill, 2006). According to Taylor (1993), if the teacher takes on the role of a controller it can have a detrimental effect on the learning process. Taylor suggests that teachers should be encouraged to work in collaborative groups and that certain classroom practices should be challenged.
Regardless of the type of constructivism, the fundamental view promoted through this learning theory is that learners actively construct (rather than acquire) their knowledge based on what they already know. Teachers, therefore, must take into account the student’s prior knowledge (personal constructivism) when delivering lessons. Teachers should also take into account cultural differences (contextual constructivism), provide students opportunities to learn through discussion and social interaction (social constructivism) and be prepared to challenge any practice within the institution that can lead to student failure (critical constructivism). To summarise, although many of these aspects of constructivism as a learning theory have merit, for the purpose of this research, social constructivism is the model most appropriate for understanding technical and further education and for informing the training of forensic scientists. These students need higher order thinking skills, they must validate their learning through discussion, be able to work in a team environment and communicate effectively. Equally important, forensic scientists need to be able to work under minimal guidance, to develop and defend their own ideas.

2.112 Constructivist approach in practice

It is important that forensic science students are provided with opportunities to gain some experience with practical work and develop skills such as critical thinking, communication, and teamwork. Kelly (2000) argued that teaching science calls for hands on learning rather than the method of rote learning. The constructivist approach to teaching science is about letting the students foster their own ideas and hypotheses to reconstruct their understanding (Baviskar, Hartle & Whitney, 2009; Kelly, 2000). The teacher merely facilities the student’s learning process through practical activities, group discussions, teamwork and problem solving scenarios (Kelly, 2000). These four pedagogical strategies used in the constructivist approach, as described by Kelly (2000), can also be incorporated into teaching forensic science. For example, first year undergraduate forensic science students could be placed in small groups/teams and asked to process a mock crime scene involving a variety of evidence including impression evidence, physical evidence and simulated biological evidence. During this practical activity, students would need to use problem solving and team work skills. Following the practical session, students could debrief with a class discussion (McGowan, 2011). Whilst Baviskar, Hartle and Whitney (2009) and Kelly (2000) are
supportive of the minimally-guided approach of constructivism, Otting et al. (2010) and Loyens, Kirschner and Paas (2011) point to important limitations with this approach.

It is important to build on students’ prior knowledge. However, with some problem-based and minimally guided classroom activities, the complexity of the problem presented in the minimally guided approach ‘needs to be tuned’ with the students’ prior knowledge (Loyens, Kirschner & Paas, 2011). Furthermore as the prior knowledge of each student may differ, this could affect the entire student team. Otting et al. (2010) argued that undergraduate students find tasks that are less structured are too difficult and challenging to produce solutions for problematic tasks. The depth of knowledge that students have in their first year of a degree is often not developed enough to solve complex tasks. Getting students used to a constructivist learning environment may be met with some initial resistance and take some time.

The author of this doctoral thesis acknowledges that early-stage forensic science students require some background knowledge before attempting complex tasks. This knowledge includes both declarative or factual knowledge (recall of labels, names, lists and figures) and procedural knowledge (knowing how to perform certain activities) (Mayer, 2003). Some direct instruction from the teacher to link prior knowledge to new knowledge will help to bring meaning to new information and assist with storing the new knowledge in the long-term memory (Mayer, 2003). To impart procedural knowledge, the teacher could provide students with a written procedure to process a crime scene and then demonstrate how to do it whilst explaining their reasoning, decision making and problem-solving.

The theory behind a constructivist approach to teaching is to develop a foundation on which the student is exposed to situations that encourage quick and lateral thinking. The student then gradually develops problem-solving skills for preparation into the final stages of their degree and subsequently use those skills in their professional career. These ideas are supported by Voss (2008) and Jonassen (1991) who argued that in the early learning stages, students first require knowledge to solve complex problems. Based on this argument, a mock crime scene scenario developed for first year students could easily be modified once the students have had the opportunity to practice processing the evidence. For example, it would be possible to change the
dynamics of the team and introduce further challenges or unexpected events (McGowan, 2011). One could change the group size to reflect that which occurs in the forensic profession (Crampton, 2008). This is where the student not only adapts their scientific principles and knowledge to scenarios at a crime scene, but also reconstructs new concepts and lateral thinking ideas to further develop their own cognitive abilities. A practical activity, such as groups of students processing mock crime scenes, requires the students to work as a team with minimal guidance from the teacher. The next section elaborates social constructivism as the main learning theory that informs this research.

### 2.113 Social constructivism in science education

Science can be construed as the social language that has been developed within a scientific community (Scott, Asoko & Leach, 2007). For example, the social language of science is different to that of geography. This view is consistent with Geelan’s (2006) description of social constructivism and indicates that social constructivism is a most suitable theory through which to analyse the teaching and learning in forensic science. Scott, Asoko and Leach (2007) claimed, however, that science taught in schools is subject to social and political pressures so that it is different to that of professional science. This situation may also be the case with regard to TAFE institutions and universities delivering undergraduate forensic science courses. Ideally, institutions preparing students for the forensic science workforce will provide an educational environment that simulates and immerses the students in the language and conventions of the workforce as a suitable stepping stone to their profession. Although there has been increased attention given to the role of the student and the way they interact with others during learning as a result of the social constructivist movement, there has been less attention given to the issue of designing science instruction from a social constructivist perspective (Leach & Scott, 2002; Scott, Asoko & Leach, 2007).

### 2.114 Limitations of social constructivism

Some Australian universities that provide undergraduate programs to prepare ‘industry ready’ graduates, undertake social constructivist-based teaching methods only after developing the student’s theoretical knowledge (Hanson & Sinclair 2008). This is in keeping with Otting’s (2010) claim that first year undergraduates may
experience difficulty finding solutions to less structured tasks. Ogrinc et al. (2003) similarly emphasized the need for beginning medical students to have didactic instruction in addition to well-defined activities that focus on the application of the didactic knowledge. The social constructivist teaching methods, such as the minimally guided approach, should be delayed until students have an understanding of the theoretical background.

The following subsection examines research from a social constructivist perspective into the professional qualities of forensic scientists and how advances in the technology of forensic processing have impacted forensic science education.

2.115 Social constructivism in forensic science

There is limited published literature on social constructivist theory applied to forensic science (Samarji, 2010). The reasons for this are unclear. This may be because forensic science is such a demanding dynamic profession. There are high demands on forensic specialist teachers who work in the forensic industry to complete case work and to teach with little time left to conduct educational research. However, significant educational research has been conducted in medical education, also an applied science. Samarji (2010) pointed to similarities between medical professionals and forensic scientists on three levels: knowledge, practice domains, and legal and ethical level. Firstly, both professions are required to integrate new knowledge and scientific evidence and secondly both include a wide variety of disciplines e.g., pathology and paediatrics in medicine and forensic biology and forensic chemistry in forensic science. Thirdly, both disciplines are required apply scientific knowledge to legal situations and are bound to ethical guidelines. Based on the similarities between the two professions, it would follow that learning theories and pedagogies would apply to both.

The history of medicine and science was founded on positivism (Mann, 2011). Positivism is a teacher-centred philosophy that emphasises places a high value on objective study and that knowledge should be gained through observable and measurable facts (Mann, 2011). Medical education has since undergone significant changes with the emergence of constructivism (Mann, 2011). Dennnick (2016, p. 200) concluded that while there is no single learning theory that accounts for how students learn in all situations, constructivism “makes more connections between different
epistemological and pedagogical theories than others”. According to Dennick (2016), diagnostic reasoning, a key skill for doctors, has characteristics in common with scientific reasoning and is based on constructivism. Communication and interpersonal skills are also important skills for doctors as they must be able to extract background information from the patient, translate their findings into language the patients can understand and then communicate with them. This process, according to Dennick, is essentially constructivist. Finally, Dennick (2016) points to the physical structure of the brain and its processes. There is increasing evidence that active learning methods, in keeping with the constructivist philosophy, is supported by neurogenesis in the adult brain (Dennick, 2016).

In adult education, there are three main types of learning approaches, related to methods of instruction; lecture-based, problem-based and practice-based learning approaches (Samarji, 2010). The two pedagogies used in medical education are the traditional lecture-based learning and problem-based learning (Samarji, 2010). According to Samarji (2010), problem-based learning was introduced in the medical education in 1970’s. Lecture-based training has been identified as providing students with an opportunity to gain scientific literacy (Riffell & Sibley, 2005) but is criticized as it doesn’t require students to think for themselves (Ekeler, 1994; Weiman, 2012).

Problem-based learning is based on four principles; constructive, self-directive, collaborative and contextual (Dolmans et al., 2005). In problem-based learning, rather than simply finding the right answer, the students must decide on the knowledge and skills required to arrive at a conclusion (Hmelo-Silver, 2004). Students must also be able to defend their decision (Savin-Badin, 2000); an important skill for both medical professionals and forensic scientists. Problem-based learning teaches students how to learn and solve problems by integrating the learning which leads to understanding and reflection but runs the risk of the students drawing the wrong conclusions.

Problem-based learning is consistent with constructive alignment; a type of social constructivism (Biggs, 2003; Biggs & Tang, 2007a; Biggs & Tang, 2007b) and often used in forensic science courses (Voss, 2008). In constructive alignment there is alignment from the objectives through to the teaching methods and assessment (Biggs, 2003; Biggs & Tang, 2007a; Biggs & Tang, 2007b). The main focus is for the student to be able to solve professional problems. Other proponents of PBL include McDonnell, O’Connor
and Seery (2007) who state that problem-based learning mini-projects reflect real-life problem solving situations. According to Biggs (2003) there are two main aspects to constructive alignment. The constructive aspect refers to how students construct meaning through relevant learning activities and the alignment part refers to the learning activity selected by the teacher to achieve the desired learning outcomes. It is what the student does that is important in determining what the students learn rather than what the educator does (Biggs, 2003; Shuell, 1986). Although learners are considered to be central to the learning process, the teacher provides a crucial role in providing a suitable classroom environment where support and guidance are provided depending on the learner needs. Constructive alignment therefore, is a teaching approach aimed at supporting learning, where the emphasis is on the process rather than the content (Reaburn, Muldoon & Bookallil, 2009). According to Walsh (2007), the focus of the constructive alignment approach is on learning activities that lead to deep transformational learning, as opposed to surface learning of the facts and information.

Whereas lecture-based and problem-based learning are curriculum-based, practice-based learning is competency-based. In the technical education field, competency-based learning is used. According to Samarji (2010), the practice-based learning approach includes field practicum and work-based training. In practice-based learning, the student must demonstrate competency or a competency level in a certain skill set. A recent development in medical education has been a shift towards the use of milestone-based evaluation or assessment (Friedman et al., 2014; Ladhani, 2014) for competency-based assessment. According to Sherbino and Frank (2011, p. 9) a milestone, in the medical context, is defined as ‘the expected ability of a health professional at a stage of expertise’. As both medicine and forensic science are applied sciences, the use of a milestone assessment tool for formative assessments could also be applied to forensic science.

There are some examples of research from a social constructivist perspective in various science disciplines, including forensic science (Crampton, 2008; Voss, 2008). Examples of potential applications of social constructivism in crime scene work follow.

Focusing on crime scene work, Kelty and Julian (2010, 2011) illustrated that crime scene officers who excel in their industry had specific characteristics, which were
noted by their peers. One significant characteristic of a high performer was their cognitive ability to ‘think on their feet’. Constructivist-based teaching could be used to develop the students’ cognitive ability and problem solving skills (Bavistar, Hartle & Whitney, 2009; Hendry, Frommer & Walker, 1999; Kelly 2000). A survey conducted with Australian lecturers found a positive association with social constructivist-based teaching methods and active learning such as practical activities, problem solving tasks, self-directed learning and discussion in pre-professional undergraduate programs (Hanson & Sinclair 2008).

With the advancement of technology in producing 'mobile laboratories', the analysis of forensic evidence will advance away from laboratories and proceed at the crime scene (Mennell & Shaw, 2006). For example, advances in technologies with respect to fingerprint evidence has meant that photographs of fingerprints left at the scene can now be transmitted to the National Automated Fingerprinting ID System (NAFIS) using a mobile phone (Mennel & Shaw, 2006). In view of these advances in technology, educational institutions could use constructivist-based teaching methods to encourage active learning such as authentic work-based tasks “whilst maintaining quality, continuity and chain of custody of forensic evidence” (McGowan, 2001, p. 17).

Willis (2010) reported that crime scene examiners develop good practice through practical assessments rather than rote learning academic research. Crime scene examiners require quick thinking abilities as well as cognitive skills to solve problems as they arrive at the crime scene (Willis, 2010). Willis (2010) described the necessary qualities of a forensic scientist:

- Good knowledge of the principles of forensic science;
- Awareness of continual assessment of assumptions;
- Training in the empirical and scientific method of the natural sciences;
- Ability to conduct statistics; and,
- Good communication skills for a diverse range of audiences.

According to McGowan (2011), the use of constructivist-based approaches to teaching would enable potential crime scene examiners to develop their cognitive thinking and
problem-solving skills. This in turn, would more likely lead to the acquisition of “efficient crime scene processing skills, whilst adding to the quality of the investigation” (McGowan, 2011, p. 18).

2.116 Connectivism

Siemens (2004) argued that while learning theories such as Behaviourism, Cognitivism and Constructivism generally are consistent on the idea that learning occurs inside the individual, they do not address the fact that the learning process can also be located within technology and organisations. He argued that in today’s world, there is a rapid increase in information and that we need to be able to source information outside our own knowledge and recognise patterns and connections so learning can occur. According to Siemens (2004) learning can reside outside the individual e.g., in organisations and non-human sources such as data bases. Siemens’ (2004) learning theory is referred to as Connectivism. Anderson and Dron (2011) made the point that even if information is abundant and the learner has the ability to find and apply the knowledge, he/she may not necessarily understand or memorise it.

Verhagen (2006) criticized Siemens (2004) Connectivism learning theory based on three points. The first point of contention was whether Connectivism was a learning theory or pedagogy. Secondly, that the Connectivism principles were also present in other learning theories. Finally, he questioned whether learning could in fact reside in non-human appliances.

Anderson and Dron (2011) raised an interesting point on the application of the connectivist model to teaching. They espoused that while cognitive-behaviourist theories are teaching focused and social constructivist theories are mainly learning focused, they can both be applied to teaching. However, according to Anderson and Dron (2011), the connectivist learning theory is largely knowledge-based and therefore difficult to translate into learning and not a useful model for teaching purposes. Using the connectivist model, the teacher is at best a “role model and fellow node in a network” Anderson and Dron (2011, p. 6). Siemens (2008), agreed and pointed out that the increasing use of the internet places the learner at the centre of the education process and the role of the tutor will change and possibly disappear. However, Siemen’s (2008) assertion, that the role of the tutor may disappear, is in contrast with
multiple meta analysis of research into the role of the teacher in computer-based learning of new millennium learners or digital natives (OECD, 2012). According to OECD (2012), there was insufficient research evidence to suggest that learners learn effectively with only access to computers and without guidance from the teacher i.e. technology attachment alone had little effect on the cognitive skills of the students.

Several authors have alluded to the problems of translating educational theory into everyday classroom practice (Geelan, 2006; Kiraly, 2014) but there are also inherent problems associated with the subject of forensic science that have the potential to widen the theory-practice gap.

2.117 Problematic nature of forensic science – the CSI effect

The popularity of television shows, such as CSI, Forensic Investigators and Crossing Jordan have glamorised the role of the crime scene examiner (Bergslien, 2006; McManus, 2010). This is known as the ‘CSI effect’. Finneran (2003) states that such shows encourage young viewers to enrol in forensic science courses to fulfil their desire to become a crime scene examiner. On the positive side, this burst of interest in forensic science has led to an increase in forensic science classes being offered in schools (Bergslien, 2006). Shapter et al. (2002) argued these TV shows may be a motivating factor for students aspiring to become crime scene examiners. On the negative side, the way in which science is used to solve crimes on TV has led to increased public expectations and misunderstandings about how forensic science works (Bergslien, 2006).

Bergslien (2006) pointed out that the way in which forensic science is presented in class has the potential to re-enforce the CSI effect. He outlines four steps to avoid such a result. Firstly, teachers should relate the project/activity to one or more real cases. Secondly, teachers should develop activities where the suspect(s) is (are) innocent. Thirdly, teachers should create activities where the evidence is contradictory and, lastly, students should be encouraged to think critically about resource management. An exercise should be created in which students are required to select a portion of material for analysis and then justify their choices. All these suggestions are contextual examples and in keeping with the educational theory of social constructivism.
2.2 Delivery modes

As Ayoade (2012) pointed out, constructivism is a theory of learning, not teaching. This section approaches the issue of different delivery methods or modes and the degree to which constructivist theory can be incorporated into classroom practice. Consistent with the research questions presented in Chapter One, the delivery modes discussed here include face-to-face, mixed or blended and fully online.

2.2.1 Face-to-face delivery

Face-to-face delivery is the traditional in-person lecture and can be either teacher-centred or student-centred. For the purposes of this research, face-to-face delivery does not include any online component. Instructional methods and strategies used in science classrooms vary from those that are primarily didactic or teacher-centred e.g., demonstrations, to those that are mainly student-centred e.g., group discussions (Treagust, 2007). Face-to-face delivery includes practical/ laboratory-based classes. For example, the instructor guides forensic anthropology students on techniques of how to study skeletons in the laboratory to estimate age, sex, stature and ethnicity (Naples, Breed & Miller, 2010).

Strategies used in teacher-centred delivery were largely based on behaviourist theory using stimuli, response and reward (Doolittle & Camp, 1999). A course that is comprised entirely of teacher-centred delivery is not in keeping with the theory of constructivism which is based on the idea that what a person knows is not passively received but actively constructed by the learner. The advantage of face-to-face, teacher-centred instruction is that the teacher is available in real time to answer questions and provide feedback and, as Bailey and Garratt (2002) pointed out, immediate feedback motivates learning. The lack of any online component to face-to-face delivery means the students are dependent on hard copy handouts from the teacher and/or their own notes from the lesson. Students may be asked a question in class without having had time to deliberate and come up with the best answer. Furthermore, the lack of technology does not reflect the modern workplace. As previously discussed, there are times when it may be necessary for students to passively receive and rote learn essential building blocks of information necessary to understand important concepts. On the flip side, it can also be a disadvantage for students to limit their learning to the memorisation of facts as this can be a hindrance.
to deeper learning (Ayoade, 2012) and problem solving (Dolittle & Camp, 1999).

Murphy (2008) cited other disadvantages of face-to-face delivery in that students have no control over the content or pace of learning. This has repercussions for levels of student motivation. According to McCrae cited in Powell (2003, p. 234), students don’t like large lectures and the standard ‘lecture then test’ format is failing.

The other type of traditional face-to-face delivery is the student-centred approach. In this approach, the teacher takes on the role of facilitator. Examples of these types of classroom activities would include group discussions, problem-based activities and work simulations. All these collaborative activities are based on social constructivist principles. As in any type of face-to-face delivery, the teacher is on hand to answer questions and provide immediate feedback. An added advantage to the student-centred approach is that when students work in groups, side-talk is encouraged and this communication between students increases understanding (Geelan, 2006). Whilst a student-centred approach encourages students to think about how to solve a problem, Otting et al. (2010) pointed out that students in the early stages of their degree may not have sufficient background knowledge to solve complex tasks.

An approach pioneered by the Biological Sciences in Curriculum study in the USA and currently being used in Primary Connections (Australian Academy of Sciences) is based on constructivist learning. The five phases of the Biological Sciences 5E Instructional model comprise of engage, explore, explain, elaborate and evaluate. The first two phases, engage and explore, involve lessons which motivate students and provide opportunities for hands-on activities to explore concepts or skills. In the third phase, explain, the teacher provides concepts and terms to explain the student’s findings. It is important to note that the explanation takes place after the students have had a chance to experiment and discover for themselves. In the fourth phase lessons should be provided where the students can apply what they have learnt. The fifth and final phase is where students can reflect on what they have learnt.

The National Institute of Forensic Science (Brightman, 2005) study purported that face-to-face delivery was the preferred option for forensic practitioners, followed by mixed delivery, distance paper-based and distance online delivery. It was interesting to note that part-time study was found to be preferable to full-time study, but this study was
undertaken with 2080 forensic practitioners, many of whom would have been in full-time employment.

Castle and McGuire (2010) conducted an analysis of online, blended and face-to-face delivery from the student perspective across various disciplines at both undergraduate and graduate level. This involved 4038 course assessment summaries over one year. The number of students averaged 25 – 30 per course. A questionnaire consisting of 30 questions using a five point Likert scale was used. Four categories were included in the questionnaire; assessment of learning, assessment of teaching, assessment of course content and assessment of web-based technology. It was found that generally both undergraduate and graduate students scored onsite forms of delivery the highest. One limitation of this study was the impact of the instructor on student self-assessment.

2.22 Blended or mixed delivery

In 2001, Franklin and Peat reported a small shift away from courses comprising all face-to-face student-teacher activities to courses with a mix of face-to-face and online activities. Blended delivery is now widely used in education (Alammary, Sheard & Carbon, 2014). Annig (2015) reported that the online education industry has a projected annual growth rate of 11.6% from 2014-2019.

As discussed in Chapter One, there are different forms of blended learning and Fee (2009) refers to four variants; the sandwich, the milestone, knowledge and skills and complementary resources. Blended classes have been used in forensic science for a number of years. Daeid (2001) used the World Wide Web for teaching document examination and intranet technology for online problem solving. These technologies were used to enhance the students’ learning experience and to support the different learning preferences. Daeid emphasised that learning should be interactive, learner-centred and support deeper rather than superficial learning. More recently, Lothridge (2012) used blended mode to deliver crime scene investigation training. This will be discussed further in the subsection 2.222.

2.221 Students’ perspectives of blended delivery

The type of delivery mode can be viewed from both the students’ and teachers’ perspective. From the students’ perspective, the advantages of blended or mixed delivery include flexibility, convenience (Clark, 2011; Waha & Davis, 2014), suitability
for a range of learning preferences (Johnson et al., 2015), and increased student engagement (Reaburn, Muldoon & Bookallil, 2009). Blended delivery also is perceived as less intimidating for students (Lloyd-Smith, 2010) and has been shown to improve assessment outcomes (Means et. al., 2010). Blended classes also have the potential to help students who may otherwise give up due to commitments outside their study. Adult learners often have family and work responsibilities and require flexible learning times and the convenience of study outside the classroom (Clark, 2011). Students perceive that the opportunity to access learning resources online helps them fully understand the material (Walters, 2008). However, Waha and Davis (2014) reported that students expect quality from all forms of learning delivery, including online Power Point presentations and lecture recordings.

Emerging digital tools used in blended learning support active learning by increasing interactivity (Huang & Arbaught, 2009; Johnson et. al., 2014) and providing opportunities for the simulation of authentic work-related activities (Ferguson, 2015). For example online discussions make it easier for students to clarify questions related to topics discussed in class and it is now possible for teachers to provide feedback in real time though virtual classes. Whereas traditionally face-to-face classes met once a week, students can now check their understanding of the course content with teachers and students online.

The online component of blended delivery is perceived by some students as being less intimidating as students have time to prepare their answers or comments in a discussion forum (Lloyd-Smith, 2010). Dziuban, Moskal and Hartman, (2004) reported that students rated the quality of their blended learning as equal to or higher than their face-to-face classes.

Reaburn, Muldoon and Bookallil (2009) utilised blended learning to facilitate work-based learning and mediate student active engagement by applying the principles of constructive alignment as described by Biggs (2003). The study revealed highly significant increases in student engagement (p=0.002) as measured by the average ‘hits per student’ on learning resources and a highly significant increase (p=0.001) in student engagement within a discussion forum on the online learning environment.
As with any delivery mode, the blended mode has disadvantages. These challenges include technology issues (Waldman & Smith, 2013), learner preferences (Clark, 2011) and time management skills (Napier, Dekhane & Smith, 2011). Technology issues can be frustrating for teachers and students alike. Waldman and Smith (2013) found that 25% (N = 3954) of students enrolled in either the Faculty of Business, Faculty of Applied Science and Technology or Faculty of Health and Community Studies, experienced technical problems with the software that was required for their course.

The very nature of any online work requires the students to participate. Some students may find this active learning e.g., interactive activities on the computer, a frustrating experience preferring the passive lecture-style delivery (Clark, 2011). Napier, Dekhane and Smith (2011) reported that students can feel overwhelmed with an increased workload and blended learning may require students to have advanced time management skills.

A recent Australian study was conducted on students’ perspectives of a blended master’s course in library and information science (Waha & Davis, 2014). This involved an online survey that was used to collect both quantitative and qualitative data. Whilst the sample number was small (N=23), the findings provide some interesting data on student motivation in blended learning. Waha and Davis (2014) found that students reported both positive and negative feedback with regard to blended delivery. Students enjoyed both the flexibility and convenience of the online component as well as the opportunities that the face-to-face component provided for building learning networks with teachers and peers. When students were asked their preferences of delivery mode, approximately half reported they preferred fully online mode, one third preferred face-to-face mode and seventeen percent indicated a preference for blended mode (N=23). Of those students who preferred online mode, two thirds preferred asynchronous online learning due to its flexibility.

Waha and Davis (2014) also investigated the students’ experiences with various learning tools e.g. videos, screencasts, audio and video recordings of lectures and PowerPoint presentations, virtual classrooms. It was found that short videos (91%; N=23) and screencasts (87%; N=23) were the most enjoyable tools because “they were quick and easy to engage with and could be accessed in a variety of ways” (Waha & Davis, 2014 p. 176). Students did not rate audio (48%), video recordings (57%) and
PowerPoint presentations (65%) and virtual classrooms (52%) as highly (N=23). For the recorded lectures and virtual classroom (Elluminate) there was some criticism of the poor quality recording as well as technical problems. Personal interaction for sharing information with both teachers and peers was reported as being important with most students indicating face-to-face classes as the most effective mode for such interaction to occur.

Another study by Means et al. (2010, p. xv), discussed further in subsection 2.232, found that blended learning leads to higher scores on both formative and summative assessment than either face-to-face or online delivery.

2.222 Teachers’ perspectives of blended delivery

There is some contention regarding whether or not blended learning does lead to higher assessment scores or whether the higher scores are attributable to other factors. As McCue (2014) pointed out, problems occur with comparison studies involving blended delivery because it is not always possible to determine the cause. For example, any advantage of blended delivery over other types of delivery modes may be due to factors such as pedagogy, differences in content or even differences between academic disciplines (Means et al., 2010).

In times of shrinking budgets and cost cutting by educational Institutions, the lure of increased enrolments, less face-to-face time and more online delivery is compelling. However, this needs to be balanced with student performance and both student and staff satisfaction. A research project investigating staff perceptions of online learning in a blended mode showed that staff were generally positive about their experiences and that it provided opportunities for student reflection, peer editing and tutoring feedback opportunities between staff and students (Keppell et al., 2004).

Blended learning requires a significant amount of time to set up before the course commences (McCue, 2014). This may contribute to some teachers being reluctant to make changes to an existing course they perceive to be working well (Graham, 2013). Graham (2013) also found that teachers who were forced to teach blended mode or flipped classes and who received training were more likely to enjoy teaching these classes compared with those who didn’t receive training. Another challenge for
teachers of blended mode that was identified by Graham (2013) was the technical skills required when using new technologies.

Lothridge (2012) used blended learning to deliver crime scene investigation training; an intermediate course that includes an online theoretical component and a three day hands-on workshop. Face-to-face delivery included mock crime scenes, hands-on exercises, demonstrations, instructor critique and evaluation. According to Lothridge (2012) the benefits of blended learning include measurable outcomes, sustainability, adaptability, cost effectiveness and accessibility to a wide population of users. The disadvantages to blended learning, according to Lothridge (2012) are that no standards have been established and that it requires thorough evaluation.

2.223 Flipped classes

Although the idea is not new, technological innovation and economic reality in education have led to a resurgence of interest in flipped classrooms (Berret, 2012). In the flipped classroom, there is an inversion of the traditional teaching approach so that what is traditionally done in the classroom e.g. lectures and what is done for homework e.g. problem solving is reversed (Herreid & Schiller, 2013). This approach can be delivered via any delivery mode but with the increased use of technology, the flipped blended model has gained popularity. Unlike Fee’s (2009) knowledge and skills form of blended delivery, where the skills component forms the middle of two pieces of e-learning or online work, the flipped blended model is more integrated. For example, in the flipped blended model the students may be asked to read some new material or view a video online before coming to class and then apply that knowledge during the face-to-face time. Students can gather information outside of class using a variety of methods such as reading, watching online lectures on computers or mobile devices via screen capture software such as Jing or Camtasia, listening to podcasts (Berret, 2012; Johnson et al., 2015). However, while the students are in class they engage in active learning e.g., class discussions, problem solving, simulations, data analysis and other higher order cognitive skills (Marcy & Brint, 2012).

There is a large body of literature that points to the limitations of a traditional lecture-style approach. Sundberg (2002) found that even high academic achievers sometimes experience difficulties grasping some science concepts via teacher-led lectures.
However, according to Marcey and Brint (2012) the traditional lecture remains as the main pedagogical approach to Science Technology Engineering and Mathematics (STEM) education at post-secondary level. The introduction of active learning via flipped classrooms is a way of overcoming some of the limitations of the didactic lecture style approach (Marcey & Brint, 2012).

An example of a blended flipped approach was used by Warter-Perez and Dong (2012) for an introductory digital engineering course in a three year longitudinal mixed method study. This report clearly outlines the instructional strategies used including lectures, problem-based and enquiry-based strategies and the time allocated for each. Another strength of this study was that the assessment instruments included quantitative and qualitative data i.e., pre and post surveys, student satisfaction surveys, focus groups and classroom observation. The study describes challenges that were encountered and possible solutions. The author of this doctoral study regards these challenges and possible solutions as transferable to other blended classes. For example, in order to free up the teacher for feedback, a series of short how to videos could be produced so students find solutions to their problems. Group discussions could be added to the end of the class to deepen the students’ knowledge. Students were trained to become familiar with the software prior to commencement of project.

2.224 Students’ perspective of flipped classes

Recent studies of student perceptions of flipped classes indicate that the majority of students view flipped classes as a positive experience (Bates & Galloway, 2012; Bishop & Verleger, 2013; Butt, 2014). Bates and Galloway (2012) conducted a case study on first year physics students (N=199) and found that 80% preferred the flipped delivery model to the traditional classroom approach. A survey conducted by Bishop and Verleger (2013) found that students were generally positive towards flipped classes with a significant minority who were opposed. Butt (2014) found final year actuary students were evenly divided regarding a proposed flipped classroom approach at the beginning of the course (N=62) but at the end of the course the percent of respondents who viewed it as positive had risen to 75% (N=50). According to Fulton (2012), students who participate in flipped classrooms can work at their own pace and their teachers are better able to recognise students who are experiencing problems and report increased levels of interest from the students.
2.225 Teachers’ perspective of flipped classes

A study by Davies, Dean and Ball (2013), using a blended flipped model, confirmed the findings of Fulton (2012) regarding how teachers are better able to gauge the students’ understanding of the content. Students were provided with videos and other materials to learn at their own pace outside of class time, while during class, constructivist problem-based activities were included. Davies, Dean and Ball (2013) found the teachers were better able to assist with struggling students. Furthermore, current learning theory supports the use of active learning. The findings from their survey of 200 teachers for the National Centre for Case Study Teaching in Science Listserv, found that flipped classrooms allowed teachers to spend more time with students on authentic research and that it allowed students more time to use scientific equipment. Johnson et al. (2014) found that flipped classes helped students develop skills needed in the workforce e.g., critical thinking, digital and collaboration skills. This has important implications for forensic science students who need practical skills in addition to scientific knowledge. If students miss class, they don’t miss out on lectures and they are more actively involved when they attend class. Although the 200 case study teachers reported that on-the-whole students enjoy flipped classrooms, Herreid and Schiller (2013) claimed that students may be resistant to this approach and come unprepared to class. Mazur (2009) also claimed that while some students embrace this approach, others never do.

There are also challenges for some teachers who implement the flipped classroom model. The flipped approach needs teachers who are good at answering questions on the spot (Berret, 2012). There is an increase in the amount of time for the initial preparation, class notes must be comprehensive and class time must be thoroughly prepared when delivering a flipped model (Butt, 2014). In my experience, the initial preparation time for any blended or online model is greater than a traditional face-to-face approach. Furthermore, it is clear that teachers should provide comprehensive class notes and that thorough preparation is paramount regardless of the delivery mode.

Butt (2014) made an important point with respect to flipped classes, that is, the provision of notes cannot replace the opportunity for students to ask questions. At the beginning of each class, therefore, time was set aside for the students in Butt’s study.
to ask questions. Students were also provided with a feedback activity on Moodle where they could post questions (Butt, 2014).

The flipped class is a way of providing digital content and maximising learning efficiency through active learning and this is an appropriate approach for use in forensic science classes. Herreid and Schiller (2013) provided an example of how a content video could be used as homework prior to the class work in which a forensic case study involving DNA is used to solve the crime.

2.23 Online delivery

Online learning is a broad term used to refer to web-based learning, elearning, distributed learning, cyber learning, virtual learning or netbased learning (Urdan & Weggen, 2000). Online learning consists of two categories; communities of learning or collaborative learning (Collison et al., 2000) and the independent study model where the students work by themselves with no peer interaction (Anderson, 2004). A student-centred collaborative learning approach, with information resources available and an online facilitator to provide support and guidance, is consistent with the social constructivist theoretical framework informing this study.

Cost, service, quality and speed are all factors that have made online learning the most promising educational technology (Liaw, Huang & Chen, 2007) and this is reflected in a strong annual projected growth rate of 11.6% for five years from 2014-19 (Annig, 2015). The key drivers of online education in Australia include internet connection, average weekly hours worked, real household disposable income and the national unemployment rate (Annig, 2015). According to Annig (2015), the expected increase in all these drivers equates to faster, more reliable internet access, an improvement in the student’s ability to pay for online courses and more time available for students to complete education and training. Furthermore, there has been an increase in government support for online education with government grants being offered to universities to support the development of online courses (Annig, 2015).

Online delivery covers both asynchronous (different times) and synchronous (same time) forms of interaction. Examples of asynchronous methods include email, assessment tools and web-based course materials. Synchronous forms of interaction could include tools such as chat, virtual classrooms, conference tools and virtual
worlds. Both these forms of online delivery have opportunities for interaction and feedback (Huang & Arbaugh, 2009). Johnson et al. (2014, p. 10) asserted that online learning increases the potential for collaboration as these tools or outlets provide opportunities for both the students to ‘meet and exchange’ ideas and the teachers to provide feedback in ‘real time’.

Online tests and quizzes make it easy for the students to gain immediate feedback. The problem is that multi-choice or true-false questions can encourage shallow thinking or the memorization of facts. Nonac (2013) of University of California, Los Angeles (UCLA) asserted that the best assessments encourage collaborative and critical thinking and that students should be allowed to use any resources to find the best solution to a problem. Nonac’s (2013) perspective on assessment is particularly relevant to forensic science because solutions to problems often require a team approach both within and between disciplines.

As with any mode of delivery, different pedagogical approaches can be taken with online learning including teacher-directed and student-centred approaches. Facilitation is a pedagogical term that applies to student-centred approaches to teaching as opposed to teacher-driven (Kempe, 2001). Online facilitation is the managing of ‘the communication of others online’ (Coghlan, 2001, p. 1). Online facilitation can also be described as the act of managing the learners and the learning through an online medium (La Trobe University, 2013). A student-centred approach with information resources available, opportunities for collaborative learning and an online facilitator to provide support and guidance is in keeping with social constructivism.

2.231 Teachers’ perspectives of online learning

Several authors support a student-centred learning approach in a constructive environment via online learning (Crampton, 2008; Ellsworth, 2005; Khoo & Preece, 1999; McLoughlin & Visser, 2003; Milne, 2005). Ellsworth (2005), a teacher and former crime scene worker, taught the same course to a face-to-face class and an online class. Her preliminary observations were that the online students were more active learners than the face-to-face students because the online students had to seek out and review course material. These students also did more of the required work
and discussed death cases on the discussion boards. Ellsworth’s (2005) study has serious limitations. Although Ellsworth (2005) taught both face-to-face classes and online classes the same course with the same content and textbooks, the assessment differed between each mode of delivery. Other limitations to Ellsworth’s (2005) study included small sample sizes ($n=6$ and $n=14$ in Spring and Fall, 2004 respectively; $n=11$, $n=14$ and $n=6$ in Spring, Summer, Fall, 2004 respectively). However, Ellsworth acknowledges that the findings are only preliminary observations and need to be augmented with student questionnaires and in-depth interviews to find out what the students learn and how the students perceive their critical thinking skills.

Crampton and Ragusa (2008) conducted a case study on user-experiences of piloting Computer-mediated communication (CMC) technologies that enabled the creation of a virtual crime scene. An introductory forensic science unit was chosen to pilot Interact, a version of Sakai, over one semester. Thirty six student participants were involved, comprising of distance students ($n=25$), enrolled in a Bachelor of Science or policing and internal students ($n=11$) enrolled in biotechnology or science major. The internal students received face-to-face lectures and these were provided as audio-narrated PowerPoint presentations to all students. Both groups received the same learning resources. A variety of virtual learning materials were trialled including asynchronous and synchronous chat rooms, podcasts, resource sharing and wikis. Students were given a virtual work experience to replicate a crime scene investigation. For the virtual learning environment there were 9 groups comprising of 4 or 5 students in each group. Each student was given one of four roles; one “First on Scene Officer”, two “Scene of Crime Officers”, a laboratory technician and a laboratory manager. The virtual learning space was informed by a social constructionist pedagogy. By combining the distance and internal cohorts, the students who lacked experience in forensic science could learn from forensic science professionals. From the perspective of the lecturer, the use of CMC technologies encouraged deep learning as they could facilitate based on the requirements of the student i.e., their preferred learning styles, the desired level of communication. The use of CMC technologies meant students were provided with feedback more consistently than would have been the case with written comments on traditional hard copy assessments. However, Crampton and Ragusa (2008) emphasised the need for teachers to be supported during the introduction of new technologies.
2.232 Students’ perspectives of online learning

According to Borstoff and Lowe (2007), there is a perception amongst students that online learning can enable higher education students to obtain their education in parallel with pursuing their personal goals and maintaining the careers, without a need to attend classes and be subjected to a rigid schedule. As evidence of these findings, Kartha (2006) reported that the number of online courses has dramatically increased due to the benefits for both universities and learners. According to Pituch and Lee (2006), having a distance learning system within the education system will not automatically lead to its use. Moreover, Dobson (2007) noted that students enrolled in the physical and natural sciences, including forensic science, were less inclined to study via distance education, probably because science degrees usually involve laboratory work.

Muilenburg and Berge (2005) investigated student perceptions regarding barriers to online learning including administrative issues, social interaction, academic skills, technical skills, student motivations, time and support, cost and access to the internet and technical problems. It is important to emphasise that the data for this study related to student perceptions. The respondents ranged from highly experienced users (14%) to those who had never experienced online learning (33%; N= 1046). Social interaction was found to be the predominant barrier for online learning perceived by the students.

There have been a number of comparative studies involving online learning (Kartha, 2006; Legutko, 2007; Means et. al., 2010; Meyer, 2002; Russell, 2001). Russell (2001) and Kartha (2006) investigated the effectiveness of online learning compared to traditional and found no statistically significant differences between the two approaches in terms of students’ achievement. Legutko (2007) compared student outcomes and attitudes in direct instruction and online delivery methods in a graduate educational research course. The analysis of student outcomes showed one significant difference in one out of six assessments and no significant differences in 11 out of 13 questionnaire responses for items measuring students’ attitudes.

A meta-analysis was undertaken into online learning by the US Department of Education in 2009. This study reviewed over a thousand empirical studies of online learning and showed that on average, students who studied via online learning
performed moderately better than those who experienced face-to-face mode. However, Means et al. (2010) urged caution in the interpretation of the assumption that online learning is superior to face-to-face mode. Rather than assume that it was the media *per se* responsible for the positive effects, Means et al. (2010) pointed to a combination of factors including additional learning time and materials and opportunities for collaboration.

Means et al. (2010) also explored the effectiveness of different online practices e.g., the inclusion of media, quizzes, simulations and individualised instruction. These researchers concluded that the major studies at that time found that the inclusion of media such as interactive videos, images, graphics and audio did not affect learning outcomes significantly. Also, the incorporation of videos and multi-choice online quizzes were not found to influence the quantity of information that students learnt. Rather, Means et al. (2010) recommended the use of individualised instruction and activities that encourage learner reflection. Instead of providing the students with correct answers immediately, it is recommended that students are given *prompts*. The inclusion of simulations was found to result in a positive effect in two out of the three studies explored by Means et al. (2010). Castaned’s study cited in Means et al., (2010) found that the order in which simulation was provided to be an important factor. Students learnt more when a simulation was provided after instruction rather than beforehand.

A recent development in online delivery is that of massive open online courses (MOOCs) that are specifically considered in the next section.

2.233 MOOCS

Massive open online courses (MOOCs) differ to traditional university courses in three main ways; open access, massive attendance and fully online education (Bond, 2013). Anyone can access a MOOC without incurring fees and there are no prerequisites required. These courses are designed to support an indefinite number of students (Yuan & Powell, 2013). No physical interaction is required between the teacher and student (Bond, 2013); therefore, MOOCs are a form of distance education. While MOOCs are outside the scope of this thesis because they are open access with no entry
requirements, the literature in this area is relevant and the findings of this study may also have implications for MOOCs.

Three branches of MOOCs have evolved since their inception; connectivist MOOCs, content-based MOOCs and vocational MOOCs (Yuan & Powell, 2013). The first branch appeared in 2008 is referred to as connectivist MOOCs or (cMOOCs), the second branch is referred to as content-based MOOCs or (xMOOCs) and the most recent branch being the vocational MOOCs (vMOOCs). The cMOOCs are based on the connectivist theory of learning while the xMOOCs are based on the behaviourist model (Yuan & Powell, 2013). The vocational MOOCs blend both online and offline activities that are associated with career training (Daeid, 2014).

In cMOOCs, students may work at their own pace, the curriculum is open and no endpoint is provided before the course begins (Clow, 2013), assessment processes are open (if they exist) and there is no formal accreditation (Rodriguez, 2012). Bates (2013), points to the difficulty encountered when attempting to apply a constructivist approach to a course that is delivered to thousands of students. The cMOOC encourages students to participate in active learning by contributing content and learning together (Bates, 2013). According to Liyangunawardena, Adams and Williams (2013), connectivity is often provided via social networking. For example, students may use blog posts to discuss different aspects of the course. The learner-centred approach used in cMOOCs can lead to online communities that are able to ‘crowd source’ solutions to problems (Yuan & Powell, 2013).

Conjecture surrounds the interpretation of high attrition rates in MOOCs. In particular, cMOOCs, have been criticised for the high withdraw/ drop-out rates (Koutropoulos et al., 2012; Clow, 2013). However, DeBoer et al. (2014), urged caution when interpreting retention rates and the high attrition rates in MOOCs. Universities should only measure those students who originally intended to complete the course (DeBoer et al., 2014). DeBoer et al. (2014) reported that there should be a distinction between enrolment statistics or the number of students who register in a MOOC and the students commitment to finish the course e.g., certification.

Perhaps another way to view the high attrition rates associated with MOOCs is to view them as a shake-up or filtering system. Ross et al. (2014, p. 64) referred to ‘reverse
selection’ in MOOCs and suggests that because barriers to entry are so low, we should be looking at measures other than course completion e.g., quality of posts.

The Chair in Educational Technology at the Open University, Mike Sharples (2014) made some interesting comments regarding the quality of teaching and student drop-out rates in MOOCs:

When your classroom is a global one, filled with well-informed online learners, they don’t cut you much slack. Hundreds of people pore over every element of your course, making well-informed and sometimes acerbic comments … On a University campus, students stick around even though the teaching may be dreadful, because they need the degree qualification. In MOOCs they leave as soon as they lose interest.

Milligan, Margaryan and Littlejohn (2013) identified motivation as an important factor for student engagement in MOOCs. Any number of motivators could impact on attrition rates e.g., self-satisfaction or achieving an academic course at a reduced cost (Milligan, Margaryan & Littlejohn, 2013). Bond (2013) suggested the addition of credit points for students completing a MOOC as a motivator and discusses the associated problem of authentication. Bond (2013) investigated various biometric methods that could be used for authentication purposes including fingerprints, facial recognition and typing rhythm. It was concluded that these methods could not alleviate frauding during the enrolment phase, but Bond (2013) emphasised that frauding can also occur in traditional classes.

At this stage, there has not been extensive published research on xMOOCs (Clow, 2013). There has been some criticism of xMOOCs in that this model remains in the traditional teacher-centred approach but with the added benefit of technology (Bates, 2013; Larry, 2012). McCue (2014) provided an example of how some educators create instructional material for MOOCs by videotaping complete lectures. There are now new technologies available that could be used to divide the lectures into smaller segments and/or add visual and audio material that would enhance the educational experience. However, many teachers are not adept at using these new technologies for learning and teaching (Johnson, Adams & Cummins, 2012).
It is unlikely that a cMOOC, that has an open-ended curriculum and no assessment, would be a suitable replacement for a Bachelor of Forensic Science. As an applied science, forensic science requires a practical component. For this reason, the vMOOC, that incorporates both online and offline activities, is probably the most suitable form of MOOC for tertiary forensic science. Hollands and Terthaldi (2014) predicted that considerable experimentation and adaptation will take place with MOOCs and this may well be the same situation for forensic science education. Being a relatively new approach to teaching, continuous improvement will be necessary to attract and keep students.

2.234 Quality of education

Due to the nature of cMOOCs i.e. the lack of both course structure and a central role for the teacher in monitoring student learning, the quality of such courses is a concern (Yuan & Powell, 2013). Participants need a certain level of digital literacy and therefore, there are issues of equality of access (Yuan & Powell, 2013). Rodriguez (2012) pointed out that users are predominantly professionals e.g., teachers, trainers, researchers, managers and university professors. Daniel (2012) suggested that MOOCs could be evaluated by learners and educators to provide league tables that rank the courses. This could lead to the disappearance of courses that achieve poor rankings.

With respect to the academic rigour of MOOCs, a teacher survey was conducted by Kolwich and Newman (2013). Of the 103 faculty teachers, only 48% reported that their MOOC was academically rigorous with only 28% in favour of allocating institutional credit for MOOC completion.

A study was conducted by Bali (2014) where he enrolled in four different MOOCs and critiqued each of them according to both Bloom’s taxonomy and Chickering and Gamson’s (1987) *Seven principles of good practices in undergraduate education*. It is not suggested that one researcher’s journey or reflections into the world of MOOCs, with no triangulation undertaken, should form the sole basis of evaluating the quality of MOOCs. However, there is some value in discussing this evaluation approach and that it warrants further investigation.

For Chickering and Gamson’s (1987) first principle regarding student/faculty contact, Bali (2014) suggested teachers provide *office hours* to enable students to pose
questions. The benefit of providing office hours is that it informs the student of when the teacher is available thus reducing any frustration and anxiety and provides the teacher with some flexibility as to when they answer questions i.e. at the time or on a different day.

In order to address Chickering and Gamson’s (1987) second principle i.e. encourage student co-operation among students, Bali (2014, p. 48) suggested teachers encourage students to discuss specific ideas when using discussion forums and provide netiquette guidelines to create a safe space for students to learn.

The third principle was to encourage active learning. Bali (2014) suggested students create an assignment, apply their knowledge, review their work with peers and then evaluate it according to a rubric assessment. Bali (2014) made the point that there needs to be a balance between the use of higher order thinking and course completion.

Prompt feedback, the fourth principle according to Chickering and Gamson (1987), can be provided through online quizzes and feedback for assignments could be provided by peers (Bali, 2014).

The fifth principle, time spent on task (Chickering & Gamson, 1987), is difficult as adults have commitments outside work. Bali (2014) reported that one of the MOOCs he experienced required scholarly research and provided good-quality open access journals and some access to relevant e-books: “on a free-to-browse, pay-to-download basis” (Bali, 2014, p. 49).

Chickering and Gamson’s (1987) sixth principle was to communicate high expectations to the learner. Bali (2014) recommended keeping assessment deadlines flexible but to avoid lowering expectations by providing overly simple assessments requiring rote learning. According to Bali (2014) MOOC’s should include scholarly research with high quality readings and resources.

In order to address the last principle of good practice i.e. respect for the diverse talents and ways of learning (Chickering & Gamson, 1987), Bali (2014) reported that MOOC teachers need to take into account the intercultural audience. For some students, English may not be the first language. Bali (2014) suggested various strategies to
address this issue including providing mini lectures, optional discussion forums, flexible deadlines or allowing enough time for technical challenges such as a cut in electricity.

While Bali’s (2014) study outlined his own experiences of MOOCs and is thus subjective, his evaluation was based on exemplary studies, Bloom’s taxonomy and Chickering and Gamsen (1987). There is a lack of literature on the evaluation of MOOCs and Bali’s (2014) approach is a good starting point for teachers to design a MOOC. Subsequent student feedback will determine if this is the right approach.

2.235 Implications of MOOCs for Higher Education in Forensic Science

The potential for large student enrolments through MOOCs could be viewed as either an attraction or a threat. Whether or not higher education institutions can replace existing courses with MOOCs is debatable. At the very least MOOCs could augment students’ access to education and provide opportunities for international delivery (Yuan & Powell, 2013). This potential for international delivery means MOOCs may influence a student’s decision to apply to a particular university. Hannis and Welsh (2009) found the most common factor that students consider when choosing a university is its location. The replacement of existing degree courses with MOOCs could dramatically change a student’s decision with regard to which university they choose. Higher Education institutions offering a range of delivery modes, including MOOCs, would surely provide a marketing edge. Some universities in the US are offering ‘sampler’ courses or mini MOOCs that comprise of one week in a bachelor degree level course. In the US, the American Council of Education has accredited several Coursera courses. In this way, students who have completed the subject can gain credit transfer to other educational institutions (Annig, 2015). Although these are not forensic science ‘sampler’ courses, these processes could be applied to forensic science education.

Over the past five years, some Australian universities have formed partnerships with MOOC providers e.g., University of Western Australia supply course materials to Coursera, a US-based MOOC provider (Annig, 2015).

Several MOOC courses in forensic science are now being delivered e.g., University of Strathclyde, Scotland (Future Learn) is offering a six week course Introduction in Forensic Science, Open University (Future learn) is offering an eight week course
Forensic Psychology; Witness Investigation, the University of Leicester (Future Learn) is offering a six week course Forensic Science and Criminal Justice, Stevenson University has on offer a ten week course Survey of Forensics that includes forensic science, cyber forensics and forensic studies and the provider Open2Study is offering a course Microbiology and Forensic Science that is four weeks in duration.

According to the Australian and New Zealand Policing and Advisory Agency (Ross, 2015), there are now a number of MOOCs that offer introductory, intermediate and advanced courses in forensic science. Such courses provide training opportunities for police in remote regions, networking and professional development opportunities. There are opportunities for the delivery of specialist forensic science MOOCs e.g., DNA, biometrics. A MOOC in biometrics was launched at the Canberra Institute of Technology in September, 2015 https://www.canvas.net/browse/canberrait/courses/biometric-technologies.

In addition to the MOOC in biometrics, the Canberra Institute of Technology offers a range of forensic science courses at different academic levels including the Certificate1V in Biometrics, Advanced Diploma in Public Safety and Bachelor of Forensic Science (Crime Scene Examination). Although each of the units in these courses contains a large practical component, much of the theoretical component can be delivered online. The University of Canberra is currently delivering a fully online unit as part of the Master of Forensic Science.

The challenges for MOOCs in forensic science include not only those encountered in other disciplines such as quality, assessment and feedback but the lack of hands-on practical work. In addition, MOOCs appear to be more popular amongst mature-age students and rely on the student’s ability to self-learn (Annig, 2015). However, if the main goal of a MOOC course in forensic science is to market a degree course, then the lack of practical work will not pose a problem.

2.236 Role of the online teacher

In order to deliver online courses and provide the necessary support for students, the teachers need not only subject expertise but a set of skills that include information technology expertise, knowledge of educational online learning resources and communication technologies. The online teacher has four main types of roles;
pedagogical, social, managerial and technical (Keengwee & Kidd, 2010). The pedagogical or intellectual role involves educational facilitation and the social role refers to the creation of a friendly social environment in which students feel comfortable to learn. The managerial role requires organisational skills such as setting objectives and scheduling learning activities while the technical role involves the teacher becoming competent with the technology being used (Keengwee & Kidd, 2010; Wilson & Stacey, 2004).

The role of traditional faculty members is changing (Keengwee & Kidd, 2010). According to Oh and Kim (2007) faculty members are now required to take on the role of instructional designer and technologist. In the past, these roles were shared amongst a team of instructional designers and faculty members.

Good online learning is a combination of technology that works, meaningful content and effective learning design (Fee, 2009). In order for online learning to be successful, Campbell and Swift (2005) asserted that both instructors and students have to change their attitudes, beliefs, behaviours, perspectives and habits in order to successfully adopt this technology. There may be a number of factors that hinder the acceptance and adoption of online learning by teachers. These factors can include computer anxiety (Venkatesh, 2000), feelings of inadequacy by the teacher (Brower, 2003), perceived difficulty of the online learning approach (Porter & Donthu, 2006; Rossiter, 2007), a preference for the familiar face-to-face approach (Singleton et al., 2004), the level of managerial support (Liang et al., 2007; Venkatesh & Bala, 2008), existing computer knowledge (Al-alak & Ibrahim, 2011) and a lack of internet access at home (Zhao & Frank, 2003). Today, access to the internet is less of a problem in developed countries, but will continue to be a barrier in developing countries and perhaps some rural and remote communities. More recently, Johnson, Adams and Cummins (2012) found many academics have not undertaken training in the new digital teaching methods.

The potential for large numbers of students enrolled in MOOC courses must have implications for the teacher. However, much of the research on MOOCs has been investigated from the learner perspective and to a lesser extent institutional threats and opportunities (Liyanagunawardena, Adams & Williams, 2013). A recent study that
investigated teacher roles and experiences of MOOCs was conducted by Ross et al. (2014).

According to Ross et al. (2014, p. 58), the MOOC teacher can take on one of three different forms; the distant ‘rock star’, the facilitator /co-participant or an automated process. The role of the teacher in both xMOOCs and cMOOCs was examined. In xMOOCs, the teacher is characterised as an expert in the field who transmits information, often through recordings but is unavailable for feedback. Feedback is achieved by way of an automated responses e.g., automatically marked quizzes. In contrast, the teacher’s role in cMOOCs is that of a supporting role for a peer learning network. Ross et. al. (2014, p. 63) provided a descriptive summary of some of the teacher experiences in a five week cMOOC, involving 51,000 participants, with an emphasis on learner-led activities. No tests or learning outcomes were included in the course.

From fear to exhilaration (often at the same time). The newness of the experience means that existing educational repertoires can feel inadequate, and that we, along with our participants, are ‘learning how to be’ in the MOOC. The scale of the MOOC led us all, at various times, to feel overwhelmed by the number of people, conversations, ideas and resources circulating - a feeling that was amplified by the leaky boundaries of MOOC and the number of locations where things were taking place.

The main issue for teachers of a MOOC, according to Ross et al. (2014) was how to deal with the ‘massiveness’, how to help students and how to evaluate its success.

2.237 Pedagogy facilitation models for learning online

Four different facilitation models for online learning include ADDIE (Bransen et al., 1975), transactional distance theory (Moore, 1973), Salmon’s five step model (Salmon & Giles, 1997; Salmon, 2000; Salmon, 2003) and the dialogic model (Wegerif, 2007). The transactional distance theory and ADDIE were proposed before computers came into common use (Shelton & Saltsman, 2006). Wegerif’s model (2007) identifies key strategies for problem solving that identify encourage reflective dialogue. However, this model can only work when the students have the access, confidence and motivation to participate. In Salmon’s model, each stage of the five stages requires
that the learner to master certain skills while the moderator progressively withdraws and takes on the role of facilitator. It is the moderator’s responsibility to manage and support all learners in the group regardless of where each student sits in the learning process. Initially, the students require support from the facilitator and as their ability to network and construct knowledge improves, the tutor can start to withdraw. There is an inverse relationship between student and tutor participation with a staged withdrawal from the facilitator as the student progresses to becoming an independent learner. Limitations to Salmon’s model can include access, students progressing at different rates, ineffective collaboration between students and poor program design (Moule, 2007). Although Salmon’s model has limitations, it does address the challenges faced by newcomers (students and teachers) to online learning. The emphasis in this thesis is on Salmon’s five step model because it is in keeping with social constructivism, it supports students throughout the learning process and it provides sufficient detail so a teacher is able to use it with all students in their class regardless of where they sit in the learning continuum.

2.3 Summary

Australian higher education comprises of two major sectors: Universities and the VET sector. Currently forensic science education is offered in both these sectors. Different adult learning approaches including lecture-based, problem-based and practice-based learning are used in both sectors. Traditionally, the learning theory behind lecture-based learning was behaviourism. Educational reform has led to a shift in learning theory from behaviourism to constructivism in science education. Constructivism emphasises that students construct their own knowledge from what the student already knows. Social constructivists view learning as a social process whereby learners construct meaning through communication with peers and teachers.

Forensic science programs can vary with respect to the science and forensic content and whether or not they are vocational in nature. Regardless of the proportion of science content in the educational program, forensic science is an applied science. Since there is a vast body of literature to support the use of social constructivism in science, it would follow that social constructivism is a suitable learning theory to
underpin pedagogical approaches in forensic science education. Examples of social constructivist-based pedagogy include case-based instruction and problem-based learning which would be suitable for forensic science education as these activities are aimed at developing skills such as cognitive thinking, problem solving and communication skills; qualities necessary for a good forensic scientist (Willis, 2010).

Social constructivism can underpin different delivery styles including face-to-face, blended or fully online classes. The flipped blended model is an approach where lecture content is provided outside the class while active learning takes place in the class (Berret, 2012; Herreid & Schiller, 2013). The introduction of active learning through the flipped model is one way of avoiding the teacher-centred didactic approach and providing students with opportunities for higher order cognitive thinking (Marcey & Brint, 2012). The flipped blended model could incorporate all three adult learning styles i.e., lecture-based, practice-based and problem-based and could be used in forensic science classes. A recent development in online learning has been Massive Open Online Courses (MOOCs). These are currently being offered in forensic science education, but they were outside the scope of the research presented in this thesis.

The question is whether one delivery style is more suited to a peer learning environment than another. This research investigated all three delivery methods including face-to-face, blended and online in the context of forensic science taught at the tertiary level in Australia. Chapter Three describes and justifies the methodology used in both Part A and Part B of this study.
CHAPTER 3: METHODOLOGY

This chapter outlines the research methodology and justifies its suitability for this study. Data collection and analysis procedures are outlined and finally the study’s rigour, limitations and ethical issues are considered.

The chapter is divided into two main sections; the methodology and the methods used. The definitions used for the methodology and method in this study are those used by MacKenzie and Knipe (2006 p. 5):

Methodology is the overall approach to research linked to the paradigm or theoretical framework while the method refers to systematic modes, procedures or tools used for collection and analysis of data.

3.1 Methodology

3.11 Research Questions

The broad aim of this study and the specific research questions were outlined in Chapter One, p. 4-5. In order to answer these questions, a pragmatic, mixed method approach was used (Figure 2). The following section justifies the use of the pragmatic approach, in which both qualitative and quantitative methods were used to investigate key stakeholder perspectives of different delivery methods in tertiary forensic science education.

3.12 Overview of research design

The research design for this study was the pragmatic approach in which both qualitative and quantitative methods were used (Brown & Hartrick Doanne, 2006; Doyle, Brady & Byrne, 2009; Hall, 2003; Morgan, 2007). The research design consisted of two major parts, Part A and Part B (Figure 2). Part A included broad data collected through a survey of students and teaching staff in various Australian universities.
Methodology

Part A – Survey
QUANTITATIVE / qualitative

Part B – Case Study
QUALITATIVE / quantitative

Sample Population

Australian Tertiary Educational Institutions
Australian Forensic Science Industry

Teachers
Students
Industry Personnel

Participants

Canberra Institute of Technology
Local Forensic Science Industry Personnel

Teachers
Students
Industry Personnel

Instruments

Part A – Survey
1. Interview
2. Questionnaire

Part B – Case Study
1. Interview
2. Documents
3. Classroom Observations
4. Reflective Journal

1. Interview
2. Documents
3. Classroom Observations
4. Reflective Journal

1. Interview
2. Documents

Figure 2. Study design shows a concurrent, equal status mixed method model.
together with forensic science industry personnel. This involved preliminary interviews with students and staff from the University of Western Australia (UWA) and the University of Canberra (UC) and local industry personnel to develop questionnaires.

Part B of the research was a local case study at the Canberra Institute of Technology (CIT) that was implemented in two phases and utilised a number of methods of data collection (Figure 3). The national survey (Part A) data and the case study data (Part B) were used to develop independent themes and to search for common themes (i.e. true triangulation).

### 3.13 Selection of research design

When choosing a research design there are three levels of decision making; the theoretical framework, the strategy of enquiry and the data collection methods (Creswell, 2013). The first consideration should be the type of knowledge claim including the theoretical perspective (Creswell, 2013). This is sometimes referred to as the research paradigm or theoretical framework (Mackenzie & Knipe, 2006). Next, the strategy of enquiry that informs the decision, that is, quantitative, qualitative or mixed methods, should be considered and finally the methods of data collection (Creswell, 2013). In this study, all these levels of decision making were considered, however, the order of selection of the categories was different to that recommended by Creswell (2013). The order and justification for the levels of decision making are summarised in Table 1. Firstly, the research questions were used to determine the most appropriate method of data collection (MacKenzie & Knipe, 2006) and then the underpinning theoretical framework and strategy of enquiry were considered. A description of each of these levels of decision making follows.
PHASE 1
Design and Pilot Interview questions

Conduct interviews
Observe classes

PHASE 2
Design and Develop Online forensic entomology course

Conduct teaching study
- Year 1
- Year 2
- Year 3

Draw conclusions

Development Stage

Collection and Analysis Stage

Conclusion Stage

Figure 3. Stages involved in conducting the case study (modified from Noor, 2008, p.13).
Table 1. Order of decision and justification of levels used to determine the research methodology for this study.

<table>
<thead>
<tr>
<th>Order of decision</th>
<th>Level of decision</th>
<th>Reason for selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Research questions</td>
<td>The main aim of the study was to compare key stakeholder perspectives of different delivery modes in tertiary forensic science education. The research questions were developed to investigate the experiences and perceptions of teachers, students and industry personnel regarding the different delivery modes.</td>
</tr>
<tr>
<td>2</td>
<td>Data collection methods</td>
<td><strong>Part A</strong> Surveys were chosen as the most appropriate method to gain a representative sample of forensic teachers, students and industry personnel across Australia. <strong>Part B</strong> Interviews were chosen as the most appropriate method of data collection to provide examples and in-depth descriptions of issues raised within the surveys. Other data collection methods, including a personal journal, document examination and classroom observations, were used to supplement the findings from the interviews and add to the reliability of the findings.</td>
</tr>
<tr>
<td>3</td>
<td>Theoretical framework</td>
<td>A pragmatic approach was chosen because the data collection methods in Part A and Part B used different approaches including both scientific method and social constructivism.</td>
</tr>
<tr>
<td>4</td>
<td>Strategy of enquiry</td>
<td>A mixed methods approach was chosen as the surveys used in Part A involved quantitative data and the interviews, personal journal, classroom observation used in Part B involved qualitative data.</td>
</tr>
<tr>
<td>4a</td>
<td>Timing</td>
<td>Quantitative and qualitative data were collected concurrently to allow sufficient time to collect the required data in a timely manner.</td>
</tr>
<tr>
<td>4b</td>
<td>Weighting</td>
<td>Quantitative and qualitative data were given equal weighting to provide a balanced picture with the numerical data providing the big picture and the qualitative data enabling the exploration of issues and discrepancies in more depth.</td>
</tr>
<tr>
<td>4c</td>
<td>Methods of data analysis</td>
<td>Quantitative and qualitative data were merged to provide descriptive examples of the themes that emerged from the numerical data.</td>
</tr>
</tbody>
</table>
3.131 Research paradigm or knowledge claim

A number of different research paradigms or knowledge claims exist and three of these are discussed in this section; scientific method, social constructivism and pragmatism. All three paradigms were considered as forming the potential theoretical framework for this study. When using the scientific method or postpositive paradigm, the researcher begins with a theory or hypothesis and then collects data to either support or refute the theory (Creswell, 2013). The assumption for this paradigm is that “the social world can be studied in the same way as the natural world” (Mertens, 2005, p. 8). Since the researcher proposes their own theory, it is important to scrutinise the methods and conclusions for evidence of bias (Creswell, 2013).

Another paradigm, social constructivism, was discussed in Chapter Two and was adopted as the main theory of knowledge that would inform this study of forensic science education. According to Creswell (2013), the goal of social constructivism is to focus on the participants’ views of the situation being studied. Creswell (2013) recommends broad open-ended questions so the participants can construct meaning from the situation. Interaction with others, such as discussions would be a suitable forum in which to observe the participants. The focus for social constructivism is to make sense of other people’s views and generate or inductively construct a theory rather than starting with a theory as in scientific method (Creswell, 2013). The methods used in social constructivism are usually either qualitative or a mixture of qualitative and quantitative (MacKenzie & Knipe, 2006).

The third paradigm considered for this study was the pragmatic approach. In this approach, the most important element is the problem rather than the method. The researcher can use a variety of approaches in order to understand the problem (Creswell, 2013) and there “is no philosophical loyalty to any alternative paradigm” (Mackenzie & Knipe, 2006, p. 4). In this approach the researcher can choose the ‘best method for the job’. Like mixed method research, pragmatic research is not tied to any particular philosophy and, therefore, several methods of data collection and analysis can be used. For the pragmatist, truth is “what works” (Howe, 1988 p. 10).

While social constructivism was selected as the paradigm to represent the theory of knowledge underpinning this study, the pragmatic approach was selected to underpin
the methodology of this study. I see merit in all three approaches discussed and as Bazeley (2002 p. 2) points out “one cannot prove paradigms”. As a scientist, I am familiar with the scientific method but education is a social science rather than a science. In this study, the research is dealing with people and there will always be variables that cannot be controlled. Utilising a social constructivist paradigm as the main theory to understand knowledge in this thesis is not inconsistent with the use of the pragmatic paradigm for methodology because both are consistent with a focus on participants’ perspectives on the phenomenon under study as is the main aim of this research. As an experienced teacher, pragmatism has served me well during my 25 years in the classroom. The choice of paradigm will influence the choice of enquiry strategy (Creswell, 2013).

3.132 Strategies of enquiry

The strategies of enquiry for research broadly include quantitative, qualitative and mixed method research. According to Kuper, Reeves and Levinson (2008) the difference between quantitative and qualitative research is more complicated than the presence or absence of numerical data. Bazeley (2002) elaborates that if one uses numbers, interpretation is still involved and, on the flip side, if the data is in the form of text numbers may be appropriate. Whereas quantitative research answers the “what?”, “how much?” and “why?” questions, qualitative research focuses on “why?” and “how?” (Kuper, Reeves & Levinson, 2008, p. 404).

A mixed research approach includes the use of induction (discovery of patterns), deduction (testing of theories and hypotheses) and abduction (uncovering and relying on the best set of explanations to understand one’s results) (Johnson & Onwuegbuzie, 2004, p. 17). According to Morgan (2007), the pragmatic approach to research is informed by the belief that the practicalities of research are such that it cannot be driven by theory exclusively and a process of abduction is recommended which enables the researcher to move back and forth between induction and deduction through a process of inquiry. In this study, the process of abduction was used whereby the learning theories previously discussed in Chapter Two informed the theoretical framework and were used to develop a set of explanations to interpret the results.
3.133 Debate regarding strategies of enquiry

There is ongoing debate about which type of educational research is the preferred method and several authors reject dichotomous thinking of quantitative versus qualitative (Eisenhart, 2005; Schwandt, 2001). According to Bryman (2001) qualitative research is a strategy that usually emphasises words rather than quantification. In comparison with large scale survey research, the qualitative researcher works with relatively small samples and is concerned with discovering new phenomena through in-depth analysis rather than statistical generalizability (Kelle, 1998).

Darlington and Scott (2002) point to three issues with regard to qualitative research. The first limitation is the degree of generalisability of findings across settings. In other words, the limitation of the study’s findings in terms of the context in which they were obtained. Another issue is a smaller sample size and that the sample is often not selected systematically to ensure that it is representative of the population. The third issue is that the researcher is immersed in the research so the researcher cannot be written out of the text as there is a high level of self-reflection about one’s part in the phenomenon under study (Darlington & Scott, 2002; Dunnion, 2012). Kuper, Reeves and Levinson (2008, p. 406) concur with Darlington and Scott (2002) and Dunnion (2012) and emphasise the need for researchers to “identify their own contexts”, known as “situating themselves” so they can understand how their beliefs can influence communication/interaction with the participants.

Quantitative methods are used when the goal is to test theories or hypotheses, gather descriptive information or examine relationships between variables (Creswell, 2013). Numerical data can be analysed statistically. The strengths of quantitative methods include the fact that comparisons and replication is allowable, replication and validity can be determined more objectively than qualitative techniques. Furthermore, in quantitative analysis there is independence of the observer and objective methods are used in the analysis (Amaratunga et al., 2002). The disadvantage of quantitative methodology is the inability to obtain deeper meanings and explanation (Amaratunga et al., 2002).
Another strategy of enquiry, known as mixed method, involves the intentional collection of both quantitative and qualitative. The mixed method was the strategy of enquiry adopted in this study (Table 1).

3.14 Reasons for selecting the mixed methods approach

The reasons for combining the quantitative and qualitative approaches in this research were to capitalize on the strengths of the two approaches and to compensate for the weaknesses of each approach (Johnson & Onwuegbuzie, 2004; Punch, 2005). The mixed methods approach illuminates problems from different perspectives and can contextualise a problem (Creswell et al., 2011). With a mixed methods approach, the researcher can begin with a macro study, in this case the quantitative national study used in Part A, and add further information about individual viewpoints through a qualitative study, such as the local case study used in Part B. According to Darlington and Scott (2002), using different methods in the one study carries with it the possibility of obtaining contradictory findings and such discrepancies may prompt the researcher to probe certain issues in more depth. The intention is that qualitative and quantitative methods will complement the other’s strengths and weaknesses.

Mixed methods research is used extensively within the nursing discipline (Creswell & Plano Clark, 2011) and in medicine (Kuper, Reeves & Levinson, 2008). Twinn (2003) suggests a growing acceptance of this design in providing an appropriate methodology to meet the health problems faced by the nursing discipline. Since the nursing discipline, medicine and forensic science are all applied sciences, mixed method research should be applicable to all of these professions and was therefore applied to this research on forensic science education. A further benefit of mixed methods research is that it results in a multi-layered approach to triangulation that adds to the trustworthiness of the findings. The research rigour of the mixed methods approach is discussed later in this chapter.

3.141 Mixed method designs

Different designs can be used in mixed methods research, two of which will be discussed; sequential and concurrent. The first design is called sequential, where one data set is used and then expanded upon with the results of another. For example, the researcher could use a qualitative method such as an interview to explore the
possibilities and then expand upon this with a quantitative method such as a survey with a large sample (Creswell, 2013). The other design is called concurrent, where two sets of data are collected concurrently and merged to analyse the problem (Creswell, 2013). In this study, both the quantitative and qualitative data were collected concurrently as it was the researcher’s intention to merge the data (Figure 2). Another reason the data were collected concurrently was the fact that Part B, the longitudinal classroom study at CIT, was conducted over three years and concurrent data collection provided the researcher with sufficient time to gain ethics approval and contact various educational institutions across Australia before distributing and collecting the surveys for Part A of the study.

3.142 Specific methods of data analysis: An overview

In the mixed methods approach, researchers deliberately combine qualitative and quantitative data rather than keeping them separate (Creswell et al., 2011). The researchers then need to decide how to integrate the data. Creswell and Plano Clark (2011) describe three approaches; merging data, connecting data and embedding data. Merging data occurs when qualitative data, either in the form of text or images is combined with quantitative information in the form of numerical data. Connecting data occurs when one data set informs the other. For example quantitative surveys can be used to design interview questions. Finally, embedding data is used when the data set of least priority is embedded into the other. In this study, the data were merged to provide descriptive examples of the numerical data. The weightings or proportions of qualitative and quantitative data were also a consideration.

3.143 Weightings of quantitative versus qualitative data

The prioritisation of either the quantitative or qualitative type of data in mixed method designs depends on the interests of the researcher, the audience for the findings and what the researcher seeks to emphasise (Creswell, 2013). In this study, I was seeking a balanced picture of forensic science education that included numerical data and also the opportunity to explore some areas in more depth. For these reasons both qualitative and quantitative data were given equal weighting. MacKenzie and Knipe (2006) disagree with Creswell’s assertion that such prioritisation should be based on the interests of the researcher. It is the research questions and paradigms that
determine the research data collection methods (Creswell, 2013; MacKenzie & Knipe, 2006). Researchers should not be defined as being either quantitative or qualitative researchers (MacKenzie & Knipe, 2006). A researcher should be able to source the required information and learn how to conduct the research using the method that best suits the research question/s. In this study, Creswell’s (2013) assertion that the intended audience needs to be taken into account when designing research, was considered important.

In this study, the intended audience was the forensic science community, comprising educators and industry personnel. Both groups would generally be familiar with scientific method and statistical analysis. This means the inclusion of quantitative analysis was appropriate to develop an overall picture to present to the audience about the relative advantages and disadvantages of delivery modes for forensic science education in Australia. The qualitative analysis was included to elucidate the micro aspects of the study related to the details of student learning and preferences with regard to delivery modes. Data from the qualitative and quantitative analyses were, therefore, considered with equal weighting and merged during the interpretation and analysis stages in order to make balanced conclusions. Included in the mixed methods approach of this research is a case study (Figure 3).

3.15 Case study

A case study is an event, an entity, an individual or unit of analysis (Noor, 2008 p. 1602) that incorporates a number of data gathering techniques (Merriam, 2001). Case study methods involve systematically gathering enough information about a particular place, social setting, event or group to permit the researcher to understand how the subject operates or functions. Case studies of organisations may be defined as the systematic gathering of enough information about a particular organisation to allow the investigator insight into the life of that organisation (Berg, 2004). This study specialised in investigating one department, namely, forensic science within the Canberra Institute of Technology (CIT).

As in all research methods, case studies have strengths and weaknesses. Case studies provide the researcher with the opportunity to gain an holistic view of an event or series of events in real contexts (Cohen, Manion & Morrison, 2007; Noor, 2008).
Further benefits of case studies include the ability to explore unexpected or unusual events (Hodkinson & Hodkinson, 2001) or discrepancies between different viewpoints (Soden, 2006). Since case studies are written in everyday language, the results are easily understood by a wide audience. Furthermore, professionals may identify with the examples and problems presented in a case study (Shen, 2009).

The disadvantages of case studies include the lack of scientific rigour due to their subjective nature (Noor, 2008; Soden, 2006) and the fact that cross-checking is not easily performed (Shen, 2009). Such subjectivity has the potential to lead to observer bias (Shen, 2009; Soden, 2006). According to Noor (2008), if replication between several case studies is found, one can have more confidence in the results. Data collection instruments used in case studies can include interviews, classroom observation, documents and personal journals. Documentary sources can be used to supplement and compensate for any limitations in other information sources (Noor, 2008).

This thesis presents a case study conducted at the Canberra Institute of Technology (CIT) over three years. I was employed at CIT during the three years in which the case study was being conducted. Endogenous research occurs when the researcher is researching the higher education institution in which they are employed (Trowler, 2011). Also known as insider research, it has some strengths, but also presents challenges that need to be addressed (Trowler, 2011). Being employed within the institution means the researcher is culturally literate (Trowler, 2011 p. 2) and familiar with everyday life and, therefore, any interaction is likely to be more natural (Green, 2014). Trowler (2011) claims that conclusions drawn from the data collected are made on the basis of insider knowledge and experience rather than theory. It is easier and cheaper to collect data if the researcher is employed at the institution from which the case study is being conducted. The challenge for endogenous researchers is the potential for conflict between their dual role of researcher and employee. For example, Trowler (2011) points to disparities of power, where the interviewer is more powerful than the interviewee or visa versa. This issue was addressed in this case study as the interviewees were provided with an information sheet that explained how the participants were free to withdraw at any time with no justification required.
Furthermore, the participants were provided with a summary of the transcript for their verification. Further ethical issues are discussed later in the chapter.

The case study design selected for this doctoral research was the single-case with an embedded (multiple-units of analysis) case design (Yin, 2009). The rationale behind the choice of case study design was the unique and revelatory case (Yin, 2009) at the forensic department within the Canberra Institute of Technology (CIT). CIT represents a unique case in tertiary forensic science education. Although CIT is a Technical and Further Education (TAFE) institution, it offers forensic programs across a range of academic hierarchy, including bachelor degree level. The findings had the potential to be revelatory as the researcher had the opportunity to investigate problems experienced by undergraduate forensic science students and forensic industry personnel who were studying in the Advanced Diploma of Forensic Science. Within the single-case case study, several sub-units of analysis were embedded to add further opportunities for analysis. For example, sub-units of analysis include the forensic science department, the classroom level, and individual cases of students and teachers. This is in keeping with Patton’s (2002) recommendation to collect data on the lowest level of unit of analysis possible.

This research involved a descriptive case study that included interviews, observation of classes, document analysis and a personal journal in an attempt to describe and report on the delivery of forensic science at CIT. The case study was chosen to provide depth to the findings of the national survey (Part A) and to provide further examples of student, teacher and industry personnel experiences of the different methods of delivery, that is, to add some life to the report. An outline of the stages involved in this case study is presented in Figure 3. According to Mackenzie and Knipe (2006) research projects don’t always follow a linear path, as was the case in this study.

This case study (Part B) involved two phases (Figure 3); Phase 1 included interviews with the three stakeholders, classroom observations, examination of documents such as meeting minutes and Phase 2 was a local teaching study conducted at CIT. The local teaching study involved first year undergraduate students studying a forensic entomology component of Biology as part of the Bachelor of Forensic Science. The outcomes were assessed using pre and post-tests, a skills test, summative assessment including theory and practical exams and an assignment, the number of online hits and
student subject evaluations. The sources of evidence from Phase 1 and Phase 2 were reviewed and analysed in parallel with one another and the findings converged to form conclusions. The convergence of information from multiple sources of data is a form of triangulation (Yin, 2009).

3.16 Methodology for Phase 2 of case study (Embedded teaching study)
A non-equivalent groups design (NEGD) was used for Phase 2 of the case study; the embedded teaching study (Trochim & Donnelly, 2008). According to Trochim and Donnelly (2008), the NEGD is commonly used in social research. The comparison group in the 2010 cohort was similar to the program group in the 2011 and 2012 study in all respects except for receiving the online program. It did, however, lack random assignment. The groups selected were as similar as possible in that they met the academic entry requirements to the course. The aim was to fairly compare the ‘treated’ groups (2011 and 2012 students) with the comparison one (2010 students) although one can never be sure the groups are comparable. Since the assignment was not random, the groups may have been different prior to the study. That is, NEGD is susceptible to internal validity threat of selection and any previous differences between the groups may affect the outcome of the study. Under the worst circumstances this can lead one to conclude that the program didn’t make a difference when in fact it did, or that it did make a difference when in fact it didn’t. Having discussed the research methodology or overall approach to the theoretical framework, the focus is now directed to the method employed in this study, including details on the participants, data collection methods and data analysis of both the Part A (national survey) and Part B (local case study).

3.2 Method

3.21 Population
The population or entire group in this study included Australian tertiary forensic science students, Australian tertiary forensic science teachers and Australian forensic science industry personnel.

3.22 Participants
3.221 Participants in Part A: National Survey

Preliminary Interviews

Preliminary interviews were conducted with forensic science students and staff (from the University of Canberra (UC) \(N=4, N=6\) respectively) and the University of Western Australia (UWA) \(N=6, N=6\) respectively) and local forensic science industry personnel \(N=5\) to develop the survey. These two institutions were chosen because UWA offers postgraduate courses in forensic science ranging though graduate diploma, masters and doctoral levels and UC offers a Bachelor of Forensic Science in addition to postgraduate level qualifications. In addition, five industry personnel from the Australian Capital Territory were selected to participate in preliminary interviews. Forensic science industry personnel were included in this study as strong partnerships between industry and academia were recommended by the National Institute of Forensic Science in Forensic Science in the National Forensic Science Innovation Strategy (Kirkbride, 2001) and the National Forensic Science Innovation Strategy Pilot Project (2002). Furthermore, one of the recommendations from the NIFS Training for the Future Report (Brightman, 2005) was that relevant forensic science industry personnel serve as industry advisors to all new and revised forensic science education programs. Kobus and Liddy (2009) advocate effective partnerships between universities and industry. According to Kobus and Liddy (2009), industry staff provide ideas for meaningful research programs and add reality and depth to forensic science courses while the academic institution can provide development opportunities for industry staff.

Questionnaire

The participants in the questionnaire were forensic science students and teaching staff from Australian tertiary institutions and Australian forensic industry personnel. A convenience sample was used to survey forensic science teaching staff. Teaching staff are often time-poor and at times unable to donate their time without jeopardising their students’ achievements. Teaching staff across 20 educational institutions were contacted by email and telephone a few weeks prior to the survey to ascertain whether or not they were willing and able to participate. It was anticipated that a sample of two staff members per institution would complete the survey \(N=40\). During
the initial telephone contact, information regarding both the staff and student national survey was disseminated.

A multistage cluster sampling technique was used to survey forensic science students in Australian educational institutions. The cluster technique is the recommended method for sampling national surveys by the Australian Council for Educational Research (Murphy & Schulz, 2006). Cluster sampling is based on the ability of the researcher to divide the population into groups, or clusters and then to select elements in each cluster using stratified random sampling (Kumar, 2011). Multistage cluster sampling is where the researcher draws simple random samples from successively smaller aggregations until the individual subject level is reached (Garson, 2009). In this study, the seven Australian states/territories formed the first stage clusters. Secondly, two tertiary educational institutions delivering forensic science were randomly selected from within each state/territory and thirdly, two individual classes (approximately 20 students per class) were randomly selected from these educational institutions. Hence, it was anticipated that the student sample size would be approximately 560 students (i.e. 20 students in two classes in two institutions in seven states/territories). Two educational institutions from each state were selected and a forensic science teacher was asked if they would distribute the questionnaire to one of their forensic science classes. The teachers were also asked if they would ask one of their forensic science teacher colleagues to repeat the procedure.

In order to maximise chances of enlisting industry personnel to complete the questionnaire, the researcher addressed the National Institute of Forensic Science (NIFS) Education and Training summit in Melbourne on 2/12/09. The researcher outlined the purpose of the research and informed the delegates that they may be contacted at a later date to ask if they would be willing to participate. A convenience sample, selected through these professional contacts was used to survey the industry personnel. It was anticipated that approximately six industry personnel across each state/territory would complete the survey (N=40). According to Burns and Grove (2011), the sample size in quantitative research, should be large enough to distinguish between groups and identify relationships between variables. The questionnaires for each of the three stakeholders were sent as attachments via email and returned via
email and hard copy. A modification was made to the sampling method and this is described in detail in the next subsection.

**Modification to sampling plan for questionnaire**

Every effort was made to maximise the response rate to the Part A questionnaire. Despite following the original plan, there was minimal response from students (N=52), teachers (N=15) and industry personnel (N=16). This was probably due to the fact that teachers and industry personnel are time-poor and there was no incentive for the students to participate in this study. Therefore, another method was needed in order to increase the response rate. The researcher attended the Australian and New Zealand Forensic Science Symposium (ANZFSS) in Hobart, Australia in September, 2012 and took this opportunity to encourage the three stakeholders to complete the Part A questionnaire. This was an excellent opportunity to speak with conference delegates from every state within Australia. As a result, an additional 37 students, 12 teachers and 9 industry personnel completed the Part A survey questionnaire. Some of these respondents completed the survey at the symposium (29 students, 4 teachers and 4 industry personnel) and others took the survey with them and returned the completed survey at a later date (8 students, 8 teachers and 5 industry personnel). Often it took a courtesy phone call or email to remind those conference delegates, who had agreed to participate, to return the completed survey. An unexpected advantage to using this method of data collection was that there was a large cross section of forensic student courses from all around Australia ranging from undergraduates to doctoral level. If only the original plan had been used to collect data, it would have been unlikely that the higher level qualifications such as research PhDs would have been represented.

Industry personnel in Part A were given a choice of whether they wanted to complete the written questionnaire or participate in a targeted telephone interview because some respondents indicated that they didn’t have the time to complete the questionnaire.

In order to further increase the sample numbers, email was used to contact professional associates of the researcher and as a result an additional 21 students, 2 teachers and 6 industry personnel completed the questionnaires.
Respondents from 16 tertiary institutions were involved in the survey for Part A of this study, including 110 students, 29 teachers and 31 industry personnel. These comprised of 16 tertiary institutions for the student questionnaire and 10 for the teacher questionnaire. Of the 16 tertiary institutions, there were only 8 tertiary institutions that were common to both the student and teacher questionnaire. For the industry personnel questionnaire, four of the five forensic science disciplines (Samarji, 2010) were represented i.e. crime scene investigation, criminalistics scientific, criminalistics technical and biomedical specialists.

3.222 Participants in Part B: Case study
Phase 1 of the case study involved in-depth interviews with participants including three students from the first year, and two students from each of the second and third year levels in the forensic science degree at the Canberra Institute of Technology (CIT). In order to develop a rich overall picture, forensic teaching staff from CIT (N=7) and local industry personnel (N= 5) were interviewed. Industry personnel were included as it is an Australian Quality Training Framework (AQTF) requirement for industry input into training and assessment within TAFE institutions. Phase 2 of the case study was an embedded teaching study and included first year undergraduate forensic biology students from CIT.

3.23 Data collection
A description of the process involved in the development, administration and collection of the Part A national survey and Part B case study are presented in the following sections. The data sources used in Part A and B of this study are presented in Table 2.

3.231 Data collection in Part A: National Survey

3.2311 Preliminary interviews
Preliminary interviews with staff and students from University of Canberra and University of Western Australia and local industry personnel were conducted. According to Punch (2005), an interview is an effective method of accessing people’s perceptions, meanings, definitions of situations and constructions of reality. Another
The advantage of conducting interviews is that the interviewer can clarify what the interviewee means (Darlington & Scott, 2002; Kumar, 2011). The disadvantages include the fact that the quality of information collected depends on the quality of the interaction and the experience of the interviewer. It can be argued that the researcher/interviewer can introduce bias in their interpretation (Kumar, 2011). This can be minimised by allowing the interviewee to check the transcripts, as was the case in this study.

The interviews were used to ascertain the reasons for student/staff/industry personnel preferences for a particular delivery mode and these ideas were used to develop the survey questionnaire. Interviews were semi-structured/semi-standardized (Berg, 2004) and were approximately 20 minutes in duration. A copy of the preliminary interview questions are presented in Appendices A, B and C.

In keeping with Fowler’s (2009) recommendations, to reduce non-response due to lack of availability, the researcher made appointments at a time that was convenient to the respondents. For two of the interviews, an audio-recording device was used, with prior consent from the interviewees as recommended by Kumar (1999). Not all the interviews were recorded because some teachers did not give consent while other teachers requested an interview at short notice and the researcher didn’t always have the recording device on hand. A recording sheet was used and a copy of the summary of questions and responses was sent to each person for their verification. This process is called member checking and enhances the validity of the findings (Kumar, 2011).

The interviewer can improve the quality of the responses by using certain interview techniques. The suggestions and recommendations of Berg (2004), Darlington and Scott (2002) and Kvale (1996) were taken into consideration whilst the interviews were being conducted. For example, allowing adequate time for interviewees to respond, or ‘echoing’ to convey to the interviewee that the interviewer is listening.

For some participants in this study, telephone interviews were the only viable method for the interviews. The disadvantage of this approach was that the interviewer was unable to see the non-verbal cues (Berg, 2004). Other respondents chose to replace the interview with a written response to the interview questions. If the respondents required further clarification on the questions, they had the opportunity of emailing
their questions to the researcher. Of the ten students participating in the preliminary interviews, six chose face-to-face interviews, three were via telephone and one student opted for a written response to allow him/her time for a considered opinion. For the twelve preliminary interviews involving teachers, eleven were telephone interviews and there was one written response. There were five preliminary interviews conducted with industry personnel of which two were face-to-face and three were via telephone.

3.2312 Part A Teacher, student and industry personnel questionnaires: Development and pilot testing

The responses from the preliminary interviews with teachers, students and industry personnel were recorded on a summary sheet. Responses were then used to develop questions for the relevant national questionnaires in Part A of this study. Copies of the questionnaires used in Part A for all three stakeholders are presented in Appendices D, E and F.

The teacher questionnaire was trialled and administered to staff at the Canberra Institute of Technology (CIT). It is important to pilot a questionnaire to remove ambiguity, detect flaws and test the adequacy of the response categories (Burns, 1995; Czaja & Blair, 2004; Fowler, 2009). Feedback from staff regarding the pilot trial highlighted the need to reduce the number of questions. Several questions were subsequently removed. Some questions were also removed or modified if there was evidence they confused the respondents. For example, respondents couldn’t distinguish between online and distance delivery, and some teachers wanted the different academic levels included.

The student questionnaire was piloted with a class of third year students at CIT. No changes were made as a result of the pilot. The industry questionnaire was more challenging to pilot. As a consequence, the researcher phoned an industry representative and arranged a time for a telephone interview and sent a copy of the questionnaire via email. The researcher read the survey questions aloud and hand wrote the responses directly onto the questionnaire. No changes were made as a result of this pilot.
As recommended by Kumar (1999), a covering letter was included with the questionnaire to communicate the main objectives and relevance of the study, to indicate that participation was voluntary and to assure participants of the anonymity of their responses. The student questionnaire comprised of five sections, namely:

1) Demographic information including age, sex, level of education, relevant work experience, home computer access and internet connection.

2) Information about their current course e.g., Is the course a forensic science major or at a postgraduate level? etc.

3) Experience with online learning, blended learning and/or face-to-face learning.

4) Preferences for the three delivery methods and reasons for their preferences.

5) Future directions

The teaching staff and industry personnel questionnaire also comprised of five sections, namely:

1) Demographic information including age, sex, level of education, area of expertise, number of years of teaching experience.

2) Information regarding their course and the units they deliver.

3) Experience teaching online and/or mixed delivery subjects.

4) Preferences for face-to-face, mixed or online delivery. This will include their perceptions of the student outcomes and the advantages/disadvantages of each method.

5) Future directions

Questionnaires consisted of 23 items for the student survey and 33 items for both the teacher and industry personnel surveys. Question types included closed, open-ended and two-tiered questions. The mixed-item questionnaire format was selected because some questions were designed to elicit fixed responses from the respondents, for example demographic information, while others were used to allow respondents to express themselves. Providing respondents with a contained number of answer options increases the likelihood that there will be enough people giving any particular
answer to be analytically interesting (Fowler, 2009). Despite this, Fowler (2009) suggests that open-ended questions have several advantages in that they permit the researcher to obtain answers that were not anticipated and they describe more closely the real views of the respondents as they allow the respondent to answer the question/s their own words. Open-ended questions were placed at the end of the survey as the respondent may become bored, lose interest and not proceed with the questionnaire if too many difficult, thought-provoking questions were placed at the beginning. Also included in the questionnaire was a two-tiered model of question where students and staff could first state their preferences for a particular learning mode and then in the second tier provide their reasons for their preferences. The two tiered questions allowed more questions to be included in the survey questionnaire without increasing the number of items.

The age groups for the student questionnaire were chosen for the following reasons. The author wanted a maximum of five age groups for ease of recording. The first group, under 18 years, represented school age children. The second group, 18 – 21 years, included students who went straight from high school to university or TAFE. The last three groups, 22-35 years, 36-50 years and over 50 years were evenly divided. The author ensured there was no overlap between age groupings so as to avoid confusion for the participants and inaccurate recording. The same age groups were chosen for the teacher and industry personnel questionnaires so direct comparisons could be made.

3.2313 Questionnaire administration
The questionnaire was issued by hard copy or electronic copy depending on the preference of the recipient. The potential advantages of mailing hard copies of questionnaires is that the respondents have time to give thoughtful answers, look up records and consult with others (Fowler, 2009). In addition, the unit costs are relatively low compared with other methods e.g. telephone and participants do not need access to a computer with internet facilities. As a consequence, the researcher made prior telephone contact with the teaching staff to ascertain whether they would be prepared to participate in this way. According to Fowler (2009), one of the problems for mail surveys is getting people to return a completed questionnaire. People who are particularly interested in the research problem are more likely to return the
questionnaires (Fowler, 2009). The teacher population in this survey is considered to be highly literate because they worked in tertiary institutions, and hence more likely to be interested in the research questions. Teaching staff were asked to distribute the questionnaire to their class and then post all copies of the completed questionnaires to the researcher. This strategy was used to increase the chances of students completing and returning questionnaires. The advantage of asking students to complete a survey in class is that it takes advantage of natural clusters and a captive audience plus in the time it takes for one student to complete a questionnaire, the whole class can do the same (Czaja & Blair, 2004). However, as Czaja and Blair (2004) point out, the major obstacle to this method is gaining the co-operation of the teachers for those classes. The disadvantage of class data collection is the authority structure in the classroom as students may feel pressured to complete the task. However, this was overcome by providing an information sheet.

3.232 Data collection in Part B: Case Study

Part B of the research consisted of a case study.

3.2321 Phase 1 of Part B Case study

The qualitative data collection in Phase 1 of the case study included in-depth interviews and classroom observations (Table 2).

In-depth Interviews

For the student interviews, seven students participated including three from first year and two each from the second and third year group. Seven teachers and five industry representatives were also interviewed.

Interviews can be used for more complex situations and for gathering in-depth information (Kumar, 2011). Darlington and Scott (2002) describes in-depth interviews as being able to clarify what the other means due to the immediacy of the collection method. Taylor and Bogdan (1998) found in-depth interviews useful when the phenomena under investigation couldn’t be observed, for example, past events. One of the weaknesses of in-depth interviews is that they allow access to what people say but not what they do (Darlington & Scott, 2002) but this was overcome in this study by the addition of classroom observations. With the interviewee’s permission, two
interviews were recorded with an audio device and all interviews were documented using hand written recording sheets.

There were 30 questions in the student interview, 27 questions in the teacher interview and 19 questions in the industry interview. Copies of the interview questions for students, teachers and industry personnel are presented in Appendices G, Hand I respectively. Interview questions for staff, students and industry personnel in Part B were designed to overlap with questions used in the national survey (Part A) so comparison of themes could be made. All interviews were semi-structured and lasted approximately 40 minutes. The wording of the questions was flexible and a semi-structured approach was used so the interviewer could probe beyond the answers to the listed questions. Wording was sometimes adjusted so that the words were familiar to the interviewees. For example, the term modes of delivery was sometimes replaced with methods of delivery. A late modification to the interview questions was the inclusion of a question on the preferred learning methods, that is, lecture-based, practice-based or problem-based as this had implications for the preferred delivery mode/s.

Classroom observations

Classroom observations of first, second and third year classes were included in the case study. As Darlington and Scott (2002) point out, observation provides access to events as they happen and if it is used in the early stages of a study, it can be a useful way of working out what important questions are to be asked. Non participant observation was conducted that involved the researcher watching what was happening and recording events as they occurred but not participating in the events (Kumar, 2011). The researcher recorded the interactions by making brief notes and then immediately after the class more detailed notes. As Kumar (2011) points out, observations are bound to be subjective based on the perceptions of the researcher, but this was only one of several forms of data collection. Furthermore, the researcher was able to witness what was happening in the class as a form of triangulation with student and teacher interviews. The students had already been provided with an information sheet outlining the study and were aware that the researcher was simply observing classes and not evaluating individual participants in any way. Observation of classes lasted for approximately one hour. During the classroom observations, both
the students and teacher were aware of the researcher’s presence as they were provided with an explanation of the purpose of the research before the class commenced. Phase 1 of the case study took place over three years for reasons previously explained.

3.2322 Phase 2 of Part B Case study

Phase 2 of the case study was a longitudinal teaching study conducted with three different first year forensic biology classes at Canberra Institute of Technology. Participants included 11 students in the first year of the study (2010), 10 students in the second year (2011) and 12 students in the third year (2012). In the first year of the study, the students were taught through blended delivery. However, the online component consisted only of subject guide, assessment items and PowerPoint presentations for revision purposes. The study lasted eight weeks. In reality though, by the time the public and term holidays and other curriculum constraints were taken into account, the students participated in a total of eight lessons on the chosen topic. During the following two years another two classes were taught through blended mode using the interactive online Forensic Entomology course described in Appendix J.

Data for Phase 2 of the case study were collected and compared over one semester for three years. Techniques for collecting evaluation data for Phase two of the case study from the students included a pre-test / post-test, a skills test, summative assessment including exam results (theory and practical) and an assignment together with documents e.g., student attendance, course evaluations, print-outs of online hits (Table 2). Self-evaluation from the researcher was through a reflective journal. Each of these techniques is described in more detail below.

Pre-test/ Post-test

Before exposing the students to the teaching models, the base-line for each group’s level of comprehension was established (Kumar, 1999). The changes in the average level of comprehension for the two groups were then compared to establish the most effective teaching method. A test was designed to test the student’s understanding of one skill and one concept; time since death or post mortem interval (PMI) and the associated skill of determining time since death respectively. Copies of the pre-test/ post-test for PMI and the skills test for PMI are presented in Appendices K and L. The PMI was chosen because forensic scientists from the different disciplines require
knowledge of this topic. Methods for determining PMI range from pathology, entomology, anthropology, biochemistry etc. Another reason this topic was chosen was because forensic entomology is part of the essential knowledge required for the first year Biology course in the Bachelor of Forensic Science (Crime Scene Examination). This test was issued to the student as a pre-test before teaching commenced and repeated as a post-test, following the eight week delivery period. The changes in the average level of comprehension for the three groups were then compared as an indicator of the most effective teaching method with regard to this concept.

**Skills Test**

A skills test was conducted to determine the students’ ability to calculate the Post Mortem Interval (PMI). The students worked in pairs whilst learning the skill of determining PMI. In 2010, the teacher/researcher had already given one face-to-face lesson lasting 30 minutes on the same topic six weeks earlier. Most of the students stated they were still confused about determining PMI using Accumulated Degree Days (ADD) so they were given another 30 minute face-to-face lesson. ADD are the heat energy units available to drive a biological process (Megysei, Nawrocki & Haskell, 2005, p. 618); in this case fly larvae. The rate of decomposition varies depending on the environment, so ADD is used as a means of standardisation, rather than temperature. The teacher provided every student with a handout entitled PMI Skill Test that included a worked example and the associated weather data. The students worked in pairs for the rest of the three and a half hour practical session and submitted their joint answer at the end of the session.

In 2011 and 2012, the students also worked in pairs and had one face-to-face lesson and one online lesson. Camtasia software was used for the online lesson that allowed a video recording of the lesson using a SMART Board. The students were able to watch and listen online as the teacher wrote the equations, filled out the table on the SMART Board while explaining how to calculate PMI. Students worked in pairs and submitted a joint answer.
**Summative Assessment**

*Theory examination*

The end of semester theory examination results for each participating student enrolled in the first year Biology course were recorded in a self-reflective teaching journal. A breakdown of the marks for the relevant forensic entomology questions were also included.

*Practical examination*

The end of semester practical examination results for each participating student enrolled in the first year Biology course were recorded in a self-reflective teaching journal. A breakdown of the marks for the relevant forensic entomology questions were also included.

*Assignment*

The assignment for the Biology course involved the study of a decomposing pig. A copy of the assignment is presented in Appendix M. The students also had to produce an entire insect collection for the pig assignment and these were conducted in pairs so it was decided that every student should be able to demonstrate that they were able to produce one dried preserved mounted and labelled insect in class. The class was given a practical lesson where they were shown how to kill, preserve, mount and label insects and during class over the next two weeks the students produced a preserved insect. The results were recorded in the self-reflective teaching journal.

*Document examination*

It is important that more than one source of evidence is used in a case study e.g., interviews, documents, observations (Burns, 1995; Darlington & Scott, 2002). For this reason, documents such as student evaluations, student attendance records and printouts of the number of online hits were collected and recorded in the self-reflective teaching journal.

*Student attendance*

Class rosters were examined and the student attendance, for the eight weeks the forensic entomology course was conducted, was recorded in the self-reflective teaching journal.
**Course evaluation**

The participating student forensic entomology course evaluation sheets were collected to provide another perspective on the study.

**Number of online hits**

A print out of the number of online hits for the class was examined and the participants’ hits were recorded in the reflective teaching journal to provide another perspective on the study.

**Self-reflective journal**

Meyer (2004), criticises the repeated use of poorly executed comparative studies between online and the more traditional delivery methods. She questions whether some researchers are using this comparative design to explore web-based learning and to prove to themselves that it is an acceptable delivery method. According to Myer (2004), these studies should be seen as personal journal research. I had the dual role of teacher and researcher and kept a reflective journal over the course of the three year study. I accept Myers (2004) point regarding teacher/researchers wishing to validate their own teaching delivery methods. However, if the teacher/ researcher discloses all factors that may influence the results such as the pedagogy used, the academic level etc., I assert that comparison studies provide valuable data for other teachers.
<table>
<thead>
<tr>
<th>Data sources</th>
<th>Research questions related to participants ‘experiences of the different delivery methods. RQ 1a) 2a) 3a)</th>
<th>Research questions related to participants ‘perceptions of the different delivery methods. RQ 1b) 2b) 3b)</th>
<th>Research questions related to outcomes as a result of the different delivery methods. RQ 1c) 2c) 3c)</th>
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<tr>
<td>Teacher survey</td>
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<td>Student survey</td>
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<td>Industry personnel survey</td>
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<td>Document examination</td>
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<td>Attendance records</td>
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<tr>
<td>Self-reflective journal</td>
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</table>
3.24 Data analysis

In this mixed method approach, the quantitative and qualitative data were merged because the findings from each type of data were closely related i.e. the same questions were used in the questionnaire and the interviews. In this way, the interview data provided descriptive examples and an insight into the numerical data. A further advantage of comparing the findings between Part A and Part B of this study was that it was possible to assess whether the data sets were convergent or divergent.

3.241 Data analysis plan

Each Research Question was linked to both the survey questions in Part A and the interview questions in Part B. A copy of the result plan linking questions in Part A and Part B are presented in Appendix N. In addition, a data analysis plan was developed by entering the type of quantitative data analysis (e.g., frequency, percentage distribution, mean, mode, range etc.) and/or qualitative data analysis (e.g., content analysis) beside each survey question onto a blank survey questionnaire. A copy of the data analysis plan is presented in Appendix O. The data analysis plan was stapled into the code book.

Identity codes were written on all the completed questionnaires and interview transcripts to ensure the anonymity of the respondents. Survey questionnaire respondents in Part A were given an identity code number i.e., SA001 – SA110 for students, TA001 – TA029T for teachers and IA001– IA0031 for industry personnel.

Audio tape recordings were converted to text data. Identity codes were assigned to the interviewees in Part B i.e. SB1-SB7 for students, TB1- TB6 for teachers and IPB-IPB5 for industry personnel.

3.242 Coding of data for the questionnaires in Part A

For the open questions in Part A, common (emergent themes) responses were ‘teased out’ and assigned a code. Known as content analysis; this is a way of managing large amounts of descriptive data where the text is searched for recurring words or themes (Patton, 2002). Firstly, inductive analysis was performed (Patton, 2002) where the author of this doctoral study examined the responses to the open questions for common themes and each theme was assigned a code. Then deductive analysis was performed (Patton, 2002), where the author’s chosen framework was checked to test
the appropriateness of the themes. The themes and their assigned codes were recorded in a code book and revised a number of times to reduce the number of response categories to ensure they were both mutually exclusive and exhaustive. The themes were reviewed by a forensic science graduate. The author believed a forensic science graduate would be in a position to judge whether the chosen themes reflected the issues that forensic science students would have. As a result, it was suggested that some common themes could be merged to further reduce the number of codes and give meaningful results when displayed in a graph.

3.243 Quantifying the data from the questionnaires in Part A

Tallies for the responses to the closed questions were recorded. For the open questions in Part A, content analysis was performed where common themes were identified, coded and quantified (Patton, 2002). Tallies of each coded response to each question in Part A were recorded in two ways; handwritten in a code book and entered into Microsoft Excel spreadsheets. Microsoft Excel spreadsheets were created for each of the Part A student (N=110), teacher (N=29) and industry personnel (N=31) data. A further consolidated Microsoft Excel spreadsheet was created in order to compare/ triangulate the three groups. Cross checks of tallies were performed between Microsoft Excel and the data in the code book.

Investigator/ analyst triangulation involves the use of multiple investigators to analyse the data (Sayre, 2001; Patton, 2002). Although only one analyst was involved in the initial data analysis for this study, a graduate research assistant was enlisted to independently analyse a proportion of the data. Intracoder reliability was performed on 15% of the tallies resulting in a 75% consistency rate. Inconsistencies in the interpretation of the two-tiered questions accounted for the 25% disagreement. For example, in question 4.4 of the student questionnaire, some respondents would provide a reason in the second tier of the question without first indicating their choice of delivery that best prepared them for a career in forensic science. The discrepancies found were discussed at a debrief meeting to achieve consensus. Once a ‘common set of rules’ was established, the primary researcher revisited all the two tiered questions and performed recounts. Graphs were created from the Microsoft Excel spreadsheets.
Intercoder reliability was performed by a graduate forensic science student on approximately 20% of the questionnaires. Each coder independently extracted themes from the responses. These themes were discussed before a final set of themes was devised.

3.244 Interview data in Phase 1 of Part B

For Phase 1 of Part B, audio tape recordings were converted to text data and each interview transcript was read before writing a summary sheet of the responses by writing all the responses to question one together, then all the responses to question two together etc. The summary sheet was then entered onto a word document. This two-step method enabled the researcher to become familiar with the data. The summary sheet from the interviews provided a fast way to examine the responses to each question and extract suitable examples that could be used to illustrate the quantitative data from Part A.

Classroom observations

Transcripts of classroom observations that were recorded in the teaching journal were examined for further evidence of information that was gleaned from the student and staff interviews. The researcher also checked for any discrepancies between interviews and classroom observations. This was conducted by firstly examining the interview summary sheets and then reading the classroom observations to gather evidence to either support or refute the interview data.

Case study in Phase 2 of Part B

Pre-test/Post-test

Phase 2 of the case study, an embedded teaching study at CIT, involved a pre-test and post-test comparison between two delivery styles. While all three years involved blended delivery, student participants in the subsequent two years used an interactive forensic entomology course. As previously cited, the design and development of the online forensic entomology course is presented in Appendix J. The number of students who grasped the concept was determined by calculating the average difference between the pre-test and post-test. The significance of differences between the pre-test results of the three years was calculated to determine whether the groups were comparable to begin with. The researcher was then able to determine whether or not
the observed results were attributed to sampling errors. Following statistical analysis, the results were displayed in tables and graphs together with a detailed description.

**Skills Test**
The results for the skills test were recorded in the teacher journal and displayed in a table with description provided.

**Summative Assessment**
The theory exam, practical exam and assignment results for the first year biology students were recorded in the teaching journal for three consecutive years. The researcher also identified and recorded those questions that were relevant to forensic entomology. A table was generated and a description was provided.

**Document Examination**
Student attendance
Student attendance, for the eight weeks the forensic entomology course was collected and is presented in a table.

Course evaluation
The participating student forensic entomology course evaluation sheets yielded qualitative data in the form of quotations.

Number of online hits
A print out of the number of online hits per participating student was examined for the different online topics and types of activities and is presented in a table together with a detailed description.

**3.25 Ethical issues**
This study was approved by the University of Western Australia Human Research Ethics committee during 2009 (File reference RA/4/1/2530) and the Human Research Ethics committee at the Canberra Institute of Technology in 2009 (Ethics approval number 10/ 2009:1).

To a large extent, concerns regarding research ethics revolve around issues of harm, consent privacy and confidentiality of data (Punch, 1994). According to Darlington and Scott (2002) both professional and research ethics are based on similar core principles such as beneficence and duty of care.
All participants, including teachers, students and industry personnel were fully informed and participation was completely voluntary. Participants were provided with a description of the study and were requested to sign a consent form or consent by completing the survey questionnaire. Copies of the information sheet and the consent form are provided in Appendices P and Q respectively. Students were informed that their grades or their access to services were not affected whether they agreed to participate in the research or not, and all participants were informed that they were free to withdraw from the study at any time without retribution. To ensure no harm comes to the subjects of research, Berg (2004) suggests it is important to debrief to determine if they require assistance or further explanations to the questions. Accordingly, all CIT students participating in the embedded teaching study were debriefed at the end of the study.

Apart from the two tertiary institutions that took part in the preliminary interviews, i.e. University of Western Australia and the University of Canberra, and the educational institute involved in the case study i.e. Canberra Institute of Technology, the names of participating educational institutions remain confidential. Personal names or other forms of identification of all participants have not been used in documents associated with this research. Pseudonyms are used in this thesis to ensure teacher and student anonymity. Although most archival data can be managed unobtrusively, researchers need to be cautious regarding certain ethical concerns (Berg, 2004). All data collected has been securely stored on a password protected computer and as the researcher, I am the only person with access to the data.

3.26 Research rigour

Mixed methods research combines quantitative and qualitative methods but this sometimes leads to problems and controversy with respect to judging the quality of such studies because indicators of quality were developed in the traditions of either quantitative or qualitative research (Curry, Nembhard & Bradley, 2009; Tashakkori & Teddlie, 2003, 2006).

In this study, the quality and rigour of the research was addressed by the indicators of validity, reliability and generalizability (Curry, Nembhard & Bradley, 2009). The parallel terms in qualitative research are credibility, dependability and transferability (Lincoln
Strategies employed to test these indicators include triangulation, participant validation (member checking) and coder reliability checks (Curry, Nemhard & Bradley, 2009) all of which were conducted in this study and expanded upon in the following sections.

3.261 Triangulation

Triangulation is a strategy for improving the validity and reliability of research (Golafshani, 2003). This study used three different forms of triangulation including methods triangulation, data triangulation and investigator/analyst triangulation (Patton, 2002; Sayre, 2001).

- **Methods triangulation** involves collecting and analysing data in more than one way (Curtin & Fossey, 2007). For example, data can be collected from different people, at different times and from different places (Carlson, 2010, p. 1104). In this study data were collected from forensic science students, teachers and industry personnel over a three year period from six states in Australia. This study used a concurrent triangulation approach, which involved collecting both quantitative and qualitative data simultaneously and then comparing the two databases in a process that enables searches for confirming and disconfirming evidence in both qualitative and quantitative data sets (Creswell & Plano Clark, 2011).

- **Data triangulation** is a technique that involves the use of multiple sources for obtaining information and is used to ensure reliability and validity of data (Carter et al., 2014; Patten, 2007; Patton, 2002). According to Hammersley (2008), it can also provide complementary information. In this study, data was collected from six different States across Australia that included sixteen tertiary educational institutions and five broad forensic science industry categories (Samarji, 2010). The process of triangulation was used for each research question at the data source level, the data collection level and the data analysis level. This multilayered process ensured the trustworthiness of the research.

Furthermore, different types of data were collected in order to represent the different levels of analysis within the forensic education system and to form an overall picture. Table 2 shows how the different data sources used in this study
relate to the research questions. The types of data collected included interviews, survey questionnaires, classroom observations and documents (Creswell & Miller, 2000) and a reflective journal (Rolfe, 2006).

- **Investigator/analyst triangulation** was previously described in subsection 3.243.

### 3.262 Validity

The parallel terms for validity in qualitative and mixed method research are credibility (Lincoln & Guba, 1985) and truth value (Sale & Brazil, 2004) respectively. Potential threats to validity can occur in the various stages in the mixed method design i.e. data collection, data analysis and interpretation (Creswell & Planoclarck, 2011). The steps taken in this study to address each of these potential threats are outlined below:

#### 3.2621 Data collection

*Survey and interview instruments*

When designing the questionnaire in Part A and the interview questions in Part B of this study, each question was carefully aligned with at least one of the research questions. The ability of the instrument to measure what it was intended to measure is known as face validity (Fowler, 2009; Kumar, 2011) and the strategy employed here made it possible to judge whether or not the answers corresponded to what they were intended to measure.

Subjective questions in the questionnaires for Part A were made as reliable as possible with standardized presentation to increase the validity (Fowler, 1995, 2009). The questionnaire included two types of subjective questions; open and two-tiered questions with clear instructions. Fowler (1995, 2009) also suggests the use of multiple questions, with different forms, to measure the same subjective state. In the questionnaire of Part A, two types of questions were used; open questions and two-tiered questions.

In this study, the same questions were used in the questionnaire in Part A survey and the interviews in Part B. Using the same questions during quantitative and qualitative data collection reduces the validity threat when merging data (Creswell & Planoclarck, 2011).
The use of alternative methods of quantitative and qualitative collection can lead to participants expressing different viewpoints (Bazely, 2002). For example, when people respond to interview questions, they may raise a different viewpoint than those responding to a structured questionnaire on the same topic. In this study, industry personnel participants were asked for their preferred delivery mode in order to prepare students for a career in forensic science. One interviewee IB3 in Part B chose face-to-face delivery and raised the issue of forensic science being a stressful career even though none of the respondents to the equivalent question in Part A mentioned this issue. The issue of stress was raised by respondents to another question in Part A. This points to the importance of looking at the findings in a holistic manner.

**Classroom observations**

In addition to the interviews with students and teachers, classroom observations were conducted to provide a broad perspective on the participants in different contexts. This increased the credibility or internal validity of Part B of the study.

**Member checking**

Participant or member validation is known as member checking (Doyle, 2007). In this study, the interviewees were provided with a summary of the participant’s comments and an opportunity to provide feedback. Immediately after the interview, the interviewer read out loud the interview transcript. All interviewees were satisfied with the transcript of their responses. However, none of the interviewees provided feedback for the interview summaries. Member checking provides participants with the opportunity to check the interpretation of the data they provided (Doyle, 2007) and an opportunity to edit it if necessary (Carlson, 2010).

**3.2622 Data analysis**

**Peer review**

During the formulation of codes and initial data entry of student results in Part A into Microsoft Excel, one of the researcher’s peers was enlisted to check the code suitability. The same method for the teacher and industry personnel data entry was then used.

**Data display**
In order to avoid an ‘uninterpretable display’ of the converged results for this study, joint tables were used with descriptive quotes used as examples for the quantitative data. The researcher was able to find suitable quotes to match the quantitative responses to avoid illogical comparisons (Creswell & Planoclar, 2011). In addition, Creswell and Planoclar (2011) recommend straightforward data transformation which was the case in this study where the codes and themes were counted. The statistics used were also straightforward due to the relatively small sample sizes. A statistician was consulted during the design phase of this study.

3.2623 Data interpretation

**Data interpretation stage**

Finally, during the data interpretation stage, when inconsistencies were found, the data were revisited and reanalysed.

3.263 Reliability

Reliability is referred to as dependability in qualitative research (Curry, Nembhard & Bradley, 2009) and consistency in mixed method research (Sale & Brazil, 2004). It is impossible to attain 100% accuracy because it is impossible to control all the factors affecting reliability (Biddix, 2015; Kumar, 2011) but this study used a number of strategies to maximize reliability, as follows:

- **Pilot application of the research instrument**

  A pilot of each of the questionnaires in Part A was administered and modifications were made based on the feedback to ‘iron out’ any ambiguities. When referring to a research instrument, reliability means the research tool is consistent and stable (Hesse-Biber, 2010; Kumar, 2011).

- **Parallel forms of the same test**

  A survey questionnaire was constructed in Part A that included the same questions as a set of interview questions in Part B and these two instruments were administered to two similar groups. Using parallel forms of the same test with the intention of measuring the same things is one way of verifying the reliability of a measure (Biddex, 2015; Kumar, 2011).
• **Test-retest**

In the embedded teaching study in Part B of this study, the same pre-test / post-test was used each year over three years. According to Biddex (2015) the test-retest method can be used to check the consistency of the measure over time. In addition, other measures were used to assess the student outcomes including: evaluations of course attendees, exam results, researcher’s direct observation and statistics provided by the Learning Management System (Elearn) that included the number of online hits. Rolfe (2006) advocates the use of a reflective journal in addition to the research report. In this way, Rolfe (2006, p. 309) argues, that judgements are made about the research itself rather than how it is presented, that is, “the actual course of the research rather than the idealized version”. During the embedded teaching study in Part B, I kept a reflective journal.

• **Code book**

The use of code notes for the subjective questions in the questionnaire in Part A and the interviews in Part B strengthened the reliability so that the same results could be obtained if the study were to be repeated.

• **Intercoder or interrater reliability**

Intercoder or interrater reliability looks at consistency between coders i.e. the consistency of judgements using the same stimulus (Biddix, 2015; Burke Johnson & Christensen, 2013; Lavrakas, 2008). This was performed by a graduate forensic science student on approximately 20% of Part A student questionnaire and Part B interviews. The student was instructed to devise her own themes, limiting the number to approximately six, ensuring they were mutually exclusive and exhaustive. The coder also had access to the original interview transcripts and was able to independently look for common themes. This process took place over three days and lasted approximately 6 hours i.e. 2 hours per day.

• **Intracoder reliability**
Intracoder reliability refers to reliability within a single coder (Burke Johnson & Christensen, 2013). The consistency of my tallies was verified by a graduate research assistant who reviewed approximately 15% of student, teacher and industry survey questionnaires in Part A. This process was conducted over the course of three days and lasted approximately 6 hours i.e. 2 hours per day. Any inconsistencies for the closed questions were accounted for during the subsequent debrief meeting. For example, there was an inconsistency for Question 2.2 of the industry questionnaire but upon review it was found that the respondent had ticked online delivery for the closed question but then went on to describe the face-to-face component in the next part of the question.

- **Debrief**

Post discussions of any disagreements of the assignment of codes may lead to a “refinement of codes” (Curry, Nembhard & Bradley, 2009, p. 5). In this study, a debrief meeting occurred following an independent review by a second coder. This process took approximately three consecutive hours. For example, in the two-tiered questions in all three questionnaires, some respondents provided reasons in the second tier without indicating their choice in the first tier. It became apparent that each coder was using a different set of rules to interpret the responses. During the debrief meeting we came up with a common set of rules and were able to perform a recount with 100% accuracy rate.

### 3.264 Generalizability

Generalizability is referred to as transferability in qualitative research (Curry, Nembhard & Bradley, 2009) and applicability in mixed method research (Sale & Brazil, 2004). According to Teddlie and Yu, (2007, p. 97):

> The sampling strategy should allow the researchers to transfer the findings of their study to other groups, individuals and contexts, and so forth if that is the purpose of the MM research.

The case study in Part B took place at Canberra Institute of Technology. The student interviewees were undergraduate forensic science students while the teachers all
taught forensic science at undergraduate level. Their experiences of forensic science education are likely to be in keeping with undergraduate forensic science students and tertiary teachers of undergraduate forensic science from other tertiary institutions. The detailed descriptions and information provided in the case study will allow other forensic science teachers to make appropriate comparisons and transfer the findings to their own context where relevant.

3.265 Objectivity

Objectivity, which is referred to as confirmability in qualitative research (Guber, 1981), and neutrality in mixed method research (Sale & Brazil, 2004) ensures the findings reflect those of the participants rather than those of the researchers. Shenton (2004, p. 72) recommends the use of ‘reflective commentary’. This involves the researcher providing a detailed description of the methodology and an audit trail so the reader can follow the steps involved in the decision making process and how data were collected and processed.

- **Documented steps involved in the decision making process.**
  
  This detailed methodology chapter summarizes the sequence of the steps involved in the decision making process and the associated justification.

- **Audit or decision trails**
  
  Audit or decision trails enhance the transparency and reproducibility of the study (Curry & Nunez-Smith, 2015). They can include raw data, notes including decisions made during data collection, coding and analysis (Curry & Nunez-Smith, 2015). In this study, three different chronological books were kept; a log book, a code book and a self-reflective teaching journal. The log book outlined the research progress from the commencement in 2009 until 2016. The code book documented the data analysis and a teaching journal was written during the embedded teaching study for Part B over a period of three years.

3.266 Peer review

Peer review is defined as the “impartial and independent assessment of research by others working in the same field” (National Health and Medical Research Council,
2007, Chapter 6, first paragraph). In this study the objective analysis and reporting of results took place during the following three occasions:

- Part of the research pertaining to Research Questions Q1a)-1c) inclusive was presented to forensic science practitioners and teachers at the 22\textsuperscript{nd} International Australian and New Zealand Forensic Science Symposium in Adelaide, September, 2014.

- The author delivered a 20 minute PowerPoint presentation pertaining to Research Questions 1-3 inclusive to her teacher colleagues at the Higher Education Committee meeting at the Canberra Institute of Technology, October 2014.

- The author was awarded the ‘Best Poster Presentation’, in Education and Training, for part of the research pertaining to Research Questions 1c), 2c), 3c) at the 23\textsuperscript{rd} International Australian and New Zealand Forensic Science Symposium in Auckland, New Zealand, September, 2016.

3.27 Limitations

Four main limitations to the methods used in this study have been identified. The first limitation was the issue of time constraints, that is, the time taken to applying for human ethics approval from participating institutions, contacting potential participants and arranging convenient interview times. Data from Part A and Part B were collected concurrently partly to allow enough time to gather sufficient data. Fortunately, it was the intention of the author to merge the data during analysis so this minimised any impact on the results.

The second limitation identified was gaining access to forensic students. Even after the teachers had agreed to distribute the student survey questionnaires, students were reluctant to participate. The sampling technique was modified as outlined in subsection 3.221 to increase the sample size.

The third limitation was the use of the two-tiered questions in the questionnaires in Part A. This type of question reduced the number of acceptable response. For example, in question number 4.1 of the student questionnaire, a two-tiered question, although there was a 100% response rate, only 61 out 110 students provided answers
that provided sufficient information where their intention was made clear. The use of a second ‘blind coder’ and a follow-up ‘debrief’ alleviated this problem to a certain extent.

The fourth limitation involved quantizing the qualitative data. According to Driscoll (2007, p. 25), this can “lead to a loss of depth”. This problem was minimised by revisiting the data and refining the codes several times as well as enlisting the help of a second ‘blind coder’. During a debrief session between the two coders, a common set of rules was devised to analyse the data.

3.28 Summary

This chapter outlined the research methodology used in this study. The research design was a pragmatic approach involving two parts: A and B. Part A was a national survey of students, staff and industry personnel across Australia. Part B involved a case study focussing on forensic science within the Canberra Institute of Technology (CIT).

A mixed method approach using multiple forms of quantitative and qualitative methods was the most suitable strategy of enquiry. A multi-layered system of triangulation (Creswell & Plano Clark, 2011) member checking and coder reliability was used to address the rigour and trustworthiness of this study.

This chapter has outlined and justified the process in which this study was undertaken. The findings from this study are provided in Chapters Four to Seven inclusive. Chapter Four presents the findings pertaining to Research Question 1a) to 1c) inclusive, the findings from the perspective of forensic science students.
CHAPTER 4: STUDENT RESULTS

4.1 Introduction

This chapter presents the findings of the forensic science students’ experiences and perspectives of the different types of delivery modes. The chapter is divided into four sections. The first section provides demographic information on the student sample used in Part A, the survey questionnaire and Part B, case study. The second section addresses research question 1a) on the students’ experiences of the different delivery modes. Section three pertains to research questions 1b) and 1c) on the student perceptions of the advantages and disadvantages and outcomes of the different delivery modes. Finally, in section four, students provide their ideas for future directions with regard to modes of teaching for forensic science.

4.11 Part A Student questionnaire

There were 110 respondents to Part A of the student questionnaire. The survey questionnaire was divided into five sections: student demographic information, information about their course, the student’s experiences of online learning, and the student’s preferences for the different delivery modes and future directions.

4.111 Demographic information

The first section of the questionnaire focused on student demographic information.

The majority of students sampled in the Part A national survey were female (67%) (Table 3) with 86% of students aged between 18 and 35 years (N=110) (Table 4). Almost three quarters of the students sampled were full-time students (Table 5). There was a similar profile for students in the Part B interviews.

Only one quarter of the student respondents from the Part A questionnaire were employed in the forensic science industry (Table 6). Of those who were employed in forensic science, the vast majority (82%) had between 1-5 years in the forensic science industry (Table 7). All 110 Part A respondents (100%) indicated that they had computer access at home and 107 respondents (98%; N=109) also had internet access at home (Table 8).
The undergraduate bachelor degree courses comprised 61 of the 108 (56%), the industry based courses accounted for 17 of the 108 students (16%) and the postgraduate courses comprised 27 of the 108 students (25%) (Table 9). The four broad academic programs in which the participants were enrolled (Table 10) closely reflected that found in the Australian tertiary STEM population (Table 11).

According to the Part A questionnaire, the blended mode of delivery was the most common type experienced by respondents in forensic science courses at the time of the survey (49%: \( N=105 \)). The traditional face-to-face mode was the second most common type (28%). Some students experienced a combination of delivery modes (Table 12).

Table 3. Percentage of male and female students who participated in Part A questionnaire (\( N=110 \)).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Male</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>Female</td>
<td>74</td>
<td>67</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>100</td>
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Table 4. *Age group of students who participated in Part A questionnaire (N=110).*

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Number</th>
<th>Percent</th>
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<tbody>
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<td>43</td>
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<td>22-35</td>
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</tbody>
</table>

Table 5. *Percentage of part-time and full-time students who participated in Part A questionnaire (N=107).*

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part-time</td>
<td>29</td>
<td>27</td>
</tr>
<tr>
<td>Full-time</td>
<td>78</td>
<td>73</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 6. **Student participants in Part A questionnaire who were employed in the forensic science industry (N=110).**

<table>
<thead>
<tr>
<th>Employment in forensic science</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>No</td>
<td>83</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 7. **The number of years of experience in the forensic science industry for the participants in Part A questionnaire (N=16).**

<table>
<thead>
<tr>
<th>Years of experience in forensic science</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>1-5</td>
<td>13</td>
<td>82</td>
</tr>
<tr>
<td>6-10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11-20</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>&gt;20 years</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 8. Student participants in Part A questionnaire with computer (N=110) and/or internet access (N=109) at home.

<table>
<thead>
<tr>
<th>Computer access</th>
<th>Number</th>
<th>Percent</th>
<th>Internet access</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>110</td>
<td>100</td>
<td>Yes</td>
<td>107</td>
<td>98</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>0</td>
<td>No</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>100</td>
<td>Total</td>
<td>109</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 9. *Academic program in which the student participants in Part A questionnaire were enrolled (N=108).*

<table>
<thead>
<tr>
<th>Program</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Bachelor Degree Course</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Industry based course - Certificate level</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Industry based course – Diploma level</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Industry based course – Advanced Diploma level</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Industry based course – Masters level</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Undergraduate Bachelor of Science with forensic electives</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bachelor of Forensic Science</td>
<td>60</td>
<td>55</td>
</tr>
<tr>
<td>Bachelor of Forensic Science with honours</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Postgraduate diploma in Forensic Science</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Master of Forensic Science</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>PhD Forensic Science</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 10. *Four broad groups of forensic science academic programs in which the student participants in Part A questionnaire were enrolled (N=108).*

<table>
<thead>
<tr>
<th>Consolidated academic program</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry-based</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>Bachelor degree (Pass and Honours)</td>
<td>65</td>
<td>60</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>Other (includes associate degrees)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 11. *A summary of full-time domestic and international students by level of education according to the Science Technology Engineering and Mathematics (STEM) country comparisons report (Marginson et. al., 2013 p. 44).*

<table>
<thead>
<tr>
<th>Qualification level</th>
<th>VET (Percent)</th>
<th>Higher education (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctoral degree</td>
<td>-</td>
<td>4.1</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>-</td>
<td>12.7</td>
</tr>
<tr>
<td>Graduate certificate or graduate diploma</td>
<td>0.1</td>
<td>4</td>
</tr>
<tr>
<td>Bachelor’s degree (Pass and honours)</td>
<td>0.2</td>
<td>73.6</td>
</tr>
<tr>
<td>Advanced Diploma</td>
<td>4.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Associate degree</td>
<td>0</td>
<td>0.8</td>
</tr>
<tr>
<td>Diploma</td>
<td>17.3</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Table 12. *Mode of delivery experienced by participants in Part A questionnaire (N=105).*

<table>
<thead>
<tr>
<th>Mode of delivery</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>Blended</td>
<td>51</td>
<td>49</td>
</tr>
<tr>
<td>Entirely online</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Both face-to-face and blended</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Both blended and online</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Research</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>105</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

4.12 Part B (Phase 1 of case study) Student interviews

All seven students, who participated in the Part B case study interviews, were enrolled in a *Bachelor of Forensic Science*. For the purposes of anonymity, the student interviewees are identified as SB1 to SB7 inclusive. There were three first year undergraduates SB1-SB3, two second year undergraduates SB4 (also enrolled in a first year subject) and SB5 together with two third year undergraduates, SB6 and SB7, in the final year of the *Bachelor of Forensic Science*. Of the seven student interviewees, three were aged between 18-21 years and four were aged between 22-35 years. The majority of the student interviewees, 5 out of 7, were female. Most of the students (6 out of 7) were studying full-time. The interviewees’ profiles generally reflected the larger sample who responded to the questionnaire. None of the seven students were
employed in the forensic science industry. All seven students had computer access at home but only six out of the seven students had internet access at home.

This section provided a description of the sampled students’ background. The next three sections provide the analysed data in order to address the research questions pertaining to forensic students.

4.2 Australian tertiary students’ experiences of different delivery modes used in forensic science

Section three of the questionnaire in Part A of this study was designed to provide data to directly address Research Question 1a).

What are Australian tertiary students’ experiences of delivery modes (face-to-face, blended and online) for forensic science?

4.21 Type of online learning

Seventy seven percent of tertiary forensic students, in Part A of the study, had experienced some form of online delivery with the most common mode being blended (56%: N=109) (Figure 4). Twenty three percent had never experienced any form of online learning. All the interviewees in Part B of the study had experienced blended learning. One of the third year students summarised his/her experiences

SB6 I have been here for five years and had blended every year. About 80% of the course is blended.

The most common online subject type, including both fully online and blended delivery, experienced by students in Part A was criminalistics scientific e.g., forensic biology, chemistry, physics. The least common online subject type was crime scene investigation (Figure 5).
Figure 4. Responses to question 3.1 of the Part A questionnaire. The type of online learning experienced by forensic science students ($N=109$).

Figure 5. Responses to question 3.1 of the Part A questionnaire. The type of subjects taught through online or blended delivery in forensic science courses ($N=44$).
4.22 Interactive online subjects

According to feedback from the student questionnaire in Part A, 56% of online subjects were reported to be interactive (N=84). Discussion forums were found to be the most popular interactive site, almost 2.5 times more common than exams/tests and four times more than virtual classrooms (Figure 6). In Part B of the study, it was found that online activities such as word matching exercises, diagrams, crosswords etc. were not ranked highly by the first year undergraduate students.

The frequency of usage of interactive sites also formed part of a three year longitudinal teaching case study in Part B where an online forensic entomology course was used with a first year undergraduate biology class. The design and development of the forensic entomology course is presented in Appendix M. At the end of the course, the number of hits was recorded for each activity. The activities included both interactive and non-interactive sites. The results of two of the eight topics are shown in Table 13.

The data obtained from both 2011 and 2012 show the most popular sites were non-interactive (Table 13). For example 90% of students accessed the PowerPoint presentation ‘classification of animals’ in 2011 and 77% in 2012. The student preferences for these sites could be due to the fact that both the PowerPoint presentations were directly related to the summative theory tests and were used by the students for revision purposes.

A similar trend is seen in all eight topics. A possible reason for the low level of use of the interactive sites, such as the crossword and matching exercise (Table 13) could be that the students were making maximum use of their study time and revising the work covered in class e.g. PowerPoint presentations and focusing on passing their assessments e.g. revision quiz. Another possible explanation could be that these activities are pitched at too low a level and would be more suitable for certificate level or high school students. For example, at the end of the semester one 2012, the biology students were given the opportunity to complete an online survey for the entire course. In response to the statement “The topics should have been covered in more depth”, one third of the respondents agreed (N=3).
Another tool used to gauge the popularity of the interactive sites in the forensic entomology course was the online student feedback survey that is regularly used as an evaluative tool in units provided by the Canberra Institute of Technology (CIT) (Table 14). The surveys were posted onto Elearn; the CIT learning management system. The online survey was available to students in 2011, 2012 and 2013. The survey results also show that the students (N=10) tended not to rank most of the interactive sites highly (Table 14). The picture/text matches and games combined constituted only 19% of the favourite sites and none of the students selected the crosswords. It is interesting to note that both problem solving activities i.e. Determining post mortem interval (33%), and the discussion i.e. The ethics of animal research (29%) were the most frequently selected activities.

In the interviews, for Part B of the study, students were asked if they thought the latest technology was relevant to forensic science. Half of the six respondents thought the latest technology was relevant.

SB1 Yes, as forensic science is constantly evolving due to new technologies / advances in technology.

SB4 Yes. For example, can communicate from home to the institution. A student can go online and access the work. It introduces you to different aspect of forensic science.

SB5 Yes. Forensic science is such a hands-on practical discipline. Anything you can take home e.g., virtual crime scene you could do overnight and practice.

The comment from SB5 regarding access to a virtual crime scene suggests that although students are interested in interactive sites, they are discerning. Students who are training to become crime scene investigators want practical experience or the opportunity to apply and practice their skills in a virtual environment.

Other students disagreed and emphasized the need for hands-on practical activities.

SB2 Not completely as forensic science requires hands-on learning.

SB3 Not really. As forensic science also needs to be practical hands-on learn to use equipment. This doesn’t offer this.
Figure 6. Responses to question 3.2 of the Part A questionnaire. Frequency histogram of the types of interactive sites experienced by forensic science students (N=31).
Table 13. The number of hits per student in an online forensic entomology course delivered by blended mode in Phase 2 of Part B (N=23). The shaded areas represent interactive sites.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Lorn activity Classification of animals</th>
<th>PowerPoint Classification of animals</th>
<th>Crossword</th>
<th>Matching exercise</th>
<th>Link to website Key</th>
<th>PowerPoint Arthropoda</th>
<th>Link to Fly Atlas</th>
<th>Activity Labelling an insect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2011</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2-2011</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3-2011</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4-2011</td>
<td>11</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5-2011</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6-2011</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7-2011</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8-2011</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>9-2011</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10-2011</td>
<td>7</td>
<td>2</td>
<td>20%</td>
<td>40%</td>
<td>10%</td>
<td>50%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Percent 2011</td>
<td>70%</td>
<td>90%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2012</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2-2012</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3-2012</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4-2012</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5-2012</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6-2012</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7-2011</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8-2012</td>
<td>8</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>9-2012</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10-2012</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>11-2012</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>12-2012</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>13-2012</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Percent 2012</td>
<td>54%</td>
<td>77%</td>
<td>31%</td>
<td>31%</td>
<td>46%</td>
<td>62%</td>
<td>15%</td>
<td>15%</td>
</tr>
</tbody>
</table>

117
### Table 14. Online student survey responses regarding their favourite types of activities in the forensic entomology course from Phase two of the case study Part B (N=10).

<table>
<thead>
<tr>
<th>What were you favourite types of activities?</th>
<th>Frequency (N=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossword</td>
<td>0</td>
</tr>
<tr>
<td>Picture and text matches</td>
<td>2</td>
</tr>
<tr>
<td>Games</td>
<td>2</td>
</tr>
<tr>
<td>PowerPoint presentations</td>
<td>4</td>
</tr>
<tr>
<td>Problem solving scenarios</td>
<td>7</td>
</tr>
<tr>
<td>Discussion</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
</tbody>
</table>

**4.23 Online or blended learning: A positive experience?**

Just less than half of the students (48%) in Part A reported that they found the online or blended delivery an entirely positive experience, 10% reported that it was an entirely negative experience (N=80), and just over 40% reported that it was both a positive and negative experience (Figure 7). The majority of Interviewees in Part B (80%) also reported that they enjoyed learning through blended delivery.

The most common positive response provided (10 students) was that of flexibility, including the ability to work at their own pace, as described by student SA009 (Table 15). Other positive reasons were ease of access (3 students), opportunity for revision (2 students) and independent learning (1 student). Negative responses were diverse, but the most frequently reported was a lack of interaction and/or participation (4 students). One student, SA053, reported that it was a positive experience if there was interaction but not if there was a lack of interaction (Table 15). Two students cited reasons for their negative experience as being that there was no-one there to help. These findings were reflected in survey feedback following the forensic entomology
study in Phase 2 of Part B (Table 16). Ten students responded and the data for question 2 of the entomology online survey is shown in Table 16.

![Bar chart](image)

**Figure 7.** Responses to question 3.3 of the Part A questionnaire. The percentage of forensic science students who reported a positive experience for online or blended learning ($N=80$).
Table 15. A sample of the reasons provided by forensic science students in Part A questionnaire reporting for or against the online learning experience being a positive one (N=30).

<table>
<thead>
<tr>
<th>Responses to the question: Did you find the online learning experience to be a positive one?</th>
<th>Sample comments/ reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>It’s useful to have material online so you can go at your own pace (SA009)</td>
</tr>
<tr>
<td></td>
<td>It was good to as blended learning gave you different challenges in a different environment (SA025)</td>
</tr>
<tr>
<td></td>
<td>Allows independent learning (SA034)</td>
</tr>
<tr>
<td></td>
<td>I like blended learning because it makes it a lot easier to revise when most of the work is online. It also makes catching up on missed work easier (SA038)</td>
</tr>
<tr>
<td>No</td>
<td>(If) not interactive then face-to-face (SA043)</td>
</tr>
<tr>
<td></td>
<td>Residentials rushed (SA047)</td>
</tr>
<tr>
<td></td>
<td>Required time management (SA009)</td>
</tr>
<tr>
<td></td>
<td>The online component of courses I took more confused me than helped me because if you got stuck and didn’t understand a concept there was non-one there to help work it through for you. You just had to work it out or you couldn’t understand the rest of the course. (SA099)</td>
</tr>
<tr>
<td>Yes and No</td>
<td>I prefer at least an initial face-to-face before going all online (SA021)</td>
</tr>
<tr>
<td></td>
<td>It’s good to be able to learn at your own pace but sometimes I feel a little lost (SA048)</td>
</tr>
<tr>
<td></td>
<td>Those which were interactive ‘yes’ those not ‘no’ (SA053)</td>
</tr>
<tr>
<td></td>
<td>SA100 Had potential but not many people participated (SA100)</td>
</tr>
</tbody>
</table>
Table 16. *Online survey feedback from students in Phase 2 of Part B on enjoyment of the forensic entomology via Elearn.*

<table>
<thead>
<tr>
<th>Did you enjoy learning through Elearn?</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>8</td>
<td>80%</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100%</td>
</tr>
</tbody>
</table>

Having discussed the students’ experiences of online and blended delivery in general, the benefits and challenges of each of these modes of delivery will be discussed in turn.

**4.24 Benefits and challenges of online learning**

The main benefits of fully online learning, reported by the students in response to the questionnaire in Part A, included flexibility, including the benefit of self-paced delivery (47%), followed by convenience (34%) and opportunities for revision (8%: \( N=30 \)) (Figure 8 and Table 17).

Feedback from the teacher, including quantity, timeliness, explanation or clarification, was reported by the students in Part A as being the most common challenge for online learning (40%: \( N=30 \)) (Figure 9). The responses regarding feedback were almost double that of the second most common challenge; reduced motivation (21%). It may be possible that these two challenges are linked and by improving the frequency and speed of feedback, individual student’s motivation may increase. Information Technology (IT) access (16%), time management/organisation skills required from students (5%) and a lack of human interaction, including peers and teacher (4%) were other challenges for online learning reported by the students (Figure 9).
A sample of student comments regarding the challenges for online learning are displayed in Table 18. Responses on the issue of feedback ranged from a situation where the teacher did not provide any feedback on the online material (SA058) to the speed of feedback (SA019).

Reduced motivation was also an issue with one student (SA077) mentioning the challenge of not having teacher and peer support (Table 18). This student also wrote that this mode of delivery may not suit everyone’s learning style. The issue of students’ perceptions of their preferred learning styles is explored in more depth later in this chapter during the interviews from Part B of the study.

Responses from the student interviewees in Part B reflected the findings in response to question 3.5, Part A. Once again the challenges identified were teacher feedback and IT problems.

SB3 *Not having a teacher to answer questions*

SB5 *Technology can be unreliable. For example, the internet may be down. The cost when the computer breaks down and you can’t be at the library all night.*

There was an interesting comment put forward by one student on their perception of online teachers.

SB7 *A lack of awareness from teachers. That is, knowing the right level of detail for online lessons.*
Figure 8. Responses to question 3.4 of the Part A questionnaire. Benefits of online learning identified by forensic science students (N=30).
Table 17. **Sample comments from forensic students in Part A questionnaire on the key benefits of online learning (N=30).**

<table>
<thead>
<tr>
<th>Benefits of online learning</th>
<th>Sample comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexibility</td>
<td><em>Still being able to study and maintain full-time work (SA002)</em></td>
</tr>
<tr>
<td></td>
<td><em>Freedom of time. No timetabled sessions (SA027)</em></td>
</tr>
<tr>
<td></td>
<td><em>The flexibility and it is at your own pace (SA028)</em></td>
</tr>
<tr>
<td></td>
<td><em>Ability to do most of the work in my own time around other commitments, ease of travel – could work from home or most often place of employment (SA091)</em></td>
</tr>
<tr>
<td>Convenience</td>
<td><em>Being able to access the course work at home and not always printed out (SA031)</em></td>
</tr>
<tr>
<td></td>
<td><em>Constant access to information (SA051)</em></td>
</tr>
<tr>
<td></td>
<td><em>It allows you to do it in your own time and in a safe and comfortable environment. There was highly detailed information in an interactive form which allows for positive reinforcement of key concepts (SA077)</em></td>
</tr>
<tr>
<td>Opportunity for revision</td>
<td><em>Continuous delivery – residentials are a summary to date whereas online is delivered in order. Podcasts are great and quizzes enabled better retention (SA005)</em></td>
</tr>
<tr>
<td></td>
<td><em>Strong set of revision notes. Review past lectures (SA078)</em></td>
</tr>
<tr>
<td></td>
<td><em>Online you are able to go back and look over everything you have learnt (SA039)</em></td>
</tr>
<tr>
<td>Other</td>
<td><em>Ability to contact teacher /other students easily (SA107)</em></td>
</tr>
<tr>
<td></td>
<td><em>Not embarrassed at asking questions face-to-face: it overcomes this problem (SA081)</em></td>
</tr>
</tbody>
</table>
Figure 9. Responses to question 3.5 of the Part A questionnaire. Challenges of online learning identified by forensic science students (N=30).
Table 18. *Sample comments from forensic science students in Part A questionnaire on the key challenges of online learning (N=30).*

<table>
<thead>
<tr>
<th>Key challenges of online learning</th>
<th>Sample comments from students</th>
</tr>
</thead>
</table>
| Motivation                       | *Motivation to do it at home (SA028)*  
I found that motivation could be a challenge and the encouragement of face-to-face support of teachers and peers. .... Allows if the information is exemplified in a certain manner that does not suit your learning style can become very difficult (SA077)  |
| Feedback/ help from teacher      | *Difficulty in getting answers to questions quickly. The most basic difficulty is getting answers to questions (S019A)*  
Teachers need to ensure there is opportunity for feedback for material posted online (SA058)  |
| Access/ IT connection            | *Internet connection – we only have satellite (SA005)*  
*Internet disruption of services (SA044)*  |
| Human interaction                | *No face-to-face time (SA051)*  
Working alone, very limited contact with others studying the same course/subjects... (SA092)  |
| Time management /organisational skills | *Felt overloaded (too much work, too little time) (SA035)*  
*Time management (SA042)*  |
| Other                            | *Locating where everything is. Not sure if doing the correct procedure. e.g., sending assignment etc. (SA032)*  
*I struggle reading off a computer screen for long periods (SA050)*  |
4.241 Examples of subjects that involved online delivery

For question 3.6 in the questionnaire, the students were asked to provide a recent example of a subject/unit involving online learning and then provide the tool that was used e.g., WebCT, Sakai. The data for the first part of question 3.6 is shown in Figure 10 as a frequency histogram as some students provided more than one example.

The results presented in Figure 10 reflect those in Figure 5 (Question 3.1) in that criminalistics scientific is the most common type of subject taught, however here statistics is the second most common subject rather than criminalistics technical. This finding suggests that criminalistics technical is mainly delivered through blended delivery, which makes sense as these subjects have a large practical component. Crime Scene Investigation (CSI) is equal last along with forensic biomedical and law.

One of the interviewees in Part B provided an example of an online lesson.

SB 4 When the teacher was absent, the students were instructed to read the PowerPoint, take notes and answer questions. It forces you to be organised and to keep ahead.

Another student described a lesson where the class members were seated in a computing class and issued with head-sets (ear phones and microphone) while the teacher was in another room. The student was late for class.

SB 5 The class sat down at computers for a Wimba virtual classroom. We could join in either in the classroom or via distance and could use thumb drive and ear phones. We could communicate through voice or typing. I was late for class but connected while I was on the bus.

This example illustrates the flexibility of online learning in that it can be conducted anywhere providing there is a computer and internet access. Teachers and students are no longer locked in to a set time and place for classes.
The next three sub sections show the findings and a discussion of the benefits, challenges and recent examples of blended delivery.

4.25 Benefits and challenges of blended learning
The most frequently reported benefits for blended learning for students in Part A were flexibility (33%) and access to the teacher (32%: \(N=66\)) (Figure 11). Other benefits included access to resources (16%) and the opportunity to learn in different ways (13%). Sample comments from the students describing the benefits for blended learning are shown in Table 19.

Flexibility was listed as a benefit from both part-time and full-time students, who also worked in the forensic science industry. Both SA003 and SA004 (Table 19) worked in the forensic science industry. Undergraduate students who were interviewed in Part B of the study also cited flexibility as a benefit of blended learning.

\textit{SB6 Flexibility in that I can work from home or anywhere. Also flexibility in time. I’m a ‘picture person’. I can take time to see how everything links. Whereas a
linear learning person will learn this part and then get around to the other part later.

SB7 If there is anything we don’t get around to in class, can put it up online.

SB3 Being able to reach lesson even when a person is sick

According to the results of the questionnaire in Part A, the most frequently reported key challenge for students of blended learning was limited feedback from the teacher (Figure 12). Limited feedback (40%) was almost four times more frequently reported than the other challenges that were identified: access to internet/IT support (11%), speed of feedback (9%) and timing of the face-to-face component (9%: N=60).

Sample comments from students in Part A of the study regarding the challenges of blended learning are shown in Table 20. The issue of limited help/support from the teacher was illustrated in a comment from a student, SA048, who referred to rushed lectures and being told to read the notes at home (Table 20).

Interviewees in Part B also reported experiencing frustration regarding teacher availability to answer questions, delayed feedback and the timing of the face-to-face component of the subject.

SB6 Sometimes when things are online and I need to ask a question, the teacher wasn’t available.

SB7 Teachers need to allow for student questions on the online component.

The speed of feedback was also cited as an issue for one of the interviewees in Part B of the study.

SB5 Teachers may take a long time to reply to emails. There is no back-up. Delayed feedback and it’s not the same as seeing them each week.
Figure 11. Responses to question 3.7 of the Part A questionnaire. Benefits of blended learning identified by forensic science students (N=66).
Table 19. *Sample comments from forensic science students in Part A questionnaire on the benefits of blended learning.*

<table>
<thead>
<tr>
<th>Benefits of blended learning</th>
<th>Sample comments from students</th>
</tr>
</thead>
</table>
| Flexible                    | *Learning at your own pace at a time suitable to me (SA003)*  
|                             | *Ability to learn material in your own time and at your own pace and then reiterate/clarify/further develop knowledge during face-to-face/residential component. Practical sessions assist reading material (SA004)*  
| Access to teacher           | *Although you still have all the ‘info’, you still have the teacher to help (SA050)*  
|                             | *When the online learning component failed to give you the appropriate depth of learning you still had the opportunity to approach lecturers to have a more in-depth discussion of the topic and get help with the areas you hadn’t mastered (SA099)*  
| Access to resources         | *Everything is available on the Elearn site (SA020)*  
|                             | *Possible to get familiar with material before the class. I could re-check materials I may have missed previously in class (SA022)*  
| Can learn in different ways | *It gives you a chance to learn in different ways and it makes it easier for some people to learn (SA0033)*  
|                             | *Have a teacher introduce the topic, reinforce through online revision and question any problems with teacher face-to-face (SA039)*  
| Other                      | *Blended learning allows for the two methods to complement each other and allows for holistic understanding of the concepts (SA077)*  
|                             | *People (SA005)*  

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Figure 12. Responses to question 3.8 of the Part A questionnaire. Challenges of blended learning identified by forensic science students ($N=60$).
Table 20. Sample comments from forensic science students in Part A questionnaire on the key challenges of blended learning.

<table>
<thead>
<tr>
<th>Key challenges of blended learning</th>
<th>Sample comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited help/ support from teacher</td>
<td>Sometimes it results in lectures being rushed through and being told to read the notes at home—leaving you wondering what you came to class for (SA048)</td>
</tr>
<tr>
<td></td>
<td>No interpretation of text or theory from lecturer (SA099)</td>
</tr>
<tr>
<td>Limited IT assistance</td>
<td>Sometimes it is very difficult to get the full effect of a blended course when you don’t have reliable access to the internet (SA026)</td>
</tr>
<tr>
<td></td>
<td>If the access to a computer was not possible due to lack of internet access it becomes difficult for part-time or full-time workers. Access to the library is dependent on being able to travel to the (name of institution) library (SA023)</td>
</tr>
<tr>
<td>Motivation</td>
<td>Too much work alone—decreased motivation (SA035)</td>
</tr>
<tr>
<td></td>
<td>Motivation for the non face-to-face (SA040)</td>
</tr>
<tr>
<td>Speed of feedback</td>
<td>Not being able to have questions answered immediately (SA003)</td>
</tr>
<tr>
<td></td>
<td>Feedback process could take time – some frustration experienced (SA084)</td>
</tr>
<tr>
<td>Other</td>
<td>Additional research that you need to do to understand the content properly. Trying to find time to study whilst working full-time (SA002)</td>
</tr>
<tr>
<td></td>
<td>Getting used to a different style of learning through the different methods (SA025)</td>
</tr>
</tbody>
</table>
4.251 Examples of subjects that involved blended learning

According to the results of the questionnaire in Part A, the two most common subject types delivered by blended mode were criminalistics scientific (46%) and criminalistics technical (17%; \(N=48\)) (Figure 13). Interviewees in Part B were enrolled in a Bachelor of Forensic Science and have been taught units by blended mode in both these subject categories.

Elearn was the most common online tool reported (11 students), followed by WebCT (6 students), Moodle (3 students) and other tools including Blackboard, Edmodo, forums/blogs (3 students).

![Bar chart showing the type of subjects taught in forensic science courses through blended delivery.](chart)

*Figure 13.* Responses to question 3.9 of the Part A questionnaire. The type of subjects taught in forensic science courses through blended delivery (\(N=48\)).

This section examined the students’ experiences of the different types of delivery. The next section provides the results and discussion of the students’ perceptions of the different delivery modes. Student perceptions, in general, are examined followed by a comparison of the student perceptions for three broad categories of forensic
programs; industry-based, undergraduate Bachelor of Forensic Science and postgraduate level.

4.3 Australian tertiary students’ preferences for different delivery modes used in forensic science.

Section four of the questionnaire in Part A was designed to address Research Questions 1b) and 1c). There were four two-tiered questions in this section. Although the response rate for questions 4.1, 4.2, 4.3 and 4.4 was acceptable (100%, 98%, 99% and 99% respectively), some of these responses could not be ascertained. For example, some respondents did not select a preferred delivery mode but then went on to provide reasons for their choice. Where the students ticked more than one delivery mode and also ticked reasons in several of the columns, it was not possible to confidently categorise the response, so these data were omitted from the results. Only clean data was used, that is, where the intention of the respondent was made clear. For example, if students indicated more than one preferred delivery mode and also wrote a comment e.g., “any mode”, “both types”, the data were included in the results. Possible reasons for the high rate of responses that could not be ascertained could have been due to the complexity of the questions, unclear instructions or respondent error.

The responses to each question in this section were analysed firstly by looking at students across all academic levels collectively. However, in order to better present the patterns evident, it was necessary to deconstruct the data and make comparisons between each of the broad academic levels.

The first two questions of section four in the student questionnaire in Part A of the study relate to Research Question 1b)

*What are Australian tertiary students’ perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?*
4.31 Student perceptions for the most convenient delivery mode to study forensic science

Over half the student respondents (56%) to the first tier of question 4.1 in Part A indicated that blended mode was the most convenient method to learn forensic science (N=61) (Figure 14). Thirty four percent of students selected face-to-face mode while 6% selected either fully online or a combination of the different types of delivery. This trend was also found amongst the seven student interviewees in Part B with the majority selecting blended mode (57%) and 43% choosing face-to-face mode.

The second tier of question 4.1, Part A, examined the reasons for the students’ choice of delivery and these data are provided in Tables 21, 22 and 23. Students were able to choose more than one reason so the frequencies are provided.

The most common reason provided by students in Part A who chose face-to-face mode as the most convenient way to study forensic science was the feedback, help and encouragement from teachers (Table 21).

Three of the seven interviewees in Part B also selected face-to-face mode in terms of convenience to study forensic science. One of the interviewees chose face-to-face delivery because of access to the teacher but could also see the advantages of online work.

SB4 The teacher is always there. Having said that online work is always there and you can access it in your own time.

Another reason provided by both students in Part A and interviewees in Part B for selecting face-to-face delivery was the need for practical work in forensic science.

SB2 Face-to-face helps with ‘hands-on’ learning.

SB7 Face-to-face is such a practical thing. It is better to demonstrate than post notes online and you get immediate feedback.

For those students in Part A who selected blended mode for convenience, the most common reason provided was the flexibility of having online work available to catch up on missed work, view pre-work and fit it in around their own schedule (Table 22).
Interviewees in Part B also mentioned the advantages of having pre-work / resources available as part of blended learning.

SB5 Only face-to-face without access to lectures is inconvenient. You don’t have to worry about taking notes in class or missing important information. You can print off lectures before you go to class, listen and concentrate on learning.

Most of the students in Part A who chose online delivery for convenience stated that they could choose the time and place they wanted to study (Table 23).

*Figure 14.* Responses to question 4.1 of the Part A questionnaire. The mode of delivery perceived by forensic science students as being the most convenient method to learn forensic science (N=61).
Table 21. Reasons provided by students in Part A questionnaire for selecting face-to-face mode as the most convenient method to study forensic science (N=21). Students could choose more than one reason.

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>The teachers are helpful and encouraging and this keeps me focused on my studies.</td>
<td>23</td>
</tr>
<tr>
<td>I am most familiar with this method of study.</td>
<td>20</td>
</tr>
<tr>
<td>The teacher tells me what do and I don’t have to plan as much.</td>
<td>6</td>
</tr>
<tr>
<td>It gives me time away from my busy working life to focus on my study.</td>
<td>6</td>
</tr>
<tr>
<td>The classes are delivered close to my home.</td>
<td>5</td>
</tr>
<tr>
<td>Another reason.</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
</tr>
</tbody>
</table>
Table 22. *Reasons provided by students in Part A questionnaire for selecting blended mode as the most convenient method to study forensic science (N=34). Students could choose more than one reason.*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>It gives me the flexibility to catch up on work that I miss in the face-to-face classes.</td>
<td>31</td>
</tr>
<tr>
<td>I have to fit in my study around my work schedule.</td>
<td>22</td>
</tr>
<tr>
<td>The pre-work and learning materials are delivered online.</td>
<td>18</td>
</tr>
<tr>
<td>I have a busy personal life and sometimes don’t have time to attend classes.</td>
<td>6</td>
</tr>
<tr>
<td>I gain computer skills whilst learning subject content.</td>
<td>6</td>
</tr>
<tr>
<td>Another reason.</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>95</td>
</tr>
</tbody>
</table>
Table 23. Reasons provided by students in Part A questionnaire for selecting online mode as the most convenient method to study forensic science (N=6). Students could choose more than one reason (N=5).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can work when and where I like.</td>
<td>7</td>
</tr>
<tr>
<td>I live a long way from where my course is delivered.</td>
<td>6</td>
</tr>
<tr>
<td>I gain computer skills whilst learning subject content.</td>
<td>4</td>
</tr>
<tr>
<td>I have a busy working life and don’t have time to attend classes.</td>
<td>1</td>
</tr>
<tr>
<td>I have family commitments and don’t have time to attend classes.</td>
<td>1</td>
</tr>
<tr>
<td>Another reason.</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
</tr>
</tbody>
</table>

The next subsection examines the students’ perceptions of the different delivery modes according to the academic level in which they were enrolled i.e., Diploma level industry-based, Bachelor of forensic science (with and without honours) or postgraduate level.

4.311 Student perceptions, according to their academic level, for the most convenient delivery mode to study forensic science.

The majority of students (87%) enrolled in industry-based courses preferred to study through blended mode for convenience (N=15) (Figure 15). Slightly more than half (54%) the students enrolled in a Bachelor of Forensic science (with and without honours) selected blended mode for convenience and 43% chose face-to-face mode (N=28) (Figure 15). Most postgraduate students in Part A (47%) chose face-to-face
mode as the most convenient method to study forensic science while 33% selected blended mode (Figure 29).

![Graph showing mode preferences](image)

*Figure 15. Responses to question 4.1 of the Part A questionnaire. A comparison of forensic science student preferences for modes of delivery, in terms of convenience, as perceived by students in different educational levels. (N=15, N=28, N=15).*

### 4.32 Student perceptions on the delivery mode for confidence to study forensic science.

Approximately half the student respondents (52%) to the questionnaire in Part A selected blended mode as their preferred mode with respect to confidence in studying forensic science with 40% choosing face-to-face mode and only 8% selecting either online or a combination of delivery methods (N=65) (Figure 16). The most common reason given by students in Part A for choosing blended mode for confidence to study forensic science was that it gave them two options for working things out (Table 25).

The most common reason provided by students in Part A for selecting face-to-face mode in terms of confidence to study forensic science was the need to acquire
practical skills (Table 24). Interviewees in Part B cited interaction with the teacher as the main reason for choosing face-to-face instruction.

SB2 *Face-to-face. As you are more able to interact with teachers.*

SB3 *Face-to-face. As you are receiving the best knowledge you can from the lecturer.*

Only two students in Part A selected fully online delivery in terms of confidence to study forensic science and the most common reason provided was that they were skilled with computer technology (Table 26). None of the seven student interviewees in Part B selected online delivery for confidence to study forensic science.

Interviews with the first year *Bachelor of Forensic Science* students in Part B revealed that they all wanted a combination of lectures, practice and problem-based activities; however they differed in the order of delivery and the amount of each type of learning.

SB1 *If you just have lecture-based, you don’t know how to do it practically. You need to know how to do it. The order is important. I would choose lecture-based first, then problem based and then practice based. For example (the problem based activity), ‘Determining the time since death’. We forgot how to do it because we hadn’t done it often enough.*

Feedback from first year undergraduate interviewees suggested that they want some level of face-to-face contact in order to participate in practical activities.

The confidence that first year undergraduate students acquire from face-to-face practical classes was also evident when the author observed a photography lesson aimed at preparing students for work as crime scene examiners. The class comprised of 13 first year undergraduate students and the teacher had over 30 years teaching experience. An excerpt from the lesson follows.

An excerpt from the lesson follows.

*(Teacher) demonstrates how to take a photo of (a) fingerprint on (a) window (of the crime scene house). Teacher asks a question. Silence from the class. Teacher prompts students by saying “We did it last week”. Several students call out answer. Teacher*
replies “Correct”. Teacher continues with demonstration. At (the) end, he looks at one student and says “You look confused”. Student replies “No”. (Teacher) asks one student to demonstrate (the procedure) to class. (Afterwards the) teacher (says) “Not too bad. It’s relatively easy to do as long as you follow the procedure I have shown you. Any questions?”. Teacher cracks a joke (by saying) “I must have made it too easy for you”. Students take cameras and tripods into (the) Crime Scene House. Teacher asks questions from different groups...My comment written at the end of the lesson. “Seems to be their first taste of crime scene work. Really appear to enjoy it”.
Figure 16. Responses to question 4.2 of the Part A questionnaire. The mode of delivery perceived by forensic science students that makes them feel most confident when studying forensic science ($N=65$).
Table 24. *Reasons provided by students in Part A questionnaire for selecting face-to-face mode for confidence to study forensic science (N=26).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>As an undergraduate student I need to acquire practical skills as well as learn the theory.</td>
<td>24</td>
</tr>
<tr>
<td>I am most familiar with this form of study.</td>
<td>23</td>
</tr>
<tr>
<td>I find personally interacting with other students gives me confidence.</td>
<td>20</td>
</tr>
<tr>
<td>I find the face-to-face information and instruction gives me confidence.</td>
<td>17</td>
</tr>
<tr>
<td>I am not confident with using computer technology for learning in forensic science.</td>
<td>2</td>
</tr>
<tr>
<td>Another reason.</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>93</td>
</tr>
</tbody>
</table>
Table 25. *Reasons provided by students in Part A questionnaire for selecting blended mode for confidence to study forensic science (N=34).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel having access to both face-to-face instruction and online instruction gives me two options for working things out.</td>
<td>24</td>
</tr>
<tr>
<td>It promotes both self-directed learning and teacher-led activities.</td>
<td>19</td>
</tr>
<tr>
<td>I can complete all my pre-work and review learning materials/class notes online.</td>
<td>18</td>
</tr>
<tr>
<td>I know I am getting the necessary practical experience and I am not getting held back by the weaker students when learning the theory.</td>
<td>14</td>
</tr>
<tr>
<td>This approximates the real world.</td>
<td>8</td>
</tr>
<tr>
<td>Another reason.</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 26. *Reasons provided by students in Part A questionnaire for selecting online mode for confidence to study forensic science (N=1).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am skilled with computer technology and this gives me confidence.</td>
<td>1</td>
</tr>
<tr>
<td>I’m more confident to interact with the instructor online.</td>
<td>1</td>
</tr>
<tr>
<td>As a postgraduate student I already have the required practical skills and I now wish to concentrate on learning the theory.</td>
<td>1</td>
</tr>
<tr>
<td>I am an introvert and I participate more using this method.</td>
<td>1</td>
</tr>
<tr>
<td>I’m more confident to interact with other students online.</td>
<td>0</td>
</tr>
<tr>
<td>Another reason.</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
</tr>
</tbody>
</table>
Having analysed the student sample as a whole, with regard to preferred delivery modes in terms of student confidence in this section, an analysis of the different academic levels follows in the next section.

4.3.2.1 Students’ perceptions, according to their academic levels, for confidence to study forensic science.

A comparison of the preferred modes of delivery for student confidence is shown in Figure 17.

For the majority of students enrolled in industry-based courses (86%), the preferred mode of delivery for confidence to study forensic science was blended (N=15) (Figure 17). However, the majority of undergraduate students were more closely divided than students in industry-based courses as to their preferred mode of delivery that made them feel most confident. Forty five percent selected face-to-face mode and 52% selected blended mode (N=33) (Figure 17). Most of the postgraduate students (50%) preferred face-to-face mode for confidence to study forensic science (N=14) (Figure 17).
Figure 17. Responses to question 4.2 of the Part A questionnaire. A comparison of forensic science student preferences for modes of delivery, in terms of confidence, as perceived by students in different educational levels; students enrolled in industry-based courses (N=15), bachelor degree students (N=33), and postgraduate students (N=14).

4.33 Student perceptions for the delivery mode that achieves the best outcomes in forensic science education.

The last two questions of section four of the questionnaire relate to Research Question 1 c)

*How do student outcomes (marks/grades) correlate with delivery modes for forensic science?*

The majority of forensic science students, in Part A, preferred face-to-face mode (52%) to provide them with the best results (N=56) (Figure 18). This was followed by blended mode (41%) and online (5%) and combination of delivery methods (2%). The finding is in contrast with their preferred delivery mode in terms of confidence i.e. blended (Figure 18).
Table 27 shows the frequency of reasons the students provided for selecting face-to-face mode as their preferred delivery mode in order to gain the best results in forensic science. The two most common reasons provided were both the opportunity to participate in practical classes and for interaction with the instructor. Students cited interaction as important not only with their teachers but also with fellow students as this allowed them to discuss their ideas with their peers.

Most of the students who selected blended mode as the method that provides them with the best results, thought the combination of face-to-face classes and online work provided them with back-up online resources, opportunities for practical work and the flexibility of self-paced work (Table 28).

When the interviewees in Part B of the study were asked which mode of delivery they thought provided them with the best results, five out of seven students selected blended mode and one chose face-to-face. This question evoked an unexpected response from one of the second year students (SB5).

SB5 I’m worried about my marks with (teacher x). I’ve never had bad grades before. It helps to have face-to-face interaction with the teacher. I don’t have marks back from (teacher x). Students don’t know if they are going well or badly.

Feedback was also an issue for one of the third year students but he/she also outlined an advantage to blended learning.

SB7 Blended. You need to contact the teacher to get feedback and they monitor what you do. Also an online component helps if you miss out on something in class.

Another first year student was aware of his/her responsibility for learning.

SB4 Blended. I believe the delivery method will affect grades if you are prepared to do the extra work online.

The opportunity to work at one’s own pace was also the most common reason provided by students in Part A who selected online delivery for the best results (Table 29).
Figure 18. Responses to question 4.3 of the Part A questionnaire. The mode of delivery perceived by forensic science students as providing the best results (N=56).
Table 27. Reasons provided by forensic students in Part A questionnaire for selecting face-to-face mode as the preferred method to gain the best results (N=29).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I learn best when I am able to participate in practical classes.</td>
<td>28</td>
</tr>
<tr>
<td>I learn best when I personally interact with my instructor.</td>
<td>28</td>
</tr>
<tr>
<td>I learn best when I have to turn up to class on a regular basis.</td>
<td>25</td>
</tr>
<tr>
<td>I am able to ‘bounce’ ideas off other students and get faster feedback from the teacher.</td>
<td>23</td>
</tr>
<tr>
<td>I learn best when I interact personally with other students.</td>
<td>18</td>
</tr>
<tr>
<td>I am most familiar with this form of study.</td>
<td>17</td>
</tr>
<tr>
<td>Another reason.</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>149</td>
</tr>
</tbody>
</table>
Table 28. *Reasons provided by forensic students in Part A questionnaire for selecting blended mode as the preferred method to gain the best results (N=23).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I learn best from the combination of face-to-face instruction with the back-up of online material for further study.</td>
<td>25</td>
</tr>
<tr>
<td>I receive benefits from both learning methods i.e. the hands-on experience from face-to-face classes and the flexibility of self-paced online work.</td>
<td>24</td>
</tr>
<tr>
<td>I need the motivation of face-to-face classes but I also need the online information to support my learning.</td>
<td>20</td>
</tr>
<tr>
<td>I am better prepared for assessment.</td>
<td>11</td>
</tr>
<tr>
<td>I am an introvert and I can participate more.</td>
<td>5</td>
</tr>
<tr>
<td>I must be organised to co-ordinate both learning environments.</td>
<td>7</td>
</tr>
<tr>
<td>Another reason.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>97</td>
</tr>
</tbody>
</table>
Table 29. Reasons provided by forensic students in Part A questionnaire for selecting online mode as the preferred method to gain the best results (N=3).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I learn best when I learn at my own pace.</td>
<td>3</td>
</tr>
<tr>
<td>I learn best when I can choose the times I want to engage with the material I have to learn.</td>
<td>3</td>
</tr>
<tr>
<td>I experience less social distractions from other students and can therefore concentrate on my study.</td>
<td>1</td>
</tr>
<tr>
<td>I learn best when I interact with the instructor online.</td>
<td>1</td>
</tr>
<tr>
<td>I learn best when I interact with other students online.</td>
<td>1</td>
</tr>
<tr>
<td>I learn best when I work by myself.</td>
<td>1</td>
</tr>
<tr>
<td>Another reason.</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
</tr>
</tbody>
</table>

Having analysed the entire student sample with respect to the preferred delivery mode for the best results; a breakdown of the different academic levels follows in the next section.

4.331 Student perceptions, according to their academic levels, for the best results in forensic science education

Most students enrolled in both industry-based level and postgraduate level chose face-to-face mode for obtaining the best results; (64%, N=14 and 52%, N=15) respectively (Figure 19). However, most undergraduate level forensic students (52%, N=25) perceived blended mode in terms of achieving the best results.
The findings for those students enrolled in industry-based courses are in keeping with the National Institute of Forensic Science (NIFS) report (Brightman, 2005), where face-to-face mode was the preferred mode for forensic practitioners.

Of the seven interviewees in Part B, five students selected blended mode for obtaining the best results and the remaining two students chose face-to-face mode. Access to the teacher and information was the reason provided for choosing blended mode.

![Graph](image1)

*Figure 19.* Responses to question 4.3 of the Part A questionnaire. A comparison of forensic science student preferences for modes of delivery, in terms of achieving the best results, as perceived by students in different educational levels; students enrolled in industry-based courses ($N=14$), bachelor degree students ($N=25$), and postgraduate students ($N=15$).

### 4.332 Student outcomes of a three year longitudinal teaching study in Phase 2 of Part B

As discussed in Chapter three, a longitudinal teaching study of first year undergraduate biology students was conducted over a three year period. The author of this thesis was the teacher. Methods of data collection used to gauge student learning outcomes included pre and post-tests, a skills test, summative assessment including theory and
practical exams and an assignment, together with documents. In all three years, the students were taught through blended delivery; the difference was that in 2010 the online component consisted only of subject guides, assessment items and PowerPoint presentations whereas in 2011 and 2012 the entire forensic entomology course was redesigned to include interactive sites as described in Appendix J. Although the forensic entomology course was initially designed to be used as a stand-alone unit for distance students, for the purposes of this study it was used as a complementary resource (Fee, 2009) and served as a backup to face-to-face classes.

Firstly, the results of the pre-test and post-test are provided followed by the outcomes for the exams (theory and practical), assignment and skills test.

Results for pre-tests and post-tests for the case study on forensic entomology in which the class was taught by blended mode were inconclusive (Figures 20 and 21). An improvement was seen in all three years of the study, but due to a number of variables it cannot be surmised the improvement was entirely due to the delivery of the program.

Figure 20 shows an improvement from the pre-test to the post-test in both the 2010 and 2011 groups. The 2011 group had a slightly higher class average for the pre-test (35%; N=10) than the 2010 group (34%, N=11). According to Hale and Astolfi (2015), a strategy that can be used to strengthen the Non Equivalent Group Design is to compare the pre-test results. Field (2009) recommends the independent t-test where there are two experimental conditions and different participants have been used in each condition. The two-tailed probability was used because no predictions were made about the direction of the effect (Field 2009). An independent two-tailed t-test revealed a t-value of 0.106 and a p-value of 0.165 at p < 0.05 i.e. the result is not significant. Therefore, the argument that the two comparison groups from 2010 and 2011 are equivalent is stronger (Hale & Astolfi, 2015). The 2011 group ended up with a lower class average at the end of the course (77%) compared with the 2010 group (92%). It is important to note that the 2010 group’s results crossed over those of the 2011 group even though the quality of their online materials was not as good as the 2011 group and to consider the reasons why this may have happened. There may be a number of factors including the number of days of delivery, student attendance, attrition rates and unexpected events.
If we look at the number of days of attendance, the 2010 group had an advantage in that it was delivered over 14 days compared with 13 days of the program in 2011. The reasoning was that there were extra resources available online in 2011. The difference in performance between the two years cannot be attributed to attendance (Table 30) however the department did experience temporary staff shortages in 2011. Another factor that may have influenced the results was that in 2010, the class comprised of two cohorts; generic associate degree students and forensic degree students. In 2011, the class commenced with two cohorts but two weeks into the course, the associate degree students were moved to another class. Some of the students were working in groups on an assignment during this transition period and it is possible this may have influenced their results. This is an example of selection history (Trochim & Donnelly, 2008). Selection history is a threat to internal validity from any other event that occurs between the pre-test and post-test that occurs groups experience differently (Trochim & Donnelly, 2008, p. 169).

Feedback from one of the students who participated in the 2011 program may also provide a reason as to why the 2011 post-test results were lower than expected.

*There seems to be too much reliance on E-learn content. Most of the readings/learning was expected to be done at home in our own time. It is hard to juggle the requirements to be in class, plus learn at home and then do our other class work. Plus also visit the pig every day and collect insect samples.*

Data illustrated in Figure 21 show a ‘cross over’ trend when the 2010 and 2012 groups are compared in a similar manner. The 2012 group scored a higher class average on the pre-test (48%; N=12) than the 2010 group (34%; N=11) but a lower class average on the post-test (83%; N=4) compared with the 92% achieved by the 2010 group (N=11).

There were a couple of factors that may have contributed to these results; selection history (previously described) and selection mortality. Selection mortality arises where there is a differential non-random drop-out between the pre-test and post-test (Trochim & Donnelly, 2008 p. 169). In 2012 there was a high attrition rate amongst the first year students. An event occurred, unrelated to the course, that lead to six students leaving before the post-test was conducted. Attendance may also be a
contributing factor. Results in Table 30 show the 2012 group had a clear disadvantage with 81% attendance rate over ten delivery days compared with 86.9% attendance rate over 14 days for the 2010 group. A limitation of this longitudinal study using the repeat measures of pre-test and post-test, is the small sample sizes. However, what can be deduced is that there has been an improvement from the pre-test to the post-test in all three years.

Next, the class results for the theory and practical exams, skills test and assignment are examined. Table 30 shows the class average for the attendance and results for the skills test and summative assessment items i.e. theory and practical exams and assignment. The skills test (Determining the post mortem interval) showed a decline over three years, but there were factors outside delivery that may have influenced the results.

There appears to be little difference between the marks for the mid-term biology exam for students in all three years but if we isolate the relevant forensic entomology questions, it is apparent that there was a decline in the class average from 81% in 2010 to 70% and 71% in 2011 and 2012 respectively (Table 30). Similarly, the results of the relevant forensic entomology questions in the practical exam dropped from 72% in 2010 to 68% in 2011 and 55% in 2012 (Table 30). This trend was repeated in the entomology assignment with a class average of 76.5% in 2012 and dropping to 70% in 2011 and 61.6% in 2012 (Table 30).

The emphasis on the skills test, where the students had to estimate the time of death, was on the process (Reaburn, Muldoon & Bookallil, 2009) and the students were required to include their calculations and be able to defend their answer (Savin-Baden, 2000). The students in 2011 and 2012 didn’t perform as well as the 2010 group on the skills test (Table 30).

Table 35 reveals a decline in both the theory and practical components of the forensic entomology section from the 2010 group that only used the online component to view assessment outlines and power points to the 2011 and 2012 group who were provided with a course including online activities designed specifically for forensic entomology students.
Figure 20. A comparison of the results for the pre-test-post-test for forensic entomology students in Phase 2 of the case study in Part B in 2010 and 2011.

Figure 21. A comparison of the results for the pre-test-post-test for forensic entomology students in Phase 2 of the case study in Part B in 2010 and 2012.
Table 30. *Class average of attendance and result for the forensic entomology component of the three year teaching study; Phase 2 of Part B.*

<table>
<thead>
<tr>
<th>Year</th>
<th>Attendance</th>
<th>Mid-term exam</th>
<th>Relevant questions in mid-term exam</th>
<th>Practical exam</th>
<th>Relevant questions in practical exam</th>
<th>Entomology assignment</th>
<th>Post mortem interval (PMI) skills test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>12.2/14 days</td>
<td>69/100</td>
<td>11.4/14</td>
<td>40.2/60</td>
<td>12.3/17</td>
<td>76.5/100</td>
<td>All students used the correct process (N=10)</td>
</tr>
<tr>
<td>(N=11)</td>
<td>86.9%</td>
<td>69%</td>
<td>81%</td>
<td>67%</td>
<td>72%</td>
<td>76.5%</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>12.4/13 days</td>
<td>54/80</td>
<td>9.8/14</td>
<td>41.4/60</td>
<td>11.5/17</td>
<td>70/100</td>
<td>77% of students used the correct process. Two students did not state whether the time of death was a.m. or p.m. (N=9)</td>
</tr>
<tr>
<td>(N=10)</td>
<td>95.4%</td>
<td>67.8%</td>
<td>70%</td>
<td>69%</td>
<td>68%</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>8.1/10 days</td>
<td>69/100</td>
<td>10.4/15</td>
<td>32.3/60</td>
<td>6.04/11</td>
<td>61.6/100</td>
<td>55% of students used the correct process. Four students did not include any calculations and it could not be determined as to whether or not they used the correct process (N=9)</td>
</tr>
<tr>
<td>(N=12)</td>
<td>81%</td>
<td>69%</td>
<td>71%</td>
<td>54%</td>
<td>55%</td>
<td>61.6%</td>
<td></td>
</tr>
</tbody>
</table>
4.34 Student perceptions on the delivery mode that best prepares them for a career in forensic science

Feedback from both undergraduate students and postgraduate students showed 53% perceived blended delivery as the best method to prepare them for a career in forensic science ($N=43$) (Figure 22).

The most common reason cited by student respondents for choosing face-to-face mode as the best delivery type to prepare them for a career in forensic science was that a forensic scientist needs excellent communication and team work skills as well as technical knowledge and skills (Table 31). The second most common reason provided was that it was the best way to participate in practical activities.

The two student interviewees in Part B who selected face-to-face mode as the best mode to prepare them for a career in forensic science thought this mode provided them with more opportunity to acquire the necessary practical skills.

*SB3* *Face-to-face as it offers the best practical experience.*

*SB7* *Face-to-face. More practical skills for the student to develop.*

For the student respondents to the questionnaire who selected blended mode as the best mode for career preparation, the need for hands-on experience as well as the required knowledge to become as forensic scientist was the most common reason provided (Table 32). Only one student in Part A chose online delivery as the best mode to prepare them for a career in forensic science (Table 33).
Figure 22. Responses to question 4.4 of the Part A questionnaire. The mode of delivery perceived by forensic science students as providing them with the best preparation for a career in forensic science ($N=43$).
Table 31. Reasons provided by students in Part A questionnaire for selecting face-to-face mode as the method that best prepares them for a career in forensic science (*N*=19).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A forensic scientist needs excellent communication and teamwork skills as well as technical knowledge and skills.</td>
<td>28</td>
</tr>
<tr>
<td>This is the best way to participate in the practical aspects of the courses in forensic science.</td>
<td>25</td>
</tr>
<tr>
<td>The instructors are good forensic science role models.</td>
<td>19</td>
</tr>
<tr>
<td>There is more opportunity to work with people in person.</td>
<td>18</td>
</tr>
<tr>
<td>There are opportunities for excursions related to forensic science.</td>
<td>10</td>
</tr>
<tr>
<td>Another reason.</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>102</td>
</tr>
</tbody>
</table>
Table 32. Reasons provided by students in Part A questionnaire for selecting blended mode as the method that best prepares them for a career in forensic science (N=23).

<table>
<thead>
<tr>
<th>Responses</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I need hands-on practical experience as well as the required knowledge to become a forensic scientist.</td>
<td>25</td>
</tr>
<tr>
<td>Forensic scientists need to be able to work in both face-to-face and online environments.</td>
<td>19</td>
</tr>
<tr>
<td>It develops time management skills.</td>
<td>18</td>
</tr>
<tr>
<td>It promotes problem solving skills.</td>
<td>14</td>
</tr>
<tr>
<td>I need the practice at using computer technology in my chosen career but I also like to be able to participate in practical classes.</td>
<td>9</td>
</tr>
<tr>
<td>Another reason.</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>86</td>
</tr>
</tbody>
</table>
Table 33. *Reasons provided by students in Part A questionnaire for selecting online mode as the method that best prepares them for a career in forensic science (N=1).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forensic scientists need to be able to work independently as well as in a team situation.</td>
<td>1</td>
</tr>
<tr>
<td>It develops/ enhances time management skills.</td>
<td>1</td>
</tr>
<tr>
<td>It promotes problem solving skills.</td>
<td>1</td>
</tr>
<tr>
<td>One has to be self-motivated to ensure the work is completed and this is an excellent attribute for my future working life.</td>
<td>1</td>
</tr>
<tr>
<td>I need the practice at using computer technology in my working life.</td>
<td>1</td>
</tr>
<tr>
<td>Another reason.</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>

The findings regarding the student perceptions, according to their academic level, on the delivery mode for the best career preparation are presented in the next section.
4.341 Student perceptions according to academic level, on the delivery mode that best prepares students for a career in forensic science

The majority of undergraduate students (68%: \(N=28\)) selected blended as their preferred mode for career preparation and (71%: \(N=15\)) of postgraduate students selected face-to-face delivery (Figure 23).

Feedback from student interviews in Part B revealed that five students selected blended mode as their preferred mode to best prepare them for a career in forensic science (\(N=7\)). Only two students chose face-to-face mode.

Two interviewees in Part B cited the opportunity to acquire computing skills as a reason for selecting blended mode.

   SB2 Blended. As computer skills are required in any career.

   SB4 Blended. One to one interaction is required on the job. Also online be it research for a particular job or getting used to technology.

Another two interviewees thought that the ability to work with people in addition to working independently were necessary prerequisites for working in the forensic field.

   SB 5 Blended. You have to have people skills as well as do stuff on your own and interpret on your own. Quiet students would never talk to one another if it was all online. I don’t think fully online would be any good as it requires a great deal of dedication.

   SB6 Blended because if you’re just doing face-to-face you always have that person to go to whereas with online you don’t. You can work on your own or in a group. Blended gives both aspects.
Figure 23. Responses to question 4.4 of the Part A questionnaire. The mode of delivery perceived by forensic science students as providing them with the best preparation for a career in forensic science (N=43).

4.4 Australian tertiary students’ ideas for future directions in forensic science education.

Section five of the questionnaire in Part A of the study was included to explore students’ ideas on improving the delivery of forensic science. This section is related to Research Questions 1a), 1 b) and 1 c). This section consisted of one open question and, as such, common themes were identified and quantified.

The three most common ideas put forward by respondents to the questionnaire for future directions in forensic science education were industry partnerships-work experience (29%), the importance of practical skills (29%) and communication-teamwork-interpersonal skills (11%; N=35) (Figure 24). A sample of student comments from Part A for future direction in forensic science education are provided in Table 34.

Five out of the seven interviewees in Part B stated that forensic science students were different to students studying other tertiary programs. The points of difference included forensic science students being career-focused, requiring excellent practical, analytical and communication skills, technical knowledge and an understanding of the big picture science.
Only thirty five students (27%) responded to this question (N=108). Some responses included several ideas-themes and therefore a frequency histogram is provided (Figure 24).

![Frequency histogram](image)

**Figure 24.** Responses to question 5.1 of the Part A questionnaire. The four main ideas cited by students for forensic science delivery (N=35).
Table 34. A sample of responses to question 5.1 of the Part A questionnaire. Ideas for forensic science delivery.

<table>
<thead>
<tr>
<th>Idea for future directions</th>
<th>Sample of student comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry partnerships-Work experience</td>
<td>Forensic science students should be made to do a year’s work experience as well as do their study (SA007)</td>
</tr>
<tr>
<td></td>
<td>Courses with more industry partnerships. Visits to labs/courts. More generalist courses (SA101)</td>
</tr>
<tr>
<td></td>
<td>As a lower level e.g., undergraduate I think a mixed approach would work well to deliver them from practitioners of different backgrounds / experts from different places.....(SA103)</td>
</tr>
<tr>
<td>Importance of practical skills</td>
<td>In some courses I believe blended and online class structure would work. Not so in such a practical course as this.....(SA016)</td>
</tr>
<tr>
<td></td>
<td>There should be a combined approach comprising both theory and practical components. The theory is no good if as a student you cannot see, feel, touch the practical aspect. Forensic science is applied to real and living situations so being a good text book forensic scientist is not the same as being able to apply what you’ve learnt in the field. Perhaps more integration of the practical component into the theory would be beneficial (SA087).</td>
</tr>
<tr>
<td>Importance of interpersonal skills</td>
<td>.... it is unrealistic to expect to become employed within the field of forensics without strengthening professional communication skills, networking and gaining practical experience.....(SA089)</td>
</tr>
<tr>
<td></td>
<td>I think we need to be mindful that ultimately our clients (lawyers, defendants, complainants Police, coroners, courts etc.) require face-to-face interaction (SA110)</td>
</tr>
<tr>
<td>Interaction with teachers</td>
<td>Early days for me. I like the guidance of being able to interact and discuss issues with teachers- both practical and theoretical. But I am also self-motivated and am happy to do the required online work and research. I am confident I would not do well in a totally online environment unless there was some mechanism provided for ongoing and useful interaction with teachers (e.g., Skype? Which I haven’t used yet) (SA073).</td>
</tr>
<tr>
<td></td>
<td>....The requirement for interacting with instructors is there with all learning methods so it comes down to the individual.....(SA091)</td>
</tr>
<tr>
<td>Other</td>
<td>The difficulty for distance education is when there is a requirement for the students to complete assessment tasks using specialised equipment e.g., compound microscope and this is not available in the student work place (SA003)</td>
</tr>
<tr>
<td></td>
<td>Have higher opportunities available at Unis specific for forensic science (SA064)</td>
</tr>
</tbody>
</table>
Interviewees in Part B were asked a number of questions, 4.1 to 4.4 inclusive, on future directions in forensic science education and ideas for improvement. For question 4.1, the interviewees were asked how learning in higher education forensic science could be supported. Two of the students mentioned industry partnerships, also a common theme with the questionnaire respondents shown in Table 34. Student SB5 also raised the issue of the different protocols for different jurisdictions and how this caused confusion for the students.

SB5 More involvement with people in the field. It is difficult as crime scene workers are busy. Make our own protocols fit with real-life protocols. Stricter standards lead to better habits.

SB7 Support from industry.

All three first year students thought finance and equipment were needed to support learning in higher education forensic science with one student, SB1, also stressing the importance of linking science concepts to forensics. All these students studied core science units (biology, physics and chemistry) in the first semester of the course.

SB1 ...could be supported by including relevant information or linking what we are learning to forensics so that we understand why we are learning it as part of our course. Equipment would support the study of forensic science.

The previous comment from SB1, a first year student, is an interesting contrast to one of the final year students SB6.

SB6 The facilitator gives us a foundation and resources but we don’t want someone who tells you how to get to step C. You need to find out how to get to the destination. Learning to learn.

Question 4.2 in the student interview probed interviewees on their ideas about how learning in forensic science should be organised and structured. SB6 elaborated on what he-she meant by ‘learning to learn’.

SB6 Need to be put in the deep end first. Then explained how it’s done correctly. Then tested so the grade you have is a reflection on what you have learnt and what you have improved upon.
All the first year students and one second year student stressed the importance of practical lessons.

SB1 *As it is. It is good to do pracs often. Some classes, assignments could be better organised. Some subject guides are inaccurate as to when things are actually due.*

SB2 *More skills-based.*

SB3 *Mainly hands-on practical using standard equipment in a laboratory.*

SB5 *An even mixture of hands-on and science side. It is a wide industry so you don’t know both angles equally...*

Interview question 4.3 was included to find out how higher education forensic science programs differed from other courses offered at tertiary institutions. One first year student mentioned the forensic science tertiary institution partnerships as an excellent teaching resource and motivator for the students.

SB1 *Forensic science is a unique field and therefore the course is unique. It is a very strong science-based course which at times can make it difficult. Four hour blocks of science can be tiring. There is also a strong industry connection-partnership which is excellent in learning about forensics. People with experience in forensic science are a fantastic source of knowledge for students and forensic science. It also keeps us motivated and engaged.*

Two of the students, SB5 and SB7, had attended different courses at other tertiary institutions.

SB5 *(Name of both institutions) are different. (This institution) has hands-on work and we also get to do lab stuff. If people want to work in the police force they are smarter cops. We learn about anatomy and physiology, stab wounds etc. We are more informed.*

SB7 *Students (studying forensic science) are more career-focused.*

Another student disagreed.
SB6 I don’t think forensic science is different to other courses. We still have to learn how to verbally communicate with other people and need written skills. It is like a big picture of science. This institution is different as it is tailored to crime scene work as opposed to a biology degree.

Interview question 4.4 was included to find out if the interviewees thought higher education forensic science students were different from or similar to students who studied in other higher education programs. The majority of the interviewees (five students) thought that forensic science students were different to other students.

SB1 Different from other students in the way in which they analyse certain situations – different thought patterns etc.

SB2 Different. They have both a skills and theory-based mind-set.

One student, SB4, discussed how forensic science students must ensure that they avoid any legal convictions in order to gain employment within the industry.

SB4 Forensic science students need to ‘keep their noses clean’. If we get into trouble our futures are ruined. It changes how you have to think about things. It requires maturity.

Only one interviewee, SB6, thought there were no differences between forensic science students and students in other courses and one interviewee said they didn’t know if there were any differences between the two groups.

4.41 Summary

In summary, 48% (N=80) of forensic science students in Part A of this study had a positive online or blended learning experience while 10% had an entirely negative experience. Flexibility, was the most common benefit identified by students for online learning (47% N=30) and blended learning (33%, N=66). Issues with regard to feedback from the teacher was the main challenge identified by forensic science students in Part A for both online (40%; N=30) and blended delivery (40%; N=60). Blended delivery was the preferred mode for convenience (56%; N=61), confidence (52%; N=65) and career preparation (53%; N=43). Most students perceived face-to-face delivery as the mode that provides them with the best results (52%; N=56). The four main ideas cited by forensic science students for forensic science delivery were industry partnerships-work
experience, practical skills, interpersonal-communication skills and interaction with teachers.

The next chapter, Chapter Five, provides the findings from the teachers’ perspective on the different delivery modes used in forensic science education.
CHAPTER 5: TEACHER RESULTS

5.1 Introduction

This chapter presents the findings of the forensic science teachers’ experiences and perspectives of the different types of delivery modes. The chapter is divided into four sections. The first section provides background, demographic information on the teacher sample used in Part A, survey questionnaire and Part B, case study. The second section addresses research question 2a) on the teachers’ experiences of the different delivery modes. Section three pertains to research questions 2b) and 2c) on the teachers’ perceptions of the advantages and disadvantages and outcomes of the different delivery modes. Finally, in section four, data on teachers ideas for future directions in forensic science education are presented.

5.11 Part A Teacher questionnaire

There were 29 respondents to the teacher questionnaire in Part A of the study. The survey questionnaire was divided into five sections: demographic information, information about the course, the teachers’ experiences of online learning, the teachers’ preferences for the different delivery modes and future directions.

5.111 Demographic Information

The first section of the questionnaire focused on demographic information. Not all questions in this section were answered by all the participants. This may have been due to the fact that the respondents wanted to protect their identity.

The majority of teachers sampled in the Part A national survey questionnaire were male (70%) (Table 35). Forty five percent of teachers sampled were aged between 36 and 50 years (N=29) and there was an equal number of teachers (27.5%) in the 22-35 year and over 50 year age group (Table 36). Responses to the interview questions in Part B case study revealed that the majority of teachers (71%) were also aged within the 36 – 50 year age group but the most of the interviewees were female (57%: N=7).

Fifty nine percent of the teacher respondents, to the questionnaire in Part A, had experience in the forensic science industry (N=27) (Table 38). Only 44% of teacher
respondents had attended a crime scene ($N=27$) (Table 39) and 58% had attended court as an expert witness ($N=26$) (Table 40). In Part B, a lower percentage of teachers had forensic science experience (43%), had attended a crime scene (29%) and attended court as an expert witness (15%: $N=7$).

Most of the teacher respondents (76%; $N=29$) to the questionnaire in Part A taught full-time (Table 37) and the majority of teachers (47%; $N=29$) had between 11 – 20 years teaching experience (Table 41). The main area of expertise was in criminalistics scientific e.g., laboratory-based chemistry, physics, forensic biology (68%: $N=25$) (Table 42).

The teacher respondents to the Part A questionnaire often taught across different educational levels and, for this reason frequencies are provided (Table 43 and 44). The different levels include industry-based courses (6%), undergraduate (45%) and postgraduate programs (49%; $N=29$). From the data presented in Table 44, it is apparent that only 6% of the teachers had taught in industry-based courses ($N=29$).

Respondents to the questionnaire in Part A reported that the two most common delivery modes used were blended (49%) and face-to-face (42%; $N=29$) (Table 45). All interviewees in Part B case study taught units through blended mode at the time of the interview ($N=7$).

According to respondents in the questionnaire Part A, the vast majority of units taught at the time of survey completion were criminalistics scientific (52%; $N=17$)) (Table 46).

5.12 Part B Teacher Interviews (Phase 1 of case study)

For the purposes of anonymity, the seven teacher interviewees who participated in Phase 1 if the case study are identified in this chapter as TB1 to TB7 inclusive. Since it is important not to identify any of the interviewees, only a summary of the combined teacher profiles is provided. Of the seven teacher interviewees, one was between 22-35 years, five were aged between 35-50 years and one was over 50 years of age. The majority of the teacher interviewees, 4 out of 7, were female ($N=7$). Most of the respondents (4 out of 7) were teaching part-time. Four out of seven interviewees had between 1 – 5 years teaching experience, one teacher had between 6 – 10 years teaching experience and two interviewees had more than 20 years teaching experience.
The teacher interviewees represented a number of different forensic disciplines. These broad groups of disciplines were outlined by Samarji (2010). One teacher had experience in crime scene investigation, two interviewees had experience in criminalistics technical, one interviewee was experienced in the biomedical science area and the remaining two interviewees had experience that could be grouped into Samarji’s (2010) fifth category i.e. ‘other forensic specialties’.

Three out of the seven teachers interviewed had worked in the forensic science industry and of these two had attended a crime scene and only one had attended court as an expert witness. The interviewees’ profiles generally reflected the larger sample who responded to the questionnaire, however, there was a higher percentage of part-time teachers (57%; N=7) than in the questionnaire (24%; N=29). In addition, a lower percentage of interviewees (43%) in the Part B case study had forensic science experience than the respondents in Part A. This was also reflected in the lower percentage of interviewees who had crime scene experience or attended court as an expert witness. Also, the percentage of females (57%: N=7) was greater for the interviewees in Part B than the questionnaire in Part A (30%: N=29). This was possibly due to the fact that the Canberra Institute of Technology delivers some subjects through distance delivery with a residential workshop component. Industry experts are often employed as casual teachers to deliver subjects in their area of expertise.
Table 35. *Percentage of male and female teachers who participated in Part A questionnaire (N=29).*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 36. *Age group of teachers who participated in Part A questionnaire (N=29).*

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-21</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>22-35</td>
<td>8</td>
<td>27.5</td>
</tr>
<tr>
<td>36-50</td>
<td>13</td>
<td>45.0</td>
</tr>
<tr>
<td>&gt;50</td>
<td>8</td>
<td>27.5</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Table 37. *Percentage of part-time and full-time teachers participants in Part A questionnaire (N=29).*

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time</td>
<td>22</td>
<td>76</td>
</tr>
<tr>
<td>Part-time</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 38. *Teachers in Part A questionnaire with experience in the forensic science industry (N=27).*

<table>
<thead>
<tr>
<th>Employment in forensic science</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>16</td>
<td>59</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 39. *Teacher participants in Part A questionnaire who had attended a crime scene (N=27).*

<table>
<thead>
<tr>
<th>Attended a crime scene</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>12</td>
<td>44</td>
</tr>
<tr>
<td>No</td>
<td>15</td>
<td>56</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 40. *Teacher participants in Part A questionnaire who have attended court as an expert witness (N=26).*

<table>
<thead>
<tr>
<th>Attended court as an expert witness</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>15</td>
<td>58</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 41. *Years of teaching experience for teacher participants in Part A questionnaire (N=15).*

<table>
<thead>
<tr>
<th>Number of years teaching experience</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 – 5 years</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>6 – 10 years</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>11 – 20 years</td>
<td>7</td>
<td>47</td>
</tr>
<tr>
<td>More than 20 years</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 42. *Part A questionnaire teacher participants’ areas of expertise (N=25).*

<table>
<thead>
<tr>
<th>Area of expertise</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crime scene investigation</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Criminalistics technical</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Criminalistics scientific</td>
<td>17</td>
<td>68</td>
</tr>
<tr>
<td>Forensic biomedical</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 43. Academic programs taught by the Part A questionnaire respondents (N=29). Respondents were able to choose more than one program if appropriate.

<table>
<thead>
<tr>
<th>Program</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Bachelor Degree Course</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Industry based course - Certificate level</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Industry based course – Diploma level</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Industry based course - Advanced Diploma level</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Industry based course - Masters level</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Undergraduate Bachelor of Science with forensic electives</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bachelor of Forensic Science</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>Bachelor of Forensic Science with honours</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Postgraduate diploma in Forensic Science</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Master of Forensic Science</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>PhD Forensic Science</td>
<td>12</td>
<td>26</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 44. *Consolidated academic levels taught by forensic science teacher respondents to Part A questionnaire (N=29).*

<table>
<thead>
<tr>
<th>Consolidated academic program</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry-based</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Bachelor degree (Pass and honours)</td>
<td>21</td>
<td>45</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>23</td>
<td>49</td>
</tr>
<tr>
<td>Other (includes associate degrees)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


Table 45. *Modes of delivery used for the units taught by teacher participants in Part A questionnaire (N=29). Respondents were able to choose more than one mode of delivery if appropriate.*

<table>
<thead>
<tr>
<th>Mode of delivery</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>14</td>
<td>42</td>
</tr>
<tr>
<td>Blended</td>
<td>16</td>
<td>49</td>
</tr>
<tr>
<td>Entirely online</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Research</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Table 46. Units taught by teacher participants in Part A questionnaire at the time of survey completion (N=17).

<table>
<thead>
<tr>
<th>Unit taught</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crime scene investigation</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Criminalistics technical</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>Criminalistics scientific</td>
<td>10</td>
<td>52</td>
</tr>
<tr>
<td>Forensic biomedical</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100</td>
</tr>
</tbody>
</table>

This section provided a description of the sampled teachers’ demographic information. The next three sections of this chapter provide the analysed data from Part A and Part B of the study in order to address the research questions pertaining to forensic science teachers.

5.2 Australian tertiary teachers’ experiences of different delivery modes used in forensic science

Section three of the questionnaire in Part A of this study was designed to provide data to directly address Research Question 2a).

What are Australian tertiary teachers’ experiences of delivery modes (face-to-face, mixed and online) for forensic science?

5.21 Experience with online or blended delivery

The most common subject category taught via online or blended mode was criminalistics scientific (N=18) (Figure 25). Teacher respondents to Part A questionnaire were almost evenly divided with respect to their experience of interactive online
facilitation. There were slightly more teachers with no experience (52%) in interactive online facilitation than those with experience (48%; N=21). Discussion forums and virtual classrooms were the two most common online interactive activities experienced by teachers (N=21) (Figure 26).

Figure 25. Responses to question 3.1a) of the Part A questionnaire. Teachers’ experience with online or blended delivery (N=18).
In Part B of this study, I used discussion forums in both my first year and third year blended classes. The first year students used the animal ethics discussion, described in Appendix J, as part of the formative assessment with limited success i.e., six out of ten students participated. However, the third year students were required to contribute posts on three different topics as part of their assessment on research methodology. The following is an excerpt from my teaching journal.

*With the first couple of discussion topics, I replied to every post. I became busier towards the end of semester and the discussion forums began to ‘take on a life of their own’. i.e., the students began to bring up other related topics. Nearly all the students were contributing as they knew it would count towards their final mark (20% weighting on tutorial participation). I was very impressed with the quality and quantity of student postings. I notified the students in class and via email during semester (of a change to the date of the summative assessment). ... A student lodged an appeal on a fail grade. The student had not made any posts in*
the allocated time for online discussion (summative assessment). This student was consistently late to class and had missed the instructions. It was decided between (names of staff) that due to the ambiguity in the subject guide, the student could gain a pass on tutorial participation because he had made one post on a formative discussion (topic). Lesson learnt: Changing the online forum discussion date would be like changing an exam date and not informing the student. Written instructions need to be precise at the beginning of Semester.

One of the interviewees, TB7, describes his/her experience with virtual classrooms in online delivery.

TB7 Online students who get through (are) generally resourceful. Students who can’t self-motivate find it difficult. I use virtual classrooms to amend their experience. It’s an interaction tool to allow us to meet on a weekly basis and discuss content for that week. Students who went through that mode went through with a better attrition rate. The problems with online is that you need to be good with computer and keyboard skills. You can be writing an answer and it takes forever to mark. I use a word document of sample comments and am able to cut and paste. It saves the teacher time and provides consistency of feedback.

5.2.11 Benefits and challenges of online delivery from the teacher perspective

Most teachers in the questionnaire in Part A cited the main benefits of online delivery for teachers as being able to conduct classes across different time zones without having to travel and also convenience for the teacher (Table 47). Most of the interviewees in Part B listed flexibility and the ability to reach remote students as a benefit for online delivery.

TB3 Students, teachers or employers may be remote. It allows learning when isolated and no expense for travel to the residential school. The students, especially mature-age working and with family commitments, can fit the lectures in at a time that suits them and not have to rely on a structured system. This is also true for teachers who are industry professional who may be complementing their primary role within the forensic field with a passion for teaching and imparting their knowledge with students.
Flexibility suits workers. It’s cheaper. More students and engages people who wouldn’t normally turn up.

Flexibility. It’s a learning space rather than a course. Work at own pace. Inspiring - hopefully.

To be national and international...People have unusual work hours, can study in their own time, at their workplace. There is a lot of visual information...

Two interviewees were emphatic that they would never use online delivery. Here is a sample comment.

I would never use fully online. It’s sterile. You lose the two way communication and physical expression.

In response to another interview question (Q2.3), TB7 described a successful online lesson that included measures to address some of the limitations to this delivery mode.

Students have dead-lines but can fast track themselves.....They need to get through the subject in (number of) days. The course has every lesson. They can submit on the due date or early. I ask the students to make changes to their submission to ensure authenticity. Each topic has a U-tube video to support and give a different perspective to learning.

The main challenge for online delivery identified by teachers in Part A were technical difficulties experienced by staff and students and the reliance on IT support (N=28) (Table 48). The next most common challenges were ensuring the authenticity of student work and the time spent in preparation for online delivery. Four out of seven interviewees also mentioned the reliance on IT technology, two of whom (TB5 and TB6) mentioned the issue of confidence in using current information technology.

Initial fear in approaching online (delivery) for a certain age group.

Feeling comfortable with technology. Not being able to translate what we do in class to directly online. You need to be more creative online (with) different types of activities.
Another two teachers (TB2 and TB7) spoke of the need to keep up-to-date with technology and to make the course user-friendly.

**TB2** Making it user-friendly and interactive. For example discussion forums. Wimba (virtual classrooms) are a good idea. The limitations are that you can’t create an interactive power point.

**TB7** Keeping up-to-date with technology. You need good computing skills, design skills, preventative measures / contingency plans. Learning to converse in a new format. You need to look at security of assessments – if it is up (online). Authenticity – is it really them?

Interviewee TB1 agreed with some teachers in part A that he/ she had no way of knowing whether or not the content was being understood.

**TB1** A lack of awareness of the classes’ comprehension. Knowing the right level of detail to put online.

The issue of no opportunity for practical work was raised by one interviewee.

**TB3** No face-to-face component. It may not foster good communications between teacher and student. No practical demonstrations which may be critical for some forensic science subjects.

In response to another interview question (Q2.4), TB7 provided an example of an unsuccessful online lesson and discussed the measures that could be taken to improve upon it next time. TB7 was running an online class from home that was scheduled between 7 - 8 pm that evening.

**TB7** I was running (name of unit) that used a mixture of online and materials. As an online teacher you need a contingency plan. .. I used the home machine but I also had a lap top -not going. There was a power failure that night that led to a shut-down five minutes into the lesson. I could have had a USB or a conference call by telephone. It took 20 minutes in the dark to set it up. You need to be prepared.
Table 47. The frequency of responses to question 3.2 of the Part A questionnaire. The benefits of online delivery from the teacher perspective (N=27).

<table>
<thead>
<tr>
<th>Benefits of online delivery</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>They can conduct classes with students across different time zones without having to travel.</td>
<td>16</td>
</tr>
<tr>
<td>They can perform their teaching duties at their convenience.</td>
<td>11</td>
</tr>
<tr>
<td>It provides opportunities for immediate private feedback or correction.</td>
<td>9</td>
</tr>
<tr>
<td>They don’t have to deal with students who don’t want to be there.</td>
<td>5</td>
</tr>
<tr>
<td>It provides a record of class participation.</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
</tr>
</tbody>
</table>
Table 48. *The frequency of responses to question 3.3 of the Part A questionnaire. The key challenges of online delivery from the teacher perspective.*

<table>
<thead>
<tr>
<th>Key challenges of online delivery</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a reliance on Information Technology (IT) support, technical difficulties and / or the students may not be able to use it properly.</td>
<td>8</td>
</tr>
<tr>
<td>It is difficult to know who is actually doing the assessment.</td>
<td>7</td>
</tr>
<tr>
<td>They end up spending more time preparing on-line courses than face-to-face courses.</td>
<td>7</td>
</tr>
<tr>
<td>They are on call every day because students expect an immediate response.</td>
<td>6</td>
</tr>
<tr>
<td>They don’t know whether content is being understood.</td>
<td>6</td>
</tr>
<tr>
<td>The rapport and engagement of students.</td>
<td>6</td>
</tr>
<tr>
<td>They end up feeling more like a facilitator or trouble-shooter than a teacher.</td>
<td>5</td>
</tr>
<tr>
<td>Other.</td>
<td>7</td>
</tr>
</tbody>
</table>
5.212 Benefits and challenges of blended delivery from the teacher perspective

The main benefit of blended delivery identified by teachers in Part A, was the flexibility it afforded the teacher i.e. they could work when and where the liked (N=28) (Table 49). The second most common benefit was that blended delivery provided the ‘best of both worlds’ with the flexibility of online delivery and the personal interaction of face-to-face delivery. There was no equivalent question in Part B, but interviewees were asked to describe a successful lesson delivered online (question 2.3). All these teachers delivered units through blended mode. For confidentiality, the name of the unit taught, is not provided.

TB6 (Name of unit) The students read stuff online and did a little research on legislation and then referred to the text. It was active (learning). They need to do things rather than just read.

TB1 I had given lectures this year and the students had requested practice questions. Rather than spend class time, I have put it directly online.

TB2 (Name of unit) is a repository of information. Next semester I hope to make it more interactive with simulations so they can explore concepts rather than just read the text.

The main challenge of blended delivery identified by teachers in Part A was that the online component needed to be relevant and interactive rather than a place to ‘dump’ lecture notes (N=26) (Table 50). There was no equivalent question in Part B, but interviewees were asked to describe an unsuccessful lesson delivered online (question 2.4). All these teachers delivered units through blended mode. For confidentiality, the name of the unit taught, is not provided.

TB6 (Name of unit). A PowerPoint with no voice-over didn’t work, Arrows on one slide showed the direction of (name provided). Arrows on another showed the evidence item. The students found that confusing. I would use Camtasia to voice over the power points next time.

TB1 I had given lectures this year and the students had requested practice questions. Rather than spend class time, I have put it directly online.
TB2 (Name of unit) is a repository of information. Next semester I hope to make it more interactive with simulations so they can explore concepts rather than just read the text.

During the teaching study in Phase 2 of Part B, I conducted a virtual classroom as part of the interactive entomology course. This involved using a PowerPoint presentation and a Universal Serial Port (USB) microscope to view maggots. I conducted a trial using the USB microscope three days earlier. There were ten students in a computing room with another teacher / moderator providing technical assistance. I was in another room. Here is an excerpt from my teaching journal that provides an insight into potential pitfalls for the inexperienced online facilitator.

Had technical assistance from (name of teacher) who ensured all students could hear and use microphone talk function. I ran through rules and etiquette i.e. if you wish to pose a question use text function at bottom of screen or wait until the end of power point, then raise the hand icon and use microphone. No drawing tools unless requested etc. ...I had difficulty focussing the microscope while it was on the stand. The stand was too light and the microscope kept toppling over. If I hand-held it, I couldn’t keep it still. Even though it could be used up to 230X (magnification), the resolution was poor. ... Sometimes I forgot to press the talk button at the beginning so the students may have missed some of what I had to say. Eventually the other moderator reminded me to lock the talk button.
Table 49. The frequency of responses to question 3.4 of the Part A questionnaire. The benefits of blended delivery from the teacher perspective (N=28).

<table>
<thead>
<tr>
<th>Benefits of blended delivery</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>It gives teachers the time and flexibility to work online when and where they want.</td>
<td>15</td>
</tr>
<tr>
<td>It provides the ‘best of both worlds’; the convenience of online delivery and the personal approach of face-to-face delivery.</td>
<td>13</td>
</tr>
<tr>
<td>It allows teachers to cover more material e.g., have extra tutorials, use message boards etc.</td>
<td>12</td>
</tr>
<tr>
<td>All learning material / assessment guidelines are online so the students can’t say they didn’t get a copy. There is no need to print out lecture notes.</td>
<td>12</td>
</tr>
<tr>
<td>It provides a record of class participation for the online component.</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
</tr>
</tbody>
</table>
Table 50. *The frequency of responses to question 3.5 of the Part A questionnaire. The key challenges of blended delivery from the teacher perspective (N=26).*

<table>
<thead>
<tr>
<th>Key challenges of blended delivery</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>The online component must be relevant and interactive so the students see it as valuable and entertaining e.g., active discussions, self-assessment etc. rather than a place to ‘dump’ lecture notes.</td>
<td>14</td>
</tr>
<tr>
<td>They may require IT training for the online component.</td>
<td>9</td>
</tr>
<tr>
<td>Increased preparation time for the online component.</td>
<td>9</td>
</tr>
<tr>
<td>They need to be a trouble shooter as well as a teacher.</td>
<td>6</td>
</tr>
<tr>
<td>It provides a structured learning package which includes support and feedback to students.</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
</tr>
</tbody>
</table>

This section examined the teachers’ experiences of the different types of delivery. The next section provides the results and discussion of the teachers’ perceptions of the different delivery modes.
5.3 Australian tertiary teachers’ preferences for different delivery modes used in forensic science

Section four of the teacher questionnaire, Part A, was broadly divided into two sections, which address Research Questions 2b) and 2c) respectively.

*What are Australian tertiary teachers’ perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?*

*How do teachers perceive student outcomes as a result of different delivery modes for forensic science?*

The first part of section four consists of Part A questionnaire consisted of three two-tiered questions that are applicable to all forensic science teachers, regardless of the academic level they teach. The second part of section four consisted of twelve two-part questions and referred to the three academic levels; diploma, undergraduate and postgraduate level. Respondents were able to select the relevant sections.

There were three two-tiered questions in the first part of section four. A few responses could not be ascertained i.e. 3%, in questions 4.1, 4.2 and 4.3 inclusive. The problem with regard to responses to the two-tiered questions in the student questionnaire was discussed in Chapter Four. However, the teacher respondents had less difficulty interpreting this type of question compared with the students.

The first part of section four of the teacher questionnaire focused on the teachers’ preferred delivery modes for convenience and confidence to teach forensic science and their perception of which delivery mode achieves the best outcomes for students.

5.3.1 Teacher perceptions for the most convenient delivery mode to teach forensic science

The majority of respondents (53%), in Part A, chose blended mode as the most convenient method to teach forensic science (N=19) (Figure 27). Most of the interviewees (57%) in Part B also selected blended mode for convenience to teach forensic science (N=7). The most common reason provided by teachers in Part A for choosing blended mode for convenience to teach forensic science was the opportunity to spend face-to-face time with the students and the flexibility to choose the times for online work (N=10) (Table 52). Most of the interviewees in Part B who selected
blended mode for convenience mentioned the advantages of being able to participate in practical work and the added advantage of the student being able to spend more time on theory through online work.

TB5 *Students can complete theory in their own time but also do practical activities.*

TB7 *(Blended mode) gives a mixture a face-to-face hands-on experience. They can work through more difficult concepts. You can get a better idea of their learning style. Online is good for pre-reading.*

For those teachers in Part A who chose face-to-face mode for convenience, the main reasons provided were that teachers perceived it as easier to judge how the students understood the information and also the ability to provide immediate feedback to the students (*N*=6) (Table 51). Only one out of seven interviewees in Part B selected face-to-face mode in terms of convenience to study forensic science because it enabled him/her to provide immediate feedback and the flexibility allowed him/her to adjust the lesson in real time according to student needs.

TB1 *You can give immediate feedback and adjust as the lesson progresses.*

For those teachers who chose online delivery for convenience, the main reasons provided included the ease of updating the course, the lack of traditional time constraints and not having to deal with difficult students (*N*=3) (Table 53).
Figure 27. Responses to the first tier of question 4.1 of the Part A questionnaire. The mode of delivery perceived by forensic science teachers as being the most convenient method to teach forensic science (N=19).
Table 51. *Reasons provided by teachers in the Part A questionnaire for selecting face-to-face delivery as the most convenient mode to teach forensic science (N=6). Teachers could choose more than one reason.*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is easier to judge how the students are absorbing the information.</td>
<td>5</td>
</tr>
<tr>
<td>I am able to provide immediate feedback to the students.</td>
<td>3</td>
</tr>
<tr>
<td>I live close to my work place.</td>
<td>2</td>
</tr>
<tr>
<td>I am most familiar with this method so there is less time spent on preparation.</td>
<td>3</td>
</tr>
<tr>
<td>I am unfamiliar with computer technology.</td>
<td>0</td>
</tr>
<tr>
<td>Another reason.</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
</tr>
</tbody>
</table>
Table 52. Reasons provided by teachers in the Part A questionnaire for selecting blended delivery as the most convenient mode to teach forensic science (N=10). Teachers could choose more than one reason.

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy spending time with students as well as the flexibility to choose when I want to do the online component.</td>
<td>6</td>
</tr>
<tr>
<td>There are multiple ways to meet the course objectives</td>
<td>5</td>
</tr>
<tr>
<td>It gives me the flexibility to catch up on work.</td>
<td>4</td>
</tr>
<tr>
<td>I can deliver pre-work, assessment and reference material online.</td>
<td>4</td>
</tr>
<tr>
<td>It allows for evolving course material where I am able to make changes easily.</td>
<td>3</td>
</tr>
<tr>
<td>Another reason.</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
</tr>
</tbody>
</table>
### Table 53. Reasons provided by teachers in the Part A questionnaire for selecting online delivery as the most convenient mode to teach forensic science (N=3). Teachers could choose more than one reason.

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have more flexibility in my working day</td>
<td>2</td>
</tr>
<tr>
<td>It is the easiest method to update course material.</td>
<td>1</td>
</tr>
<tr>
<td>There are less traditional time constraints.</td>
<td>1</td>
</tr>
<tr>
<td>I don’t have to deal with conflict between students.</td>
<td>1</td>
</tr>
<tr>
<td>I can perform my teaching duties when and where I like.</td>
<td>1</td>
</tr>
<tr>
<td>I can deliver classes to distance students.</td>
<td>1</td>
</tr>
<tr>
<td>Another reason.</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

#### 5.32 Teachers’ perceptions on the delivery mode for confidence to teach forensic science.

Most of the teacher respondents (45%) in Part A questionnaire chose face-to-face mode for confidence to deliver forensic science (N=18) (Figure 28). This finding was supported by three of the seven interviewees in Part B. The two most common reasons cited by teachers in Part A for choosing face-to-face mode for confidence to deliver forensic science were that they could tell if students understood the material and that they could build rapport with the students (Table 54).

Comments from the teachers in response to interview question 3.2, in Part B, suggest how their confidence in teaching forensic science relies to some extent on interaction with the students. Teachers, TB2 and TB4, mentioned how they were able to pick up
cues from the student regarding how they were responding to the concepts being taught.

 TB2 *Pick up so much more in the classroom environment ‘non-verbal stuff’.*

 TB4 *Instant feedback. You know where they are going wrong and can fix it on the spot.*

Another teacher, TB6, discussed the advantage of being able to deliver practical activities and how he/she could raise the level of difficulty to challenge the students.

 TB6 *Face-to-face. You can concentrate on theory and practical activities without having to worry about computer problems. You can give immediate feedback and students can ‘practice under pressure’.*

For those teachers in Part A who chose blended delivery for confidence to teach forensic science, the most common reason provided was that it promotes self-directed learning and provides flexibility of content delivery (Table 55).

One the interviewees in Part B who chose blended as their preferred delivery mode for confidence to teach forensic science was referring to students who were already working in the forensic science industry.

 TB6 *Blended. Because I can see what they have done before they attend the residential (workshops). It allows learners to come prepared if they do the work.*

Another interviewee, TB1, mentioned the advantage of being able to place work online.

 TB1 *Blended. I prefer face-to-face but if there is anything we don’t get around to in class I can put it online to cover it.*

Only one teacher in Part A chose online delivery for confidence and cited his/her skill in using computer technology as one reason for their choice (Table 56). One interviewee, TB7, agreed with the issue of having to deal with difficult situations in class.
TB7 Online delivery. If you are still in a face-to-face situation, students can have issues and utilize you more for personal problems. In a classroom, students may use you more as a counsellor. In online you can mark at any time.

For the teachers who selected more than one mode (12%) (Figure 28), the reason provided was that the choice of delivery mode depends on the program being taught (N=18). One interviewee, TB3, selected more than one mode for confidence depending on the program being taught.

TB3 Face-face- for students out of school as they have no industry experience or prior learning. Blended - for people working in industry as their knowledge is already supported by experience. These however could be interchangeable if the course is structured correctly.

Also relevant to a teacher’s confidence in teaching tertiary forensic science would be their preferred adult learning approaches; lecture-based, practice-based and –or problem-based. Four out of the five teachers used all three approaches. The remaining teacher, TB2, had a preference for problem-based learning but recognised the need for some lecture-based learning.

TB2 Problem-based but you need lecture style to get the information across and gain theory for problem-based.

These findings are generally consistent with the students’ opinions in Part B of the student questionnaire discussed in Chapter Four.
Figure 28. Responses to question 4.2 of the Part A questionnaire. The mode of delivery perceived by forensic science teachers that makes them feel most confident when teaching forensic science ($N=18$).
Table 54. *Reasons provided by teachers in the Part A questionnaire for selecting face-to-face delivery for confidence to teach forensic science (N=10). Teachers could choose more than one reason.*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can tell if the students understand the material.</td>
<td>8</td>
</tr>
<tr>
<td>I am able to build rapport with my students.</td>
<td>5</td>
</tr>
<tr>
<td>I find personally interacting with other students gives me confidence.</td>
<td>2</td>
</tr>
<tr>
<td>I find the face-to-face information and instruction gives me confidence.</td>
<td>1</td>
</tr>
<tr>
<td>I am not confident with using computer technology for teaching forensic science.</td>
<td>0</td>
</tr>
<tr>
<td>Another reason.</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>
Table 55. *Reasons provided by teachers in the Part A questionnaire for selecting blended delivery for confidence to teach forensic science (N=7).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>It promotes both self-directed learning and students can take responsibility for their own learning.</td>
<td>2</td>
</tr>
<tr>
<td>It allows flexibility in content delivery and I can gauge how deeply I need to go into a particular area.</td>
<td>2</td>
</tr>
<tr>
<td>I feel having access to both face-to-face instruction and online instruction gives students two options for working things out.</td>
<td>1</td>
</tr>
<tr>
<td>It gives me time to learn about online delivery without having to use it exclusively.</td>
<td>1</td>
</tr>
<tr>
<td>Another reason.</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
</tr>
</tbody>
</table>
Table 56. *Reasons provided by teachers in the Part A questionnaire for selecting online delivery for confidence to teach forensic science (N=4).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am skilled with computer technology and this gives me confidence.</td>
<td>1</td>
</tr>
<tr>
<td>I can cover more material.</td>
<td>1</td>
</tr>
<tr>
<td>I don’t have to deal with students who don’t want to be in class.</td>
<td>1</td>
</tr>
<tr>
<td>I don’t have to deal with conflict between students.</td>
<td>1</td>
</tr>
<tr>
<td>I am an introvert and I participate more using this method.</td>
<td>0</td>
</tr>
<tr>
<td>It promotes self-directed learning so students take responsibility for their own learning.</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
</tr>
</tbody>
</table>

5.33 Teachers’ perceptions for the delivery mode that achieves the best outcomes in forensic science education.

The last two questions of section four of the questionnaire relate to Research Question 2 c)

*How do teachers perceive student outcomes as a result of different delivery modes for forensic science?*

The majority of teacher respondents to the questionnaire (75%) selected blended mode as the delivery method that best prepared students for a career in forensic science (N=16) (Figure 29). None of the teachers in Part A selected online mode in order to prepare students for a career in forensic science. Four of out the seven
interviewees in Part B agreed. The most common reasons provided by teachers for choosing blended mode as the best career preparation for forensic science students was the flexibility of the online learning component allowing more time for self-paced learning and that forensic scientists need to be able to work both in face-to-face and online environments in their jobs (Table 58). Also considered to be important was the need to be able to work in both face-to-face and online environments. One of the interviewees, TB5, agreed.

TB5 *Our students are already working in forensic science but if they weren’t they must get to know and understand people and also blended needs computer skills. A support base is available and can get to know people.*

TB2 *Blended. They need a basic understanding of theory and practical skills.*

One teacher, TB3, was ambivalent as to whether to choose face-to-face or blended mode.

TB3 *Face-to-face and blended because they both have more practicals / demonstrations and learning. Some students will learn better if they can conceptualise through action.*

For those teachers who selected face-to-face mode as the best career preparation for forensic science students, the two most common reasons provided were that teachers can take time with the students, gauge the level of learning and provide feedback and that it was the best method in terms of practical activities and simulated workplaces (Table 57). One of the interviewees in response to question 3.4, Part B, TBI agreed,

TB1 *Face-to-face. Need to develop more practicals skills for students.*
Figure 29. Responses to question 4.3 of the Part A questionnaire. The mode of delivery perceived by teachers as providing the best forensic science career preparation for students \((N=16)\).
Table 57. *Reasons provided by forensic teachers in the Part A questionnaire for selecting face-to-face delivery as the preferred mode to best prepare students for a career in forensic science (N=5).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>The teachers can take time with the students, gauge the level of learning and provide feedback.</td>
<td>2</td>
</tr>
<tr>
<td>This way is the best way to participate in the practical aspects of the course in forensic science.</td>
<td>2</td>
</tr>
<tr>
<td>This is the best way in which to provide a simulated workplace.</td>
<td>2</td>
</tr>
<tr>
<td>Regular interaction means the teacher can establish rapport with the students and decrease communication barriers.</td>
<td>2</td>
</tr>
<tr>
<td>The students are provided with opportunities to meet forensic science guest speakers.</td>
<td>1</td>
</tr>
<tr>
<td>Another reason</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>
Table 58. *Reasons provided by forensic teachers in the Part A questionnaire for selecting blended delivery as the preferred mode to best prepare a student for a career in forensic science (N=11).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students like some level of online learning to do in their own time. It allows the students more time to revisit the lecture notes, data from demonstrations/ experiments etc.</td>
<td>8</td>
</tr>
<tr>
<td>Forensic scientists need to be able to work both in face-to-face and online environments in their jobs.</td>
<td>8</td>
</tr>
<tr>
<td>It provides opportunities for students to gain computer skills that are an important part of their job.</td>
<td>7</td>
</tr>
<tr>
<td>There are increased opportunities for human interaction, communication and contact among students.</td>
<td>5</td>
</tr>
<tr>
<td>There are more opportunities for peer tutoring as the student community consists of experienced forensic scientists as well as inexperienced undergraduates.</td>
<td>3</td>
</tr>
<tr>
<td>Another reason.</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
</tr>
</tbody>
</table>

The first part of section four in the Part A questionnaire was aimed at all forensic science teachers, regardless of the academic level in which they taught. The next part of section four examined the teachers’ opinions on the best delivery mode for convenience, confidence, student outcomes and career preparation according to the student’s academic level, that is, diploma, undergraduate and postgraduate level.
5.34 Teachers’ perceptions on the best delivery mode for students according to their academic level

5.341 Diploma students working in forensic science

The majority of teachers who responded to the Part A questionnaire (57%) perceived blended delivery as the most convenient mode for diploma students to study forensic science (N=14) (Figure 30). Most teachers listed time management and work commitment as limiting factor in their choice of delivery methods in terms of convenience for diploma students (Table 59). Another issue apparent in Table 59 is practical work but some teachers were divided as to whether it should be incorporated in the course (TA005) or not (TA007 and TA012).

Most teachers who responded to the Part A questionnaire (64%) selected blended delivery for diploma students in term of confidence to study forensic science (N=14) (Figure 30). The most common reason provided by teachers for choosing blended mode for confidence to diploma students was that interaction with staff and students allowed for more feedback than just online (Table 60).

Blended delivery was perceived by the majority of teachers (72%; N=14) as providing the best outcomes for diploma students (Figure 30) with the main reason being the flexibility that it offered (Table 61). One respondent, TA009, chose face-to-face delivery because he/she thought the students learnt best when they could apply their knowledge through practical sessions.
Figure 30. Responses to questions 4.4, 4.5 and 4.6 of the Part A questionnaire. Teachers’ perception of the best delivery mode, in terms of convenience (N=14), confidence (N=14) and best outcomes (N=14) for diploma forensic science students, working in the police force.
Table 59. A sample of teacher comments in the Part A questionnaire regarding their choice of delivery mode for diploma students in terms of convenience to study forensic science.

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Teacher comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blended</td>
<td><em>Police are time poor – being able to complete tasks online with face-to-face support/practicals overcomes this challenge (TA002)</em>  &lt;br&gt;They would be working/employed so this method would be supporting their time management (TA004)  &lt;br&gt;Practical scene examination is predominantly hands-on (TA005)  &lt;br&gt;I would hope their employers would support their learning and so would allow time off for the face-to-face time at University. If this time is scheduled then there is less pressure for all study to be done in their own time leading to a less stressful family/home life (TA006)</td>
</tr>
<tr>
<td>Online</td>
<td><em>Time management is the key. Online has some drawbacks but it is more flexible (TA014)</em>  &lt;br&gt;They already have practical experience (TA012)  &lt;br&gt;This method will be the most easy to fit around their day-to-day duties as serving officers (TA013)  &lt;br&gt;They have access to the practical aspect of hands-on training with colleagues and hence need more theory and opportunity for critical reflection (TA007)*</td>
</tr>
</tbody>
</table>
Table 60. A sample of teacher comments in the Part A questionnaire regarding the type of delivery mode for diploma students in terms of confidence to study forensic science.

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Teacher comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Face-to-face</strong></td>
<td>Most used to face-to-face interaction in the workplace (TA001)</td>
</tr>
<tr>
<td></td>
<td>They may want to ask more questions (009TA)</td>
</tr>
<tr>
<td></td>
<td>Students can concentrate on learning content and acquiring practical skills without having to worry about computer problems. They have access to lecturers and immediate feedback. Can interact with other students / learn to work collaboratively with their peers (TA029)</td>
</tr>
<tr>
<td><strong>Blended</strong></td>
<td>A lot of content can be covered online but there is still that professional interaction with teachers and forensic science professionals (TA021)</td>
</tr>
<tr>
<td></td>
<td>They constantly have to deal with technology / computers so the blended method would give them more experience and confidence in future. (TA004)</td>
</tr>
<tr>
<td></td>
<td>The face-to-face interaction would allow them time to ask direct questions when they are fully focused on study and not distracted by other pressures from their full time job (TA006)</td>
</tr>
<tr>
<td><strong>Online</strong></td>
<td>May not get required support from supervisor (TA010)</td>
</tr>
</tbody>
</table>
Table 61. A sample of teacher comments in the Part A questionnaire regarding the type of delivery mode terms of the best outcomes for diploma students working in the police force.

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Teacher comments</th>
</tr>
</thead>
</table>
| Face-to-face          | *Convenience to ask more questions (TA009)*  
                        | *They learn best when they can apply the theory they have learnt during practical sessions (TA011)*  
| Blended               | *I think this method gives opportunities to build the best skills for a serving officer – both the ability to learn at their own pace and the ability to interact in a classroom setting (TA013)*  
                        | *Gives them time to work when the situation allows and personal contact with the teacher as well (TA015)*  
                        | *Blended provides the best academic support (TA021)*  
| Online                | *More likely to be supported and is achievable (TA007)*  
                        | *Work commitments (TA008)*  
| All modes             | *I would say that no one method is better than another as far as results go (T005)*  |
5.342 Undergraduate forensic science students

Questions 4.7 to 4.9 inclusive of the questionnaire relate to the teachers’ perception of the best delivery mode for undergraduate forensic science students, in terms of convenience, confidence and best outcomes respectively. There was a 97% response rate to all these questions.

The majority of teachers (72%) perceived blended delivery as the most convenient mode for undergraduate students to study forensic science (N=18) (Figure 31). Flexibility was the most common reason provided by teachers for choosing blended mode, in terms of convenience for undergraduate students (Table 62). The vast distances that some students have to travel was one reason for teacher, TA006, choosing blended mode for convenience. Although teacher, TA017, listed blended as a preferred mode for convenience, he/she mentioned that a limiting factor was whether or not the students had a proven track record of achievement.

Most teachers (50%) perceived blended delivery as the best method for students’ confidence to study forensic science (N=18) (Figure 31). The most common reason provided by teachers for choosing blended mode for confidence for undergraduate students was the need for practical skills and revisiting learning (Table 63).

Blended delivery was chosen by the majority of teachers (50%) for the best outcomes for undergraduate students (N=16) (Figure 31). A common reason cited for the choice of delivery method for the best outcomes for undergraduate students was that students at this level require support and interaction (Table 64).
Figure 31. Responses to questions 4.7, 4.8 and 4.9 of the Part A questionnaire. Teachers’ perception of the best delivery mode, in terms of convenience (N=18), confidence (N=18) and best outcomes (N=16) for undergraduate forensic science students.
Table 62. *Teacher comments in the Part A questionnaire regarding their choice of delivery mode for undergraduate students in terms of convenience to study forensic science.*

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Teacher comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>Most of them would be full-time students spending more time on campus attending other lectures and practicals too (TA004)</td>
</tr>
<tr>
<td></td>
<td>It’s relatively easy for them to get to classes and face-to-face classes are the quickest and easiest way for them to engage with the material (TA008)</td>
</tr>
<tr>
<td></td>
<td>Contact with teachers makes students more inclined to perform and reinforces the gravity of their studies (TA015)</td>
</tr>
<tr>
<td>Blended</td>
<td>I have found that the many students travel long distances to get to University here in Australia so giving them a break once in a while to be able to stay home and take part in an online section would allow them more time to get on with other study components (TA006)</td>
</tr>
<tr>
<td></td>
<td>Most experienced with blended. Difficult to get to know students when fully online. Can’t pick up who is struggling online (TA016)</td>
</tr>
<tr>
<td></td>
<td>Most suited for people with a proven track record of achievement and who can manage their time and study, possibly while working (TA017)</td>
</tr>
<tr>
<td>Online</td>
<td>Should not be based on convenience (TA022)</td>
</tr>
<tr>
<td>Any mode</td>
<td>Different methods appropriate in different circumstances e.g., online for international students and blended when they have access to campus (TA018)</td>
</tr>
</tbody>
</table>
Table 63. A sample of teacher comments in the Part A questionnaire regarding their choice of delivery mode for undergraduate students in terms of confidence to study forensic science.

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Teacher Comment</th>
</tr>
</thead>
</table>
| Face-to-face          | *Interaction (TA005)*  
|                       | More opportunity to ask questions and interact with their peers (TA012)  
|                       | Most of their subsequent experience will be face-to-face and they develop professional contact and interaction skills (TA015)  
| Blended               | They can gain the skills need at workplace and industry (TA009)  
|                       | Can pick up on other key indicators e.g., glazed eyes, frantic look on faces. Can’t rely on tone in emails (TA016)  
| Online                | May not get required support from supervisors (TA010)  
|                       | Comes with knowledge of content irrespective of which method (TA018) |
Table 64. A sample of teacher comments in the Part A questionnaire regarding the choice of delivery mode for the best outcomes for undergraduate forensic science students.

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Teacher comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>As undergraduates, most of them would be having varied career ambitions/prospects so through face-to-face discussions with the teachers, it would be easier for them to solve the varied problems that arise based on their future ambitions. (TA004)</td>
</tr>
<tr>
<td></td>
<td>It depends on their age and level of experience of learning. The younger students tend to strongly prefer face-to-face. They are much less confident in their ability to learn from online delivery. Some online learning would be beneficial as they mature (TA008)</td>
</tr>
<tr>
<td></td>
<td>I think most students need a lot of coaching (TA009)</td>
</tr>
<tr>
<td>Blended</td>
<td>A variety of teaching methods would allow all students to remain focused and engaged with the course (TA006)</td>
</tr>
<tr>
<td></td>
<td>The provision of high quality blended learning would create the best outcomes. A student who makes good use of the online material and participates well in the classroom setting would be a well-rounded student with the appropriate range of skills required for a job in forensic science (TA013)</td>
</tr>
<tr>
<td></td>
<td>Students can benefit from face-to-face contact, build networks from a variety of experts and gain the benefits of face-to-face education, but still have access to material and study groups online (TA017)</td>
</tr>
<tr>
<td>Online</td>
<td>But does this reflect understanding? It depends how the units are set up. Could be more quizzes online and more robust. Easier to get assistance online (TA016)</td>
</tr>
<tr>
<td>Any mode</td>
<td>All are possible depending on the quality of the lecturer (TA007)</td>
</tr>
</tbody>
</table>
5.343 Postgraduate forensic science students

Questions 4.10 to 4.12 inclusive of the questionnaire relate to the teachers’ perception of the best delivery mode for postgraduate forensic science students, in terms of convenience, confidence and best outcomes respectively. The response rates for questions 4.10 to 4.12 were 87%, 83% and 83% respectively.

The majority of teachers (40%) chose face-to-face delivery for postgraduate students, in terms of convenience to study forensic science \((N=20)\) (Figure 32). A common reason listed by teachers for choosing face-to-face mode for postgraduate students, in terms of convenience, was that some projects are research-based and require the students to perform practical work (Table 65).

Most teachers selected face-to-face delivery for postgraduate students’ confidence to study forensic science \((N=19)\) (Figure 32). The most common reason provided by teachers for choosing face-to-face mode for postgraduate student confidence was interaction and feedback (Table 66). Teacher, TA007, made the point that the choice of delivery method depends to a large extent on whether the students are doing research or course-based study.

Blended mode was selected by most of the teachers (42%) preferred delivery mode for the best student outcomes for all academic levels \((N=19)\) (Figure 32). A common reason provided for selecting blended mode for the best outcomes was that postgraduate students required minimal supervision, had a different motivation and could cope with the online component (Table 67).
Figure 32. Responses to 4.10, 4.11 and 4.12 of the Part A questionnaire. Teachers’ perception of the best delivery mode, in terms of convenience (N=20), confidence (N=19) and best outcomes (N=19) for postgraduate forensic science students.
Table 65. Sample teacher comments in the Part A questionnaire regarding their choice of delivery mode in terms of convenience for postgraduate students to study forensic science.

<table>
<thead>
<tr>
<th>Type of delivery Mode</th>
<th>Teacher Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>Most are research-based so you would be working in a lab under the supervision of a teacher (TA021)</td>
</tr>
<tr>
<td></td>
<td>At this level I think that students expect a high level of staff involvement in their programs of study and they expect to see these staff regularly. In my experience postgraduate courses tend to have a significant practical component and this is best achieved within the university and therefore on a face-to-face basis (TA013)</td>
</tr>
<tr>
<td></td>
<td>Not about convenience. It’s easier to judge how students are absorbing all the information in-house (024TA)</td>
</tr>
<tr>
<td>Blended</td>
<td>They are academically mature enough and need a little guidance (TA009)</td>
</tr>
<tr>
<td></td>
<td>Most suited for people with a proven track record of achievement and who can manage their time and study, possibly while working (TA017)</td>
</tr>
<tr>
<td></td>
<td>Study is sometimes determined by geography (TA029)</td>
</tr>
<tr>
<td>Online</td>
<td>Postgraduates mostly do their work independently (TA009)</td>
</tr>
<tr>
<td></td>
<td>It allows postgraduate students to study from anywhere in the world (TA006)</td>
</tr>
<tr>
<td></td>
<td>Part-time and full-time options (TA020)</td>
</tr>
<tr>
<td>All modes</td>
<td>Depends on students access to resources and if they are doing research or course-based study. Course-based study could be online but it would depend on student’s experience with online education (TA007)</td>
</tr>
<tr>
<td></td>
<td>Different delivery methods appropriate to different circumstances e.g., online for International (TA018)</td>
</tr>
</tbody>
</table>
Table 66. A sample of teacher comments in the Part A questionnaire regarding their choice of delivery mode for postgraduate students in terms of confidence to study forensic science.

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Teacher Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>Constant interaction on a personal level (TA001)</td>
</tr>
<tr>
<td></td>
<td>Face-to-face involvement allows for self-assessment relative to peers which can build confidence in postgraduate students (TA013)</td>
</tr>
<tr>
<td></td>
<td>Get support immediately, show supervisor your results and have a discussion (TA021)</td>
</tr>
<tr>
<td>Blended</td>
<td>Even if the face-to-face component is a very minor part of the course (say a week intensive training) I still think it is important to be able to humanise the course a little (TA006)</td>
</tr>
<tr>
<td></td>
<td>Give them exposure to both modalities of learning and they have feedback live and online (TA017)</td>
</tr>
<tr>
<td></td>
<td>They are academically mature enough and need a little guidance (TA009)</td>
</tr>
<tr>
<td>Online</td>
<td>It gives them much more freedom to work, think and communicate (TA004)</td>
</tr>
<tr>
<td>All modes</td>
<td>Depends on students access to resources and if they are doing research or course-based study. Course-based study could be online but it would depend on student’s experience with online education (TA007)</td>
</tr>
</tbody>
</table>
Table 67. A sample of teacher comments in the Part A questionnaire regarding the choice of delivery mode for the best outcomes for postgraduate forensic science students.

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Teacher comments</th>
</tr>
</thead>
</table>
| Face-to-face          | It suits the type of work the best. Most higher degrees don’t have any course-work so aren’t that well suited for online or blended learning (TA021)  
Do very little of others. Can provide continuous feedback (TA024)  
Students more comfortable asking challenging questions. Immediate feedback (TA026) |
| Blended               | Because they always need some guidance in unfamiliar arrears (TA009)  
The additional skills that blended learning activities create (IT skills) are valuable for a student’s future career and as such would provide the best outcomes (TA013)  
They can work independently while still having ongoing contact and building relationships and contacts, as well as having lab. experience (TA017) |
| Online                | Postgrads, following graduation should work without much supervision. So minimum guidance during postgrad would make them more confident (TA004)  
If resources are available online then they can schedule the learning in against their other commitments (TA006)  
Because they are mature age and its postgrad – different motivation (TA018) |
| All modes             | Depends on students access to resources and if they are doing research or course-based study. Course-based study could be online but it would depend on student’s experience with online education (TA007) |
The teachers’ perceptions on the preferred delivery modes in terms of convenience, confidence and best outcomes for students, according to their academic level, have been examined. The next subsection of this chapter compares the teacher’s perceptions of the best delivery method for students, according to their academic level.

5.35 A comparison of the teachers’ perceptions of the best delivery mode for students, according to their academic level

Figures 33, 34 and 35 show the teachers’ perceptions of the best delivery mode for student convenience, according to their academic level.

The majority of teachers perceived blended mode as the best delivery method in terms of convenience for students at diploma (57%; $N=14$) and undergraduate level (72%; $N=18$) (Figure 33). However, for postgraduate students, most teachers (40%) listed face-to-face mode for convenience to students ($N=20$).

In terms of student confidence, majority of teachers perceived blended mode as the best delivery method for diploma (64%; $N=14$) and undergraduate students (50%; $N=18$) (Figure 34). However, teachers listed face-to-face mode as the preferred method for postgraduate student confidence with the main reason provided being the interaction and feedback from both peers and supervisors.

The majority of teachers chose blended mode as the preferred delivery method for the best student outcomes for all academic levels (72%, $N=14$; 50%, $N=18$ and 41%, $N=19$ of teachers selecting blended mode for diploma, undergraduate and postgraduate level respectively) (Figure 35).
Figure 33. A comparative graph from the Part A questionnaire showing the teachers’ perception of the best delivery mode for convenience for forensic students, according to their academic level; diploma, undergraduate and postgraduate level (N=14; N=18; N=20 respectively).
Figure 34. A comparative graph from the Part A questionnaire showing teachers’ perceptions of the best delivery mode for student confidence, according to their academic level; diploma, undergraduate and postgraduate level (N=14, N=18, N=19 respectively).
Figure 35. A comparative graph from the Part A questionnaire of the teachers’ preferred delivery mode for the best outcomes for forensic science students according to their academic level; diploma, undergraduate and postgraduate (N=14; N=18; N=19 respectively).

5.4 Australian tertiary teachers’ ideas for future direction in forensic science education

Section five of the questionnaire in Part A of the study was included to explore the teachers’ ideas on future directions and improvements for forensic science education. This section is related to research questions 2a) 2 b) and 2 c). This section consisted of four open questions and, as such, common themes were identified and quantified.

5.4.1 Specific developments for those who teach and assess in forensic science

Teachers in Part A, identified five key developments for those who teach and assess in forensic science (Figure 36). The most common specific development listed by teachers as a requirement for forensic science educators was that teachers need to be forensic science practitioners or have operational experience. The next most common specific requirement was that teachers need ongoing professional development in new
technologies. Industry involvement, consistency across different forensic courses and teaching relevant forensic content and skills were also identified as important developments for forensic science teachers. A sample of teacher comments from Part A is presented in Table 68. Teacher (TA026) is a supporter of teachers having forensic science industry experience either as a practitioner or as a bare minimum a researcher in the forensic science field.

Interviewees in Part B of the study were also asked the five most important specific developments for those who have to teach and assess in forensic science. Of the four interviewees who responded to this question, two mentioned that forensic science teachers should have relevant industry experience (N=7). In order to fully understand some of the interviewee comments, it is necessary to provide some background on the educational institute in which they were employed at the time of the interview. Teachers in the forensic section of this institute comprise of full-time and part-time permanent and contract staff in addition to casual teaching staff. Most of the casual teaching staff are forensic practitioners who are employed to deliver one specialised component of a subject. Furthermore, the majority of these staff are not teacher trained but work under the supervision of qualified teachers and/or staff possessing the required training and assessment qualification.

TB6 They need experience in what they are teaching – industry experience. In terms of assessment they need training in how to conduct assessment – teacher training.

Another teacher agreed that forensic science teachers require teacher training.

TB7 ... A degree in science and teacher qualifications. They can then make judgements about learning styles.

An understanding of the online environment was also identified by some interviewees as an important development for forensic science teachers.

TB1 Training in how to use Elearn. Uniform marking rubrics. You need training before commencing. An awareness in forensic science either experience and/or basic training. For example biology, chemistry or physics you need to know the forensic significance.
TB2 Have an understanding of the online environment. You need to know the area you are teaching.

![Bar Chart]

**Figure 36.** Responses to question 5.1 of the Part A questionnaire. The five most important specific developments identified by teachers for those who have to teach and assess in forensic science (N=25).
<table>
<thead>
<tr>
<th>Specific developments</th>
<th>Teacher comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience in forensic science</td>
<td>Teachers need to understand the needs of the forensic industry. Teachers should have relevant industry experience...(TA003)</td>
</tr>
<tr>
<td></td>
<td>Must include ongoing industry experience including rotations with working accredited laboratories working with forensic service providers or in keeping with accreditation in specific disciplines (TA005)</td>
</tr>
<tr>
<td></td>
<td>Must be a practitioner or as a bare minimum a researcher in forensic science (TA026)</td>
</tr>
<tr>
<td>Ongoing professional development</td>
<td>Being aware of the industry needs and responding accordingly. Providing a service that enables professionals to learn new technologies...(TA007)</td>
</tr>
<tr>
<td></td>
<td>Minimum teaching qualifications in training and assessment. Ongoing professional development in subjects being taught (TA010)</td>
</tr>
<tr>
<td>Industry involvement</td>
<td>Understanding the industry via industry release. Incorporating current methods via industry links. Maintaining validity via industry oversight panels (TA002)</td>
</tr>
<tr>
<td></td>
<td>Industry accreditation of courses (TA018)</td>
</tr>
<tr>
<td>Uniformity across courses</td>
<td>...Standardisation of marking schemes under National Centre of Forensic Science (NCFS) (TA006)</td>
</tr>
<tr>
<td></td>
<td>A detailed Australia wide standard level of training expected in forensic science graduates (diploma, undergraduate and postgraduate). What are the graduate attributes for forensic science students? How should these attributes be assessed? (TA013)</td>
</tr>
<tr>
<td>Industry relevant content and skills</td>
<td>Contemporizing the content to keep up with technological developments. Providing industry relevant knowledge and skills...(TA021)</td>
</tr>
<tr>
<td></td>
<td>... Need a balance between education and training. Need to understand what a lab. does and how to apply it to forensics (TA028)</td>
</tr>
<tr>
<td></td>
<td>...Ensure that students are ready for on the job training. Ensure that the course prepare students who are not currently in the industry for a multitude of employment opportunities and not just for forensics...TA007</td>
</tr>
</tbody>
</table>

Table 68. A sample of teacher comments from the Part A questionnaire on specific developments required for forensic science educators.
5.42 Ways in which forensic science education can be supported

Figure 37 shows that industry links and an increase in funding were equally listed by the teacher respondents to the Part A questionnaire as being the most important ways in which tertiary forensic science could be supported. Industry links included reference groups and guest lecturers from industry. ‘Other’ ideas included a value placed on the hours spent teaching and allowing teacher hour reductions to conduct research or develop online courses.

A sample of teacher comments regarding ideas to support tertiary forensic science is shown in Table 69. Teacher, TA017, raised an interesting point regarding forensic science professionals who teach within educational institutions. He/she pointed out that forensic educators are not always traditional academics. I believe that regardless of whether tertiary educational institutions employ traditional academics (with no or limited experience in forensic science) or forensic science professionals (with no or limited teacher training) to teach forensic science, there will always be educational shortcomings. There are two options to overcome this problem; either employ trained teachers with forensic science experience or use forensic science experts along with a trained teacher to ensure the delivery and assessment meets Australian Skills Quality Authority (ASQA) [http://www.asqa.gov.au/] and/ or Tertiary Education Quality Standards Agency (TEQSA) [http://www.teqsa.gov.au/] requirements. The advantage of using the second option is that the forensic practitioners will be familiar with the latest developments in their area of expertise. The down-side of using a forensic science professional /casual teacher along with a qualified teacher is time and cost.
Figure 37. Responses to question 5.2 of the Part A questionnaire. Teachers’ ideas on how tertiary forensic science can be supported (N=29).
Table 69. A sample of teacher comments in the Part A questionnaire on ways to support tertiary forensic science.

<table>
<thead>
<tr>
<th>Ideas</th>
<th>Sample comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry links</td>
<td>Stakeholder support. Get stakeholders to participate in the program itself- give lecturers, participate in research...(TA028)</td>
</tr>
<tr>
<td></td>
<td>Peer support from forensic community (via meetings etc)...(TA014)</td>
</tr>
<tr>
<td></td>
<td>Industry participation (TA012)</td>
</tr>
<tr>
<td>Increased funding</td>
<td>More resources (Name of institute) There are problems with capacity. Want high numbers of students but need staffing resources and lab. facilities (TA019)</td>
</tr>
<tr>
<td></td>
<td>Government subsidies. Financial. Scholarships. (TA010)</td>
</tr>
<tr>
<td></td>
<td>Through extra funding and research activities (TA009)</td>
</tr>
<tr>
<td>National/ International standards for courses</td>
<td>Bring together universities from around the world. Accredited courses can be used around the world. Need International accreditation (TA022)</td>
</tr>
<tr>
<td></td>
<td>...Look a developing national guidelines for content...(TA021)</td>
</tr>
<tr>
<td></td>
<td>Direction from a single body. National standards. Industry regulation (like pharmacy) (TA001)</td>
</tr>
<tr>
<td>Training for academics</td>
<td>Better training given to academics teaching forensic science (TA013)</td>
</tr>
<tr>
<td></td>
<td>A network of teachers with workshops help by forensic professionals to help contextualise the theory and provide missing experience (TA007).</td>
</tr>
<tr>
<td>Work experience for students</td>
<td>Professional placements. Work experience for students...(TA024)</td>
</tr>
<tr>
<td></td>
<td>Allow students to actively participate in crime scene investigating and post-mortem examining. (TA004)</td>
</tr>
<tr>
<td>Other</td>
<td>Research grants and a value placed on time spent teaching (TA020)</td>
</tr>
<tr>
<td></td>
<td>...Institutional support for recognising that forensic educators are not always traditional academics and don’t always fit the traditional academic profile. Institutional recognition that laboratory training is a vital component of the program, and supplying laboratories and required equipment to make this possible (TA017)</td>
</tr>
</tbody>
</table>
The two most frequently cited specific developments identified by teachers in Part A, namely industry links and increased funding, were also mentioned by the interviewees in Part B of the study. Four of the interviewees in Part B (TB1, TB2, TB6 and TB7) cited industry links as a way in which forensic science education could be supported (N=7).

TB1 Contact with forensic science professionals. For example guest lecturers currently working in the field.

TB2 More funding. Close links with those at the ‘coal face’ so students get to see reality.

TB6 Access to industry personnel. Up-to-date equipment. Teacher support from peers to help with teaching and assessment.

In addition to citing industry links as an important development to support forensic science education, interviewee TB7, mentioned the importance of more professional development, further funding and mentoring for new staff.

TB7 ...Higher education teachers getting more professional development including money and hours available to expand their skills. Mentor new teachers, particularly for online. Return-to-industry programs. Money to fund new technologies and equipment. Better industry links to allow us to use the equipment...

Interviewee, TB4, agreed with the need for new equipment.

TB4 By having equipment and resources that works.

5.43 Ways in which teaching forensic science online can be supported

Question 5.3 of the teacher questionnaire asked the teachers how teaching forensic science online could be supported. There was an 82.8% response to this question (N=29). A frequency histogram summarising the data from responses to question 5.3 is shown in Figure 38. In hindsight, I acknowledge that this is a leading question because the emphasis on online delivery could be perceived as bias by the author. However, it didn’t prevent two teachers responding that online delivery shouldn’t be supported and another four teachers mentioning that it requires the support of practical work. A
selection of some comments from teachers on how to support online delivery in forensic science are provided in Table 70.

![Chart showing ideas on how to support online delivery of forensic science](chart.png)

*Figure 38.* Responses to question 5.3 of the Part A questionnaire. Ideas on how online delivery in forensic science could be supported (N=24).
Table 70. *Sample teacher comments from the Part A questionnaire on how online delivery in forensic science could be supported.*

<table>
<thead>
<tr>
<th>Ideas</th>
<th>Sample comments</th>
</tr>
</thead>
</table>
| Increased funding                        | *... Increased funding to allow academics the time and resources to achieve high quality blended learning materials (TA013)*  
*... Funding equipment marketing tools (TA026)*  
*Funding for staff to develop appropriate online resources, including support to buy them out for long enough to develop and update the required resources... (TA017)*                                                                 |
| Online (OL ) training for teachers       | *... Developing training for staff not only to give them the required skills set but to develop an understanding of what can be achieved by OL delivery (TA017)*  
*Teachers get paid appropriately for hours spent teaching online. Teachers get time to prepare and develop online resources. Teachers get adequate (online) training (TA011)*                                                                 |
| Industry involvement                     | *Get stakeholders involved. ANSSS or stakeholders to teach (TA028)*  
*Resources should be specific to the industry... Students could have the ability to contact people from industry for specific support through email or online chat. Webinars or online chat sessions could be arranged involving industry specialists (TA003)* |
| Requires support of practical work       | *For blended, some mechanism to have the practical component...Need infrastructure equipment and money to support the practicals (TA016).*  
*Must have a practical component (TA029).*                                                                                   |
| IT support                               | *With good IT support (not necessarily specific to forensics)...(TA018)*  
*A mentoring system between experienced online educators and the techno experts (TA007)*                                                                                                                                     |
| Shouldn’t be supported                   | *By ensuring face-to-face contact. Do not support online (TA025)*  
*Shouldn’t be supported (TA022)*                                                                                                                                                                                                                                               |

When interviewees in Part B were asked how teaching forensic science through online delivery could be supported, the four teachers who responded mentioned the need for
training in online delivery. Three teachers chose not to respond. It is worth noting that online delivery was an institute priority at the time.

TB1 Training in Elearn. Access to online journals and resources for staff and students. Staff may be able to direct students to resources.

TB2 Professional development in Elearn. Training in technology.

TB6 Support to use technology well. Sharing information between staff.

TB7 For online or blended, the teacher needs computing and communication skills.

There were a number of questions in the interviews that were not included in the questionnaire. I thought that the questionnaire would have been too long if these extra questions had been included and risked increasing the non-response rate. An account of these extra interview questions is presented.

Teachers in Part B, who all deliver subjects via blended mode, were asked to name the key challenges for teachers delivering forensic science (Question 4.4). Comments from two interviewees, TB4 and TB1, on class attendance raises the issue of whether students feel there is a need to attend all the face-to-face component of a subject if it is offered via blended delivery. For example, if the face-to-face lectures are also posted via power points online, then some students would see their attendance as optional. With more students seeking flexible delivery options, perhaps teachers should be more flexible with their expectations of class attendance. Alternatively, teachers need to be very clear as to the sections of the course that require face-to-face attendance.

TB7 Practical sciences. Understanding chemicals in a lab situation. Access to fingerprinting equipment. You cannot do this in online delivery. Blended allows us to cover these aspects. Student numbers could be a problem in the future.

TB6 Maintaining currency of skills and knowledge. Being paid in parity with industry.

TB4 Regarding distance blended delivery, getting material submitted on time. Students taking leave.
Interesting your students. Capitalizing on the wave of forensic science T.V shows. Inspiring student learning.

Class attendance. Being able to access individual student progress. Balancing theory and practicals.

Question 4.4 Are there differences between tertiary forensic science students and other tertiary students?

Another question (4.5) that was included in the teacher interviews in Part B but not in the questionnaire in Part A, was whether forensic science students were different from or similar to students who studied other higher education programs.

Three teachers thought there were no differences between forensic science students and students studying other programs. Two teachers who thought there were differences between the student groups mentioned future employment.

Slight difference. Forensic science students tend to be more employment oriented at the end. For example psychology degree students are less focused on future employment.

Could be different in that they have a clear career path in mind.

One teacher was referring to the forensic degree students and thought they might be more academic than other students.

Perhaps forensic students are more academic with a less hands-on approach. More about theories and report writing and less about getting day to day results in the field, ‘knee-deep in God knows what’.

Another interviewee disagreed and mentioned the practical component of forensic science courses.

Similar to other programs that have a practical knowledge component incorporated.

Only one of the interviewees referred to the communication skills required by forensic science students. There was also an inference made regarding the psychological
challenges of forensic work. For example forensic science students may be exposed to disturbing images, attend post mortems etc.

TB5 Forensic science students need to be able to express why they are interested in something. They need care and support. Open discussions in a group.

Question 4.5 Is teaching in forensic science different from teaching in other programs?

Question 4.7 in the interview in Part B was included to find out if the teachers thought that teaching in a forensic science program was similar to or different from teaching in other programs. Five out of seven interviewees had also taught in programs other than forensic science and only one of them thought there were any differences.

TB2 ...Different expectations. Some (students) are more independent than others. Different levels of Australian Quality Framework (AQF) and depth of content.

One teacher mentioned a similarity.

TB7 Similar if it has a practical component.

5.44 Further comments on forensic science education

The final question, 5.4, in the questionnaire in Part A was included to ascertain if the teachers had any other comments regarding delivery methods in forensic science. A selection of comments is provided in Table 71. The majority of respondent comments to question 5.4 of the questionnaire pertained to the need for some level of face-to-face interaction (Table 71). I agree with respondent TA001, in that forensic science ‘clients’ require face-to-face interaction. Therefore, it’s important that forensic science students have some exposure to this form of delivery; even if it is part of blended delivery. I also believe that the type of delivery method employed depends to some extent on circumstances such as geography, age and experience and as respondent 007TA, mentioned, the pedagogy that meets the learning outcomes.
Table 71. Additional comments by teacher respondents in the Part A questionnaire regarding delivery methods used in forensic science education (N=18).

<table>
<thead>
<tr>
<th>Preferred delivery Mode</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>I think we need to be mindful that ultimately our clients (lawyers, defendants, complainants, Police, Coroner courts, etc.) require face-to-face interaction (TA001)</td>
</tr>
<tr>
<td></td>
<td>Teaching needs to be integrated with demonstration and lab. work (TA025)</td>
</tr>
<tr>
<td>Blended</td>
<td>It should always be blended rather than purely online as students need to do scene work as well (009TA)</td>
</tr>
<tr>
<td></td>
<td>Much of the teaching I observe relies on traditional face-to-face methods. Colleagues of mine have expressed concern that they equate online/blended learning with a lack of engagement by students as there is less of an obligation for a student to attend the university at a designated time. Better training in what blended learning means in the context of forensic science education would alleviate some of these concerns I am sure (TA013)</td>
</tr>
<tr>
<td></td>
<td>Answer is blended delivery. Practitioners can up-skill with online courses (TA019)</td>
</tr>
<tr>
<td></td>
<td>Blended is a good option. Allows better students to do well but other students need face-to-face (TA023)</td>
</tr>
<tr>
<td>Different modes for different circumstances</td>
<td>Delivery should reflect the needs of the student, the pedagogy that will meet the learning objectives and does just use technology because it is there (TA007)</td>
</tr>
</tbody>
</table>

5.45 Summary

Forensic science teacher participants in Part A identified flexibility and convenience as the main benefits to online and blended delivery. The main challenge cited by teacher participants in Part A for online delivery was the reliance on information technology.
For blended delivery, teacher participants commented that the relevance and interactivity of the online component was important.

Blended delivery was selected by teacher participants (53%; $N=19$) in Part A as the most convenient mode to teach forensic science while face-to-face mode was selected for the teacher’s confidence (45%; $N=18$). In terms of career preparation for students, most teachers selected blended mode (75%; $N=16$) because of the flexibility and the fact that forensic scientists need to be able to work in both face-to-face and online environments.

Forensic science teacher participants in Part A questionnaire and interviewees in the Part B case study identified industry links and increased funding as the main two important ways in which to support the delivery of forensic science.

This chapter has outlined the findings from the forensic science teachers’ perspective. The next chapter, Chapter Six, provides the results from the forensic science industry personnel perspective on the different delivery modes used in forensic science education.
CHAPTER 6: INDUSTRY RESULTS

6.1 Introduction

This chapter presents the findings and a discussion of the experiences and perspectives of forensic industry personnel with respect to the different types of delivery modes. The chapter is divided into four sections. The first section provides demographic information on the industry personnel sample used in Part A for the survey questionnaire and Part B, case study. The second section addresses research question 3a) on industry personnel’ experiences of the different delivery modes. Section three pertains to research questions 3b) and 3c) on industry personnel’ perceptions of the advantages, disadvantages and outcomes of the different delivery modes. Finally, in section four, data on industry personnel’ ideas for future directions in forensic science education are presented.

6.11 Part A Industry personnel questionnaire

There were 31 respondents to the industry personnel questionnaire in Part A of the study. The survey questionnaire was divided into five sections: demographic information, information about the course, the industry personnel’ experiences of online learning, their preferences for the different delivery modes and future directions.

6.111 Demographic Information

The first section of the questionnaire focused on demographic information. Not all questions in this section were answered by all the participants.

The majority of industry personnel sampled in the national survey in Part A were female (59%; N=22) (Table 72). Most of the respondents (45%) were aged between 22 and 35 years and the second most common age group was > 50 years of age (32%; N=22) (Table 73). For the interviewees in Part B, three out of five were aged between 35 – 50 years and most (60%) were male (N=5). The National Institute of Forensic Science (NIFS) report (Brightman, 2005, p. 27) provided age profiles for the total population of forensic practitioners but used different age categories, so a direct
comparison is not possible. However, the NIFS report found that no practitioner respondents were less than 20 years of age which is consistent with the findings in Table 73. The most common age category found in the NIFS report was between 30-39 years of age.

The most common category of expertise listed by the respondents in Part A was crime scene investigation (42%; N=31) (Table 74). The majority of respondents (50%; N=18) had between 1 – 5 years’ experience in the forensic science industry (Table 75) and this was consistent with the NIFS report (Brightman, 2005) that also found the majority of the respondents (198) had been employed in their current employment between 1 and 5 years (N=461). For the interviewees in Part B, 4 of the 5 broad categories of expertise in forensic science (Samarji, 2010) were represented and reflected those seen in the Part A participants. Their length of experience in forensic science ranged from 11 – 30 years.

The majority of respondents (69%; N=26) were studying at the time of survey completion and most (68%; N=22) were enrolled in industry-based courses. However, none of the interviewees were studying at the time of survey completion.

Table 72. Percent of male and female industry personnel respondents to the Part A questionnaire (N=22).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>9</td>
<td>41</td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>59</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 73. Age group of industry personnel respondents to the Part A questionnaire (N=22).

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-21</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>22-35</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>36-50</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>&gt;50</td>
<td>7</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 74. Area of expertise for industry personnel respondents to the Part A questionnaire (N=31).

<table>
<thead>
<tr>
<th>Area of expertise</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crime scene investigation</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>Criminalistics technical</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>Criminalistics scientific</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Forensic biomedical</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 75. Years of experience for forensic science industry personnel respondents to the Part A questionnaire (N=18).

<table>
<thead>
<tr>
<th>Number of years</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>1 – 5 years</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>6 – 10 years</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>11 – 20 years</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>More than 20 years</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>

Section two of the questionnaire pertains to information about the current course in which the industry personnel respondents were enrolled at the time of completion of the questionnaire.

6.112 Information about the current course

Section 2 of the industry personnel Part A questionnaire was included to provide information about the course in which they were studying at the time of the questionnaire.

The data in Table 76 shows that the majority of industry personnel (59%), who were studying at the time of the questionnaire, were enrolled at diploma level (N=22).

The data in Table 77 reveals that 68% of industry personnel respondents who were studying at the time of the questionnaire were enrolled in industry-based courses and the next highest academic category was postgraduate level (14%; N=22). Although the NIFS report (Brightman, 2005) did not include an equivalent question, it reported the formal qualifications obtained by industry personnel since they entered the forensic field. More respondents reported that they had completed TAFE qualifications (132) than had completed university qualifications (96; N=228).
Eighty percent of respondents in Part A were enrolled in forensic science subjects that were delivered through blended mode \((N=20)\) (Table 78). All the interviewees had experienced either blended learning or both online and blended learning \((N=5)\).

In summary, although there is only a small sample of industry personnel \((N=31)\) who participated in the questionnaire in Part A of this study, the profile largely reflects the population of forensic practitioners. The relatively high percentage of practitioners from the crime scene investigation group will be taken into account in the analysis.
Table 76. Academic programs in which the industry personnel respondents to the Part A questionnaire were enrolled (N=21).

<table>
<thead>
<tr>
<th>Program</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Bachelor Degree Course</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Industry based course - Certificate level</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Industry based course – Diploma level</td>
<td>13</td>
<td>59</td>
</tr>
<tr>
<td>Industry based course - Advanced Diploma level</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Industry based course - Masters level</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Undergraduate Bachelor of Science with forensic electives</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bachelor of Forensic Science</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bachelor of Forensic Science with honours</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>Post graduate diploma in Forensic Science</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>Master of Forensic Science</td>
<td>2</td>
<td>9.0</td>
</tr>
<tr>
<td>PhD Forensic Science</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 77. Consolidated academic levels in which industry personnel were enrolled at the time of the Part A questionnaire (N=22).

<table>
<thead>
<tr>
<th>Consolidated academic program</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry-based course</td>
<td>15</td>
<td>68</td>
</tr>
<tr>
<td>Bachelor degree with or without honours</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Postgraduate level</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 78. The type of delivery mode used for subjects in which the industry personnel were enrolled at the time of the Part A questionnaire (N=20).

<table>
<thead>
<tr>
<th>Type of delivery mode</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Blended</td>
<td>16</td>
<td>80</td>
</tr>
<tr>
<td>Online</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>
6.12 Part B (Phase 1 of case study) Industry personnel interviews

Five industry personnel participated in the interviews in Part B of the study. Only a summary of the combined industry personnel profiles is provided in order to protect the identity of the participants.

Interview questions 1.1 to 1.5 inclusive were included to ascertain relevant demographic information of the interviewees. Of the five interviewees, three were aged between 36 and 50 years and two were more than 50 years of age. There were three male and two female interviewees (N=5).

Four of the five broad categories of expertise in forensic science, according to Samarji (2010) were represented by the interviewees, that is, crime scene investigation, criminalistics technical, criminalistics scientific and forensic biomedical (N=5).

None of the interviewees were studying at the time of the interview although one had completed a postgraduate qualification the previous year.

Although the interviewees in Part B had, on average, more years of experience in the forensic science industry than the majority of Part A respondents, I believe their input provided a valuable insight into forensic science education. Although none of the five interviewees were studying at the time of the interview, all had previously experienced either blended learning or both blended and online learning.

This section provided a description of the demographic information about the industry personnel who participated in the questionnaire in Part A and the interviews in Part B of the study. The next section provides the analysed data to address Research Question 3a).
6.2 Australian industry personnel experiences of the different delivery modes used in forensic science education

Section three of the questionnaire in Part A of this study was designed to provide data to directly address Research Question 3a).

*What are Australian industry personnel experiences of delivery modes (face-to-face, blended and online) for forensic science?*

### 6.21 Experience with online or blended delivery

Most respondents in Part A, were experienced with blended learning or online learning with almost 90% indicating that they had experienced either one or both modes of delivery ($N=29$). All five Part B interviewees had experienced either online or blended delivery. When industry personnel were asked to indicate the subject and program in which they had experienced online or blended delivery, 42% listed industry-based courses, 35% listed professional development and 3% listed postgraduate programs and the remainder fell into the ‘other’ category ($N=29$).

Only 4% of industry personnel in Part A indicated that the course in which they were enrolled was interactive ($N=25$). The most common type of interactive activity experienced by the respondents was a discussion forum (Figure 39). Respondents were able to list more than one type of activity so the frequencies are provided.

Most industry personnel (71%) in Part A found online or blended learning to be a positive experience and 21% indicated there were both positive and negative aspects ($N=14$). Only half of these respondents answered the second part of question 3.3 regarding the reasons for their experience and most of the reasons provided were for the negative experiences including a lack of both feedback and interaction with staff and students.
Figure 39. Responses to question 3.2 of the Part A questionnaire. The types of interactive activities experienced by industry personnel (N=15).

6.22 Benefits and challenges of online delivery

The three most common benefits of online learning that were identified by industry personnel in Part A were flexibility, convenience and access to resources (N=20) (Figure 40). These benefits were also identified by four out of five interviewees in Part B of the study.

During the interviews in Part B, interviewees were asked what they saw as the benefits of online learning for industry personnel. Four out of five interviewees described benefits that were listed by the respondents in Part A. Interviewee, 1B1, also described other benefits of online learning for industry personnel.

1B1 There is an increase in available training, access to staff in remote locations, consistency of content and benefits in terms of staff rostering means the staff can do it. Can target specific groups. By not paying accommodation, there is a decrease in the costs of training. Can use existing online computer systems, learn after hours and learn and work at the same time...
The key challenges of online learning identified by respondents in Part A were equally listed as lack of assistance (29%; N=19) and demographics (29%; N=19) (Figure 41). These were almost three times more frequently cited than the next two most common challenges; delayed feedback and limited interaction.

For question 2.3 of the interview in Part B, participants were asked if there were any disadvantages to online learning. Delayed feedback and decreased motivation were identified as disadvantages to online learning.

IB5 Feedback. Delay in getting feedback.

IB4 Staying focused.

![Figure 40. Responses to question 3.4 of the Part A questionnaire. A summary of benefits of online learning identified by industry personnel (N=20). Respondents were able to list more than one benefit.](image)
Figure 41. Responses to question 3.5 of the Part A questionnaire. The key challenges for online learning identified by industry personnel (N=19). Respondents were able to list more than one challenge.

6.23 Benefits and challenges of blended delivery

The main benefit of blended learning identified by respondents to the questionnaire in Part A was flexibility (N=23) (Figure 42). This was also mentioned by one of the interviewees in Part B.

Interview question 2.4 also addressed the benefits of blended learning for industry personnel.

One interviewee, IB4, provided an example of the flexibility of blended learning.

IB4 Students can work at their own pace.

Another interviewee, IB5, described the value of the face-to-face component in providing feedback and clarification.
There is some face-to-face time. Even one hour of ‘face-to-face’ can clarify problems rather than going back and forth online. High quality learning.

Interviewee, IB1, was able to list several other benefits to blended learning.

Can meet broader training needs For example theory and practical. Reduced training time for staff. Reduced costs ...

The main challenge of blended learning identified by respondents in Part A was a lack of assistance (N=14) (Figure 43). Delayed feedback was also listed. Challenges identified by the interviewees included the intensity and rushed nature of the residential workshops.

For interview question 2.5 in Part B, interviewees were asked for the disadvantages of blended learning

Time constraints on the practical component of the course may result in less technical skills in the forensic science course. This is equally true if the students are not working in the field. Practical component needs to be very targeted at the skills required and the desirable outcomes for skills set.

Face-to-face (component) is more challenging. The intense four or five days for residential (workshops) are rushed.
Figure 42. Responses to question 3.6 of the Part A questionnaire. The benefits of blended learning experienced by industry personnel (N=23). Respondents were able to list more than one benefit.

Figure 43. Responses to question 3.7 of the Part A questionnaire. The key challenges of blended learning experienced by industry personnel (N=14). Respondents were able to list more than one key challenge.
6.3 Australian industry personnel preferences for different delivery modes used in forensic science education

Section four of the industry personnel questionnaire in Part A was designed to address Research Questions 3b) and 3c) respectively.

What are Australian industry personnel perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?

How do Australian industry personnel perceive student outcomes as a result of different delivery modes for forensic science?

Two-tiered questions, each referring to different academic levels, were used in this section. As discussed in chapters four and five, the academic levels can be collated into four broad groups: industry-based courses, bachelor degree courses, postgraduate programs and other programs, including associate degrees. Three of these groups are now addressed in turn.

6.31 Preferred delivery modes for diploma students working in the police force.

The majority of industry personnel in Part A selected blended mode for convenience (86%: N=21) and confidence (75%: N=20) for diploma students working in the police force (Figure 44). In terms of best outcomes for these students, most respondents (55%) chose face-to-face mode (N=20) (Figure 44).

As in Part A, the majority of the interview responses (60%) in Part B, chose blended mode as the best mode for both convenience and confidence to study forensic science for diploma students working in the police force (N=5). However, unlike the majority of Part A respondents, most of the Part B interviewees (80%) chose blended mode as the delivery method that provided the best outcomes in forensic science education (N=5).

Tables 79 to 81 inclusive provide a summary of reasons provided by industry personnel for their choice of delivery mode for convenience, confidence and best outcomes (respectively) for diploma forensic science students working in the police force.

The most commonly listed reason for selecting blended mode for convenience for diploma students was that they could complete the theory component in their own
time and attend the practical sessions in a ‘block’ of time e.g., summer school (Table 79).

A comment from an interviewee, IB1, in Part B of the study highlights the need for practical work in addition to theory.

IB1 Blended (mode) meets the needs of theory and ‘prac’. It uses existing technologies that are available today. Students and most staff are ‘savvy’ with the use of technology.

The most commonly listed reason for selecting blended mode for confidence for diploma students was that it gave the students two options for working things out (Table 80).

One of the interviewees in Part B described his/her experiences in one of the face-to-face residential workshops that formed part of a blended forensic science program. Police from different jurisdictions participate in these workshops.

IB4 Blended. The face-to-face component takes you out of your comfort zone. You have to interact with other students. It lifts performance.

The most commonly listed reason for selecting face-to-face mode for the best outcomes for diploma students was that it prevents students from procrastinating and ‘cramming’ (Table 81).

Also related to a student’s confidence would be their preferred adult learning style. Industry personnel were asked during the interviews in Part B whether their preferred learning style was lecture-based, practice-based or problem-based. Three interviewees thought all three learning styles had merit and two interviewees preferred problem-based activities. The order in which the activities were delivered was an issue for two of the interviewees. Comments from IB1 highlight the need to consider the order of these learning approaches.

IB1 All have merit. I like problem-based but they need the other two beforehand. Give the basic information first. For example, fingerprint training. Students ask “Why do you talk about the history of fingerprints?” It’s about understanding
subject matter. You can talk about the discipline itself. I like scenarios. You can assess whether they have understood and if they have practiced.

Another interviewee provided examples of how he/she would use each method.

IB2 All 3 have value. Lecture-based to gain knowledge. Problem-based to give scenarios. For example, ‘Why is the body buried there’? They need knowledge from lecture-based. Practice-based for any technical repetition such as working bagging exhibits. Doesn’t require thought process.

Two interviewees, IB4 and IB5, provided reasons for selecting the problem-based approach.

IB4 Problem-based scenario problems are good. They learn to think forensic science is about practical skills and ‘thinking on your feet’.

IB5 Problem-based is a good way of going. It invites free thinking, juggling priorities and reassessing demands.
Figure 44. Responses to questions 4.1 to 4.3 inclusive of the Part A questionnaire. Industry personnel perceptions of the best delivery mode in terms of convenience ($N=21$), confidence ($N=20$) and best outcomes ($N=20$) for diploma forensic science students working in the police force.
Table 79. Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting blended mode as the best delivery mode for convenience for diploma students working in the police force (N=10).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students can complete the theory component in their own time and attend practical sessions in a ‘block’ of time e.g., summer school</td>
<td>6</td>
</tr>
<tr>
<td>This type of work is highly reactive /shift work and students can’t always attend classes</td>
<td>4</td>
</tr>
<tr>
<td>Students sometimes can’t make classes but need some practical work</td>
<td>4</td>
</tr>
<tr>
<td>It gives students the flexibility to catch up on work that they missed in the face-to-face classes</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 80. *Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting blended delivery as the best mode for confidence for diploma students, working in the police force (N=17).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Having access to both face-to-face instruction and online instruction gives students two options for working things out</td>
<td>4</td>
</tr>
<tr>
<td>Students have access to a lecturer and immediate feedback</td>
<td>3</td>
</tr>
<tr>
<td>Students can complete their pre-work and review learning materials/ class notes online</td>
<td>2</td>
</tr>
<tr>
<td>It approximates the real world</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
</tr>
</tbody>
</table>
Table 81. Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting face-to-face delivery for the best outcomes for diploma students, working in the police force (N=11).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>It prevents the students from procrastinating and ‘cramming’</td>
<td>11</td>
</tr>
<tr>
<td>Students learn best when they interact personally with other students</td>
<td>10</td>
</tr>
<tr>
<td>Students learn best when they interact personally with the instructor</td>
<td>1</td>
</tr>
<tr>
<td>Students learn best when they have to turn up to class on a regular basis</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>
6.32 Preferred delivery modes for undergraduate forensic science students

For undergraduate students, most respondents listed blended mode for convenience (62%; $N=8$), confidence (50%; $N=8$) and best outcomes (72%; $N=7$) (Figure 45).

Tables 82 to 84 inclusive provide a summary of reasons provided by industry personnel for their choice of delivery mode for undergraduate forensic science students. There were no equivalent questions in the interview in Part B. Industry personnel were able to choose more than one category so the frequency of responses is provided.

The main reason provided by industry personnel for choosing blended mode for convenience for undergraduate students (Table 82) was the need for flexibility and practical work. In terms of confidence for undergraduate students, the reasons were varied (Table 83).

Reasons provided for selecting blended mode for the best outcomes for undergraduate students included better preparation time and review of online material and that students learn best from the combination of instruction with the back-up of online material (Table 84).

Four out of the five industry personnel interviewees selected blended mode for the best results.

IB5 Crime scene subjects need to be practical. Face-to-face for theory. Purely online won’t work.

Most respondents (78%; $N=9$) selected blended mode for the best career preparation for undergraduate students because forensic scientists need to be able to work in both face-to-face and online environments as part of their job (Table 85).

Interviewees in Part B were also asked which delivery method would best prepare students for a career in forensic science. The academic level of the student was not given. Out of five interviewees, one chose face-to-face mode and two chose both face-to-face and blended delivery mode.

IB2 Face-to-face and blended because they have both practical demonstrations and learning. Some students will learn better if they conceptualize the action.
IB3 Face-to-face. Must understand people on a feeling level but also need computer skills. Forensic science is a stressful career therefore need support base but also need computer skills.

When respondents to the questionnaire in Part A were asked if they would employ a forensic science graduate who studied a program that was fully online, 76% of respondents indicated they would not ($N=17$). The need for practical work was listed by 92% of respondents as the most common reason ($N=13$). However, when asked if they would employ a forensic degree graduate who studied a blended program, incorporating an online and face-to-face practical component, 100% of respondents indicated that they would. There was only a 29% response rate to the second part of the question and these respondents qualified their response by stating “given appropriate knowledge and skills” ($N=17$).

Unlike the majority of respondents in Part A, most of interviewees in Part B (60%) stated that they would employ a graduate who studied a forensic program that was delivered entirely online ($N=5$).

IB4 Yes. They get trained anyway in industry...

Another interviewee disagreed.

IB5 No. There is a heavy load of comparison work.

All interviewees stated that they would employ a forensic science graduate who studied a program through blended delivery mode ($N=5$).
Figure 45. Responses to questions 4.4 to 4.6 inclusive of the Part A questionnaire. Industry personnel perceptions of the best delivery mode in terms of convenience (N=8), confidence (N=8) and best outcomes (N=7) for undergraduate forensic science students.
Table 82. *Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting blended delivery as the best mode for convenience for undergraduate forensic science students (N=5).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students sometimes can’t make classes but do need some practical activities</td>
<td>2</td>
</tr>
<tr>
<td>Students can complete the theory component in their own time and attend the practical session in a ‘block’ of time.</td>
<td>1</td>
</tr>
<tr>
<td>It gives students the flexibility to catch up on work they missed in the face-to-face classes</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 83. *Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting blended delivery as the best mode for confidence for undergraduate forensic science students (N=3).*

<table>
<thead>
<tr>
<th>Reason</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students need face-to-face time IA23</td>
<td>1</td>
</tr>
<tr>
<td>Everyone has a chance to excel IA24</td>
<td>1</td>
</tr>
<tr>
<td>Students learn collaboratively with their peers during prac. IA30</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 84. *Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting blended delivery for the best outcomes for undergraduate students (N=4).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students learn best from the combination of face-to-face instruction with the back-up of online material for further study</td>
<td>1</td>
</tr>
<tr>
<td>Students need the face-to-face instruction but also need the online information to support their learning</td>
<td>1</td>
</tr>
<tr>
<td>Students are better prepared</td>
<td>1</td>
</tr>
<tr>
<td>It allows more time to review the material</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 85. Reasons provided by industry personnel in the Part A questionnaire for choosing blended delivery as the best mode for career preparation for undergraduate forensic science students (N=6).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forensic scientists need to be able to work in both face-to-face and online environments in their jobs.</td>
<td>3</td>
</tr>
<tr>
<td>Students need the practice of using computer technology in their chosen career but they also like to participate in practical classes</td>
<td>2</td>
</tr>
<tr>
<td>There are more opportunities for peer tutoring as the student community consists of experienced forensic scientists as well as inexperienced graduates</td>
<td>1</td>
</tr>
<tr>
<td>It develops time management skills</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
</tbody>
</table>

6.33 Preferred delivery mode for postgraduate forensic science students

Figure 46 reveals that the majority of respondents selected a different mode of delivery in terms of convenience, confidence and best outcomes for postgraduate students. For postgraduate students, most respondents (42%) selected online delivery as the most convenient method (N=7) (Figure 46). The main reason was that students can work where and when they like (Table 86).

For confidence, most respondents perceived face-to-face mode for postgraduate students (N=8) (Figure 46). The most frequently selected reasons for choosing face-to-face mode for confidence for postgraduate students were the high level of interaction and the access to the lecturer and immediate feedback (Table 87).
For best outcomes for postgraduate students approximately 38% of industry personnel chose blended mode (Table 46) for a variety of reasons including the motivation from the face-to-face component together with online support, better preparation for assessment and more time to review material (N=8) (Table 88).

Figure 46. The perceptions of industry personnel participants in the Part A questionnaire of the best delivery mode in terms of convenience (N=7), confidence (N=8) and best outcomes (N=8) for postgraduate forensic science students.
Table 86. Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting online delivery for convenience for postgraduate forensic science students (N=5).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students can work where and when they like</td>
<td>5</td>
</tr>
<tr>
<td>Some students live a long way from where the course is delivered.</td>
<td>2</td>
</tr>
<tr>
<td>Anywhere you have a computer you have a classroom</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 87. Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting face-to-face delivery as the best mode for confidence for postgraduate forensic science students.

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students have access to a lecturer and immediate feedback</td>
<td>3</td>
</tr>
<tr>
<td>There is a high level of interaction</td>
<td>3</td>
</tr>
<tr>
<td>Students learn collaboratively with their peers</td>
<td>2</td>
</tr>
<tr>
<td>It gives students an opportunity to practice under pressure</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 88. *Reasons provided by forensic science industry personnel in the Part A questionnaire for selecting blended delivery for the best outcomes for postgraduate students (N=5).*

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students need face-to-face motivation but also need the online information to support their learning</td>
<td>1</td>
</tr>
<tr>
<td>Students learn best from the combination of face-to-face instruction with the back-up of online material for further study</td>
<td>1</td>
</tr>
<tr>
<td>Students are better prepared for assessment</td>
<td>1</td>
</tr>
<tr>
<td>It allows more time to review the material</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
</tbody>
</table>

### 6.4 Future directions in forensic science education

Section five of the questionnaire in Part A of the study was included to explore the ideas of industry personnel on improving delivery in forensic science and is related to Research Questions 3a) 3b) and 3c). This section consisted of six questions of which the first four were two-tier questions, comprising of a closed and open section, and the final two were open questions.

Most respondents (78%) to the questionnaire in Part A indicated that forensic science students had different educational needs compared with other students and the most common reason provided was the need for practical skills (N=23) (Table 89).
Interviewees in Part B were also asked if forensic science students had different educational needs compared with other students and three out of five interviewees believed there were differences between the two groups.

IB1 My own training is in (names the disciplines). A difference in needs but a great need for practical.

IB5 Yes because competency-based qualifications need to report results in court. (They) need to have confidence in evidence requirements

IB4 ...need training specific to that area

There were only three responses to the last part of question 5.1 on how these needs could be addressed. The reasons provided included industry recognised training, regular updated training, mentoring programs, and care and support. One respondent IA027 made an interesting comment on career opportunities in forensic science.

IA027 I think there are far too many students studying forensics and very few opportunities for employment. Many students should be encouraged to undertake alternative careers as the forensic field has contracted in recent times and will probably continue to do so.

IA002 No they just need access to people, resources etc. relevant to field.

Most respondents (83%) in Part A thought undergraduate forensic science courses should undergo industry validation with the most common reason being the importance of standardisation and relevance to industry (N=23) (Table 90). Only 29% of respondents in Part A thought a national accreditation board should determine the content of undergraduate forensic science courses (N=24) (Table 91). Sixty seven percent of industry personnel believed that if a national accreditation board did determine the content, then the delivery method would be affected as more practical skills/ face-to-face would be required.

Most respondents (46%) in Part A indicated that they intended to study in the future (N=22) (Table 92). Their preferred delivery mode was online (55%) mainly so they could both work and continue their education (N=11). The preferred method of delivery chosen by the majority of respondents (55%) was online delivery and the
remaining 45% chose blended mode. For the respondents who chose blended mode, no reasons were provided (N=11). This low response rate could have been because they have already provided their reasons in a previous question. The main reason for selecting online mode was so they could work and continue their education. These findings were in line with industry personnel respondents who chose online mode for postgraduate students for convenience to study forensic science. However, according to the NIFS report (Brightman, 2005, p. 52) the most preferred delivery modes were face-to-face and a mixture of delivery modes. It is possible that improved technologies and facilitator training may have influenced user preferences over the past nine years.

Of the five interviewees in Part B of the study, two intended to study in the future, one was considering further study, another had no intention of further study and one did not know.

IB2 Blended – I love it. It suits me to learn when I can and catch up if I am busy another week. I find residential schools focused and informative. I wouldn’t study any other way.

Two other interviewees preferred online learning.

IB4 Maybe online. I now have the prac skills I need.

IB5 Online I can juggle study and family commitments.

The final question, 5.5, of the questionnaire in Part A was included to capture any further comments or suggestions regarding improvements on delivery methods in forensic science. There were seven responses to this question. Two of the respondents expressed the need for forensic practitioners to be informed about disciplines other than their own field of expertise.

IA0031 ... Practitioners need to be aware of what is available in other disciplines.

IA027 I would like to learn more about how training meets the needs of practitioners in the field. I have come to the field from another discipline and have worked within a very restricted area of forensics. I cannot therefore provide authoritative advice about the needs of forensic practitioners. I can understand
that there is a strong trend to increase online content in courses wherever possible as a means of reducing teaching costs.

Another two respondents had experienced difficulties through distance education including finding time to study and accessing specialised equipment.

IA001 Offer study leave for more involved subjects such as biology- Residents important to clarify info.

IA012 The difficulty of distance education is where there is a requirement of the students to complete assessment tasks using specialist equipment such as compound microscopes, and this equipment is not available within the student’s workplace.

Two other respondents described the need for practical skills.

IA018 Each method has benefits. Prac skills are important and should be taught face-to-face but being able to take control of one’s own study and learning for theory based learning can be done by either face-to-face or online. Not all people can take enough control to do online learning but if it’s something you really want then you would make the effort...

IA022 Must have practical component.

The final respondent to Question 5.5 of the questionnaire provided positive feedback on his –her experience of online learning.

IA030 Some websites at (named the institution) were very good. Interactivity, lectures online. Prompt responses from lecturer.
Table 89. Responses to question 5.1 of the questionnaire. Reasons provided by respondents in Part A regarding educational needs of forensic science students.

<table>
<thead>
<tr>
<th>Different educational needs of forensic science students</th>
<th>Frequency</th>
<th>Sample Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for practical skills/Competency-based</td>
<td>14</td>
<td>Some practical requirements but these could be addressed in in-house courses (IA015)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It is a complex area that requires very specific skills. There is a lot of pressure. Mentoring programs are essential as training and practical case-based must be mentored (IA022)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes, because it’s competency-based qualification. They need to report results in Court and need confidence in evidence requirements (IA023)</td>
</tr>
<tr>
<td>Access to specialised equipment</td>
<td>11</td>
<td>Access to equipment...(IA005)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Requires particular equipment (IA014)</td>
</tr>
<tr>
<td>Work experience</td>
<td>9</td>
<td>Make them do a year’s work experience as part of it (IA03)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Practically-based. Need to do work experience (IA071)</td>
</tr>
<tr>
<td>Personal needs – Forensic science is a stressful career</td>
<td>3</td>
<td>Educational needs the same. Personal needs will be different. Forensic science is stressful and demandingemotionally. Need support when they get out there. Open discussions within the group (IA028)</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>... Specific detailed knowledge is often required in a rapidly changing environment can invalidate previous knowledge. Their work (based on their study) has long reaching consequences...(IA017)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>... I think a major aspect of forensic science is to be able to follow strict procedures and, if possible, have a creative role in developing procedures. Clearly Crime Scene Officers and SOCO’S need to have a good grounding in the principles of evidence type, crime scene examination and collection of evidence...(IA027)</td>
</tr>
</tbody>
</table>
Table 90. Responses to question 5.2 of the Part A questionnaire. A sample of reasons provided by industry personnel on whether or not forensic science courses should undergo industry validation (N=23).

<table>
<thead>
<tr>
<th>Responses to the question: Do you think all undergraduate forensic science courses should undergo industry validation?</th>
<th>Sample comments/ reasons</th>
</tr>
</thead>
</table>
| **Yes** | *It would be a means of standardising expertise within the various areas of forensic science and ensuring that the quality of teaching at each university offering forensic science courses remains high at least reaches minimum standards when benchmarked with others offering similar subjects or training* (IA018)  
*If not relevant to industry then pointless* (IA002)  
*Some consultation and feedback at a minimum* (IA023)  
*Need to be NATA accredited* (IA004) |
| **No** | *Not all. Impractical* (IA022)  
*Need to be able to rapidly adapt to changes in opportunities and scientific knowledge* (IA024)  
*Some are doing it for interest not employment* (IA031)  
*Going to train new staff anyway* (IA030) |
Table 91. Responses to question 5.3 of the Part A questionnaire. A sample of reasons provided by industry personnel on whether an accreditation board should determine the content of undergraduate forensic science courses (N=22).

<table>
<thead>
<tr>
<th>Should a national accreditation board determine the content of undergraduate forensic science courses?</th>
<th>Sample of reasons provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>There should be national standards (IA01)</td>
</tr>
<tr>
<td></td>
<td>Consistency is important (IA017)</td>
</tr>
<tr>
<td></td>
<td>It would be driven and satisfy accreditation (IA022)</td>
</tr>
<tr>
<td></td>
<td>Some basic standards are needed (IA027)</td>
</tr>
<tr>
<td></td>
<td>Industry knows these courses meet a certain standard (IA030)</td>
</tr>
<tr>
<td>No</td>
<td>But should have input (IA002)</td>
</tr>
<tr>
<td></td>
<td>University should maintain autonomy offering courses and subjects that are slightly different from others (Provides examples of the subject and institution) but nowhere else, thus providing a wider choice of specialty areas for students. However, a national accreditation board could set minimum standards for all institutions to meet (IA018)</td>
</tr>
<tr>
<td></td>
<td>Input but national board would be difficult to control for all jurisdictions... (IA023)</td>
</tr>
<tr>
<td></td>
<td>Gives rise to power cliques (IA024)</td>
</tr>
<tr>
<td></td>
<td>But educational institutions should be consulting with them as to what is required (IA031)</td>
</tr>
<tr>
<td>Depends</td>
<td>Who makes up the board? (IA022)</td>
</tr>
</tbody>
</table>
Table 92. Responses to question 5.3a) of the Part A questionnaire. A sample of reasons provided by industry personnel on whether a national accreditation board’s involvement in choosing course content would affect the delivery mode (N=22).

<table>
<thead>
<tr>
<th>If the national accreditation board determined the content of forensic science courses, would this affect the delivery mode?</th>
<th>Sample of reasons provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>More face-to-face (IA009)</td>
</tr>
<tr>
<td></td>
<td>Possibly if practical sessions/ workshops are required then face-to-face teaching or attendance of residential schools would be needed...Not such a bad idea for teaching students the necessary practical/ laboratory/ field skills (IA018)</td>
</tr>
<tr>
<td></td>
<td>Will have electronic delivery to all states, industry and educational partnerships (IA023)</td>
</tr>
<tr>
<td></td>
<td>They may be against online learning (IA031)</td>
</tr>
<tr>
<td>No</td>
<td>Would depend on content. Some subjects easier and less complicated than others (IA001)</td>
</tr>
<tr>
<td></td>
<td>To an extent. Provided practicals can be undertaken. Other material is interchangeable (IA017)</td>
</tr>
</tbody>
</table>

6.41 Summary

Industry personnel participants in the Part A questionnaire identified flexibility as the main benefit of online and blended delivery. In terms of challenges, participants for both online and blended delivery, most participants identified a lack of assistance as the main challenge.

Blended delivery was perceived by most industry personnel participants in Part A as the preferred mode for convenience and confidence for diploma (85%; N=21: 75%; N=20) and undergraduate (62%; N=8: 50%; N=8) forensic science students. While most industry personnel participants selected blended delivery for the best outcomes for
undergraduate students (72%; N=7), most listed face-to-face mode as being the preferred mode for diploma students (55%, N=20).

The need for practical skills was identified by the majority of industry personnel in Part A as being a key educational need. Another argument to support the importance of practical skills, particularly for the technical field practitioners, is the advancement in technology. Increasingly, scientific instruments are being used in the field by forensic practitioners rather than laboratory technicians (Brightman, 2005). It is essential that these practitioners acquire both knowledge and skills such as chemical and manual handling and also scene management. Industry validation for undergraduate courses was considered to be necessary by most respondents as a means of standardising courses and keeping them relevant. Chapters four and five revealed that industry involvement was also considered to be important by the majority of students and teachers. These key educational issues, that is, the importance of practical skills and the relevance of forensic science courses were also identified in the NIFS report (Brightman, 2005). Furthermore, according to Brightman (2005), technical field officers and scientific laboratory staff had the most concerns regarding educational issues and these were the most common groups in this study.

The next chapter, Chapter Seven, provides a comparative analysis of the experiences and perceptions of forensic science students, teachers and industry personnel of the different delivery modes.
CHAPTER 7: COMPARATIVE RESULTS

This chapter presents a comparison of the experiences and perceptions between the three groups of participating stakeholders in this study. Data is presented with the purpose of highlighting common themes and differences between the stakeholders. The chapter is divided into four sections. The first section compares the experiences of different delivery modes in forensic science of each group including tertiary students, teachers and industry professionals. The second section compares the preferences of each of these groups for the different delivery modes. The third section synthesises common ideas and suggestions for future directions in forensic science education. The final section provides a summary of the comparative findings presented in this chapter.

7.1 A comparison of the experiences of students, teachers and industry personnel for the different delivery modes

7.11 Benefits and challenges of online delivery

Table 93 provides data from both open and closed items of the survey questionnaire on the benefits and challenges of blended and online delivery as identified by students, teachers and industry personnel. In Table 93, the common themes identified between different groups are highlighted in light grey and inconsistencies are highlighted in dark grey.

All three groups, that is, students, teachers and industry personnel, identified flexibility and convenience as the main benefits of online delivery (Table 93). For students, this meant ease of access and time management. Geographical advantages were identified by both teachers and industry personnel with teachers identifying opportunities to teach across different time zones and industry personnel recognising the advantage of being able to access staff in remote locations. One interesting benefit that was identified only by teachers was immediate private feedback.

Teachers reported concerns related to the unrealistic expectations of students with regard to the timeliness of feedback for online delivery and did not report any
feedback problems for blended delivery. In contrast, both students and industry personnel reported that they had experienced feedback delay in both online and blended delivery. Both students and industry personnel had concerns over the lack of social interaction in fully online learning.

7.12 Benefits of and challenges of blended delivery

Flexibility was also reported by students, teachers and industry personnel as being a benefit of blended learning (Table 93). In addition, students and industry personnel appreciated the opportunity of having access to the teacher and both students and teachers reported that student access to resources was an additional benefit of blended delivery.

Information technology problems were reported as a challenge for both online and blended delivery by students, teachers and industry personnel (Table 93) with some teachers reporting that they often felt they had to be a trouble-shooter as well as a teacher. A common challenge identified by both students and industry personnel was the timeliness of feedback. The majority of teachers did not raise this as a concern.

In summary, while students and industry personnel reported concerns over the timeliness of feedback in both online and blended delivery, most teachers mentioned immediate private feedback as being an advantage of online delivery. As cited in Chapter 6, one forensic practitioner, who was also studying at the time of survey completion, described how face-to-face feedback clarifies problems immediately and avoids the ‘back and forth’ communication that is often encountered in online or blended delivery. Teachers believed students expected an immediate response for online delivery and did not see feedback as an issue for blended delivery. Clearly, there are inconsistencies with regard to feedback in both online and blended mode between teachers and both students and industry personnel. A possible solution may be that teachers provide clear guidelines at the beginning of the course or subject regarding their contact details, availability and perhaps feedback turn-around time. One teacher interviewee, TB7, discussed his-her approach to feedback for online students.

TB7 The problem with online (is that you) need to be good with computer and keyboard skills. You can be writing an answer and it takes forever to write and mark. I use a word document of sample comments and I am able to cut and
paste. It saves the teacher time and can lead to consistency of feedback. With fully online there is no classroom interaction. It’s all through email but I always offer phone support. (You) need to experience what’s happening from the student’s point of view. It’s easier to explain to someone on the phone. (You can) hear inflections in the voice, the tone of the voice. Emails don’t necessarily put you in the zone.
Table 93. Benefits and challenges of online and blended delivery identified by students, teachers and industry personnel in the Part A questionnaire. Students' online benefits, challenges and blended benefits and challenges (N=30, 30, 66 and 60 respectively). Teachers online benefits, challenges, and blended benefits and challenges (N=27, 28, 28 and 26 respectively). Industry personnel online benefits, challenges and blended benefits and challenges (N=20, 19, 23 and 14 respectively).

<table>
<thead>
<tr>
<th>Benefits of online learning</th>
<th>Challenges of online learning</th>
<th>Benefits of blended learning</th>
<th>Challenges of blended learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Students</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexible</td>
<td>Feedback</td>
<td>Flexible</td>
<td>Help from teacher</td>
</tr>
<tr>
<td>Convenience</td>
<td>Motivation</td>
<td>Access to teacher</td>
<td>IT problems</td>
</tr>
<tr>
<td>Time management</td>
<td>Social interaction</td>
<td>Access to resources</td>
<td>Motivation</td>
</tr>
<tr>
<td>Revision</td>
<td>Time management</td>
<td>Learn in different ways</td>
<td>Speed of feedback</td>
</tr>
<tr>
<td></td>
<td>IT problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Teachers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teach across different time zones</td>
<td>Reliance on IT</td>
<td>Time and flexibility</td>
<td>Must be relevant and interactive</td>
</tr>
<tr>
<td>Convenience</td>
<td>Who is doing the assessment?</td>
<td>Best of both worlds</td>
<td>May require IT training</td>
</tr>
<tr>
<td>Opportunities for immediate feedback</td>
<td>Preparation time</td>
<td>Can cover more</td>
<td>Increased preparation time</td>
</tr>
<tr>
<td>Don’t have to deal with difficult students</td>
<td>Students expect immediate feedback</td>
<td>All material online</td>
<td>Must be a trouble-shooter and teacher</td>
</tr>
<tr>
<td><strong>Industry personnel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexible (study and work full-time)</td>
<td>No help from teacher</td>
<td>Flexibility</td>
<td>No assistance</td>
</tr>
<tr>
<td>Convenience</td>
<td>Demographics</td>
<td>Feedback</td>
<td>Equipment</td>
</tr>
<tr>
<td>Access to staff in remote locations</td>
<td>Feedback delay</td>
<td>Apply prac to theory/residential</td>
<td>Time management</td>
</tr>
<tr>
<td>Can target specific groups</td>
<td>No social interaction</td>
<td>People</td>
<td>Delayed feedback</td>
</tr>
</tbody>
</table>
7.2 A comparison of the preferences of students, teachers and industry personnel for the different delivery modes

In this section, the preferences for the different delivery modes in terms of convenience, confidence, best outcomes and career preparation are examined from the perspectives of students, teachers and industry personnel. As in Chapters 4, 5 and 6, the preferences for each delivery mode will be examined for three different academic levels; diploma students working in the police force, undergraduate and postgraduate students.

7.21 Preferred delivery modes identified by students, teachers and industry personnel for diploma students working in the police force

Preferences for the different delivery modes can be examined by subdividing into convenience, student confidence and best outcomes.

7.211 Convenience for diploma students working in the police force

Blended delivery was identified by the majority students, teachers and industry personnel as the preferred mode for convenience to study forensic science for diploma students working in the police force (87%, N=15; 57%, N=14; 86%; N=21 respectively) (Table 94). Data in Table 94 were collected from all three survey questionnaires. Closed items were used in both the student and industry personnel questionnaires in order to maximise the completion rate whereas open items were used for the teacher survey questionnaire. I was in direct contact with most of the teacher participants and the reasoning behind this type of question was that teachers could be encouraged to spend time and provide thoughtful and reflective views.
Table 94. *The most convenient delivery mode selected by students, teachers and industry personnel for diploma students working in the police force. The highest percentage for each stakeholder has been highlighted.*

<table>
<thead>
<tr>
<th>Percentage of stakeholders/Delivery Mode</th>
<th>Student (N=15)</th>
<th>Teacher (N=14)</th>
<th>Industry personnel (N=21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Blended</td>
<td>87%</td>
<td>57%</td>
<td>86%</td>
</tr>
<tr>
<td>Online</td>
<td>13%</td>
<td>43%</td>
<td>14%</td>
</tr>
<tr>
<td>Combination</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

7.212 Confidence for diploma students working in the police force

Blended delivery was also selected by the majority of students, teachers and industry personnel (86%, N=15; 64%, N=14; 75%, N=20 respectively) in terms of confidence to study forensic science for diploma students working in the police force (Table 95). The data presented in Table 95 were collected from student, teacher and industry personnel survey questionnaires using closed, open and closed items respectively.
Table 95. *The delivery mode selected by students, teachers and industry personnel as providing diploma students, working in the police force, with the most confidence to study forensic science. The highest percentage for each stakeholder has been highlighted.*

<table>
<thead>
<tr>
<th>Percentage of stakeholders/ Delivery Mode</th>
<th>Students (N=15)</th>
<th>Teachers (N=14)</th>
<th>Industry personnel (N=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>7%</td>
<td>29%</td>
<td>20%</td>
</tr>
<tr>
<td>Blended</td>
<td>86%</td>
<td>64%</td>
<td>75%</td>
</tr>
<tr>
<td>Online</td>
<td>7%</td>
<td>7%</td>
<td>0%</td>
</tr>
<tr>
<td>Combination</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
</tr>
</tbody>
</table>

7.213 **Best outcomes for diploma students working in the police force**

Table 96 provides data collected from student, teacher and industry personnel survey questionnaires using closed, open and closed items respectively.

Face-to-face mode was selected by both the majority of students (64%; N=14) and industry personnel (55%; N=20) as providing the best outcomes for diploma students working in the police force while most teachers (72%; N=14) chose blended mode for this academic level (Table 96).

These data are different from those for convenience (Table 94) and confidence (Table 95) where blended mode was the most favoured mode by all three groups. The data
reported in Table 96 show a perception amongst students and industry personnel that students will achieve better learning outcomes with face-to-face delivery. This finding raises other relevant questions, for example, does this mean that most diploma students working in the police force feel disadvantaged by not having face-to-face classes?

Table 96. *The delivery mode selected by students, teachers and industry personnel as providing diploma students, working in the police force, with the best outcomes. The highest percentage for each stakeholder has been highlighted.*

<table>
<thead>
<tr>
<th>Percentage of stakeholders/ Delivery mode</th>
<th>Students (N=14)</th>
<th>Teachers (N=14)</th>
<th>Industry personnel (N=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>64%</td>
<td>14%</td>
<td>55%</td>
</tr>
<tr>
<td>Blended</td>
<td>21%</td>
<td>72%</td>
<td>40%</td>
</tr>
<tr>
<td>Online</td>
<td>15%</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>Combination</td>
<td>0%</td>
<td>7%</td>
<td>0%</td>
</tr>
</tbody>
</table>
7.22 Preferred delivery modes identified by students, teachers and industry personnel for undergraduate forensic science students

7.221 Convenience for undergraduate students

The majority of all three stakeholders selected blended mode for convenience for undergraduate students i.e., most students (54%, N=28), teachers (72%, N=18) and industry personnel (62.5%, N=8) (Table 97). Table 97 provides data collected from survey questionnaires; students and industry personnel using closed items and teachers using open items.

Table 97. The most convenient delivery mode selected by students, teachers and industry personnel for undergraduate students. The highest percentage for each stakeholder has been highlighted.

<table>
<thead>
<tr>
<th>Percentage of stakeholders/ Delivery mode</th>
<th>Students (N=28)</th>
<th>Teachers (N=18)</th>
<th>Industry personnel (N=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>43%</td>
<td>17%</td>
<td>25%</td>
</tr>
<tr>
<td>Blended</td>
<td>54%</td>
<td>72%</td>
<td>62.5%</td>
</tr>
<tr>
<td>Online</td>
<td>3%</td>
<td>5.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Combination</td>
<td>0%</td>
<td>5.5%</td>
<td>0%</td>
</tr>
</tbody>
</table>
7.222 Confidence for undergraduate students

A similar trend is discernible with respect to both convenience (Table 97) and confidence (Table 98) for undergraduate students to study forensic science. Blended mode was also selected by both the majority of all three stakeholders for confidence for undergraduate students to study forensic science with almost half all respondents choosing blended mode.

Table 98 reveals that most student (52%, $N=33$), teachers (50%; $N=18$) and industry personnel (50%; $N=8$) chose blended delivery for confidence. Closed items were used for both the student and industry personnel survey questionnaires whereas open items were used for the teacher survey questionnaires in Tables 97 and 98.

Table 98. The delivery mode selected by students, teachers and industry personnel as providing undergraduate students with most confidence to study forensic science. The highest percentage for each stakeholder has been highlighted.

<table>
<thead>
<tr>
<th>Percentage of stakeholders/ Delivery mode</th>
<th>Students ($N=33$)</th>
<th>Teachers ($N=18$)</th>
<th>Industry personnel ($N=8$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>45%</td>
<td>39%</td>
<td>38%</td>
</tr>
<tr>
<td>Blended</td>
<td>52%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Online</td>
<td>0%</td>
<td>5.5%</td>
<td>12%</td>
</tr>
<tr>
<td>Combination</td>
<td>3%</td>
<td>5.5%</td>
<td>0%</td>
</tr>
</tbody>
</table>
7.223 Best outcomes for undergraduate students

Data in Table 99 shows the majority of all three stakeholders prefer blended mode for best outcomes for undergraduate students i.e., most students (52%, \(N=25\)), teachers (50%, \(N=16\)) and industry personnel (72%, \(N=7\)).

Data provided in Table 99 were collected from the student, teacher and industry personnel survey questionnaires using closed items, open items and closed items respectively. Considered from the industry perspective, face-to-face mode is not an option for many due to the nature of the work e.g., rostering, remote postings etc. As reported in Chapter 5, some teachers reported that blended mode allows students to participate in practical work and also re-visit work that is posted online. Student respondents were almost equally divided between blended and face-to-face mode when selecting their preferred mode for best learning outcomes.

Table 99. The delivery mode selected by students, teachers and industry personnel as providing undergraduate students with the best learning outcomes. The highest percentage for each stakeholder has been highlighted.

<table>
<thead>
<tr>
<th>Percentage of stakeholders/ Delivery mode</th>
<th>Students ((N=25))</th>
<th>Teachers ((N=16))</th>
<th>Industry personnel ((N=7))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>48%</td>
<td>39%</td>
<td>14%</td>
</tr>
<tr>
<td>Blended</td>
<td>52%</td>
<td>50%</td>
<td>72%</td>
</tr>
<tr>
<td>Online</td>
<td>0%</td>
<td>5.5%</td>
<td>0%</td>
</tr>
<tr>
<td>Combination</td>
<td>0%</td>
<td>5.5%</td>
<td>14%</td>
</tr>
</tbody>
</table>
7.224 Career preparation for undergraduate students

The majority of all three stakeholders, students (68%; \(N=28\)), teachers (75%; \(N=22\)) and industry personnel (80%; \(N=5\)) reported that blended mode provided undergraduate students with the best preparation for a career in forensic science (Table 100). The data presented in Table 100 were collected from closed items in the student, teacher and industry personnel survey questionnaires.

Students identified not only practical skills and required knowledge as being important in career preparation but also other skills such as problem solving and time management (Table 32).

Data relating to online delivery in Tables 97 to 99 inclusive support the findings provided by industry personnel, in response to open items of the survey questionnaire, when they were asked if they would employ a forensic science graduate who studied a course that was fully online. Most industry personnel (76%; \(N=17\)) reported they would not employ such a graduate with the main reason (92%; \(N=13\)) being the lack of practical work. However, 100% of industry personnel respondents indicated they would employ a forensic science graduate who studied via blended mode (\(N=17\)). The author believes this has implications for the future employment of forensic science graduates and warrants further investigation by educational institutions.
Table 100. *The delivery mode selected by students, teachers and industry personnel as providing the best preparation for a career in forensic science for undergraduate students. The highest percentage for each stakeholder has been highlighted.*

<table>
<thead>
<tr>
<th>Percentage of stakeholders/Delivery mode</th>
<th>Students (N=28)</th>
<th>Teachers (N=29)</th>
<th>Industry personnel (N=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>29%</td>
<td>19%</td>
<td>20%</td>
</tr>
<tr>
<td>Blended</td>
<td>68%</td>
<td>75%</td>
<td>80%</td>
</tr>
<tr>
<td>Online</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Combination</td>
<td>0%</td>
<td>6%</td>
<td>0%</td>
</tr>
</tbody>
</table>

7.23 Preferred delivery modes identified by students, teachers and industry personnel for postgraduate students

7.231 Convenience for postgraduate students

While most students (47%; N=15) and teachers (40%; N=20) prefer face-to-face mode for convenience for post graduate students to study forensic science, most industry personnel (42%, N=7) prefer online mode (Table 101).

Data in Table 101 were collected from survey questionnaires for the three stakeholders. Closed items were used for students and industry personnel and open items were used for the teachers’ survey questionnaire.
Table 101. **The most convenient delivery mode selected by students, teachers and industry personnel for postgraduate students. The highest percentage for each stakeholder has been highlighted.**

<table>
<thead>
<tr>
<th>Percentage of stakeholders/Delivery mode</th>
<th>Students (N=15)</th>
<th>Teachers (N=20)</th>
<th>Industry personnel (N=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>47%</td>
<td>40%</td>
<td>29%</td>
</tr>
<tr>
<td>Blended</td>
<td>33%</td>
<td>30%</td>
<td>29%</td>
</tr>
<tr>
<td>Online</td>
<td>13%</td>
<td>20%</td>
<td>42%</td>
</tr>
<tr>
<td>Combination</td>
<td>7%</td>
<td>10%</td>
<td>0%</td>
</tr>
</tbody>
</table>

**7.232 Confidence for postgraduate students**

Most of the three stakeholders perceived face-to-face mode as providing postgraduates with the most confidence to study forensic science i.e., most students (50%, N=14), teachers (47%, N=19) and industry personnel (50%, N=8) (Table 102).

The data in table 102 were collected from survey questionnaires for the three stakeholders. Closed items were used for students and industry personnel and open items were used for the teachers’ survey questionnaire.
Table 102. *The delivery mode selected by students, teachers and industry personnel as providing postgraduate students with most confidence to study forensic science. The highest percentage for each stakeholder has been highlighted.*

<table>
<thead>
<tr>
<th>Delivery mode</th>
<th>Percentage of stakeholders/ (N=14)</th>
<th>Teachers (N=19)</th>
<th>Industry personnel (N=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>50%</td>
<td>47%</td>
<td>50%</td>
</tr>
<tr>
<td>Blended</td>
<td>29%</td>
<td>33%</td>
<td>38%</td>
</tr>
<tr>
<td>Online</td>
<td>7%</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Combination</td>
<td>14%</td>
<td>10%</td>
<td>12%</td>
</tr>
</tbody>
</table>

7.233 **Best outcomes for postgraduate students**

Blended mode was selected by both teachers (42%; N=19) and industry personnel (37.5%; N=8) as the delivery method providing the best outcomes for postgraduate students. However most students (53%; N=15) selected face-to-face mode for the best outcomes for this academic level (Table 103). Being able to interact with their supervisor as well as their peers is important to the students.

These data were collected from survey questionnaires for the three stakeholders. Closed items were used for students and industry personnel and open items were used for the teachers’ survey questionnaire.
Table 103. The delivery mode selected by students, teachers and industry personnel as providing the best outcomes for postgraduate students. The highest percentage for each stakeholder has been highlighted.

<table>
<thead>
<tr>
<th>Percentage of stakeholders/ Delivery mode</th>
<th>Students (N=15)</th>
<th>Teachers (N=19)</th>
<th>Industry personnel (N=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>53%</td>
<td>33%</td>
<td>25%</td>
</tr>
<tr>
<td>Blended</td>
<td>33%</td>
<td>42%</td>
<td>37.5%</td>
</tr>
<tr>
<td>Online</td>
<td>7%</td>
<td>15%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Combination</td>
<td>7%</td>
<td>10%</td>
<td>25%</td>
</tr>
</tbody>
</table>

This study shows that most of the three stakeholder respondents are in agreement in their preferred choice of delivery for undergraduate students i.e. blended mode was selected in terms of convenience, confidence and best learning outcomes and career preparation. However, some differences were highlighted between stakeholders for the best delivery mode for the diploma and postgraduate students. While blended mode was selected by all stakeholders for diploma students in terms of convenience and confidence, most students and industry personnel prefer face-to-face mode in terms of best learning outcomes. There appears to be a perception amongst students and industry personnel that diploma students gain better results with face-to-face mode.

Diploma students, working in the police force, are unable to attend regular face-to-face classes due to work commitments. A possible solution may be to augment the
face-to-face component of the blended classes. Students also perceived that postgraduate students achieve better learning outcomes with face-to-face mode while most teachers and industry personnel chose blended mode for best outcomes at this academic level.

Online delivery was the least preferred choice. The only time online mode was selected by the majority of any stakeholder was when industry personnel selected this mode in terms of convenience for postgraduate students. In Chapter Four, students identified how forensic scientists need to be able to work in both face-to-face and online environments (Table 32).

7.3 Future directions in forensic science education

Industry involvement was identified as an important aspect of forensic science training by all three stakeholders with students and teachers also emphasising the importance of teachers possessing relevant industry experience. The majority of industry personnel (83%) were in favour of industry validation for undergraduate forensic science courses as a means of standardisation and maintaining relevance ($N=23$). Uniformity across different forensic science courses was also identified as an important issue by 5 out of 25 teacher participants. This finding raises an important question. If an employer believes certain forensic science courses do not meet their needs or standards, will the graduates of such courses be disadvantaged in terms of immediate employability and job readiness?

The majority of all three stakeholders, student interviewees (72%, $N=7$), teacher interviewees (80%, $N=5$) and industry personnel respondents (78%, $N=23$) reported that forensic science students were different when compared with other students studying tertiary courses. The need for practical and communication skills was listed by both students and industry personnel as being the main reason for the differences between forensic science students and other tertiary students. Industry personnel cited advancements in technology as being one of the main drivers. Teachers identified forensic science students as being more career-focused and needing excellent communication skills, however, most did not think that teaching forensic science students was different to teaching other students.
7.4 Comparative findings

The comparative findings 1 – 15 provide a summary of the results presented in this chapter.

**Comparative finding one.** Teachers reported concerns related to the unrealistic expectations of students with regard to the timeliness of feedback for online delivery and did not report any feedback problems for blended delivery. In contrast, both students and industry personnel reported that they had experienced feedback delay in both online and blended delivery (Table 93).

**Comparative finding two.** Information technology problems were reported as a challenge for both online and blended delivery by students, teachers and industry personnel (Table 93) with some teachers reporting that they often felt they had to be a trouble-shooter as well as a teacher. A common challenge identified by both students and industry personnel was the timeliness of feedback. The majority of teachers did not raise this as a concern.

**Comparative finding three.** Both students and industry personnel had concerns over the lack of social interaction in fully online learning (Table 93).

**Comparative finding four.** Blended delivery was identified by the majority of students, teachers and industry personnel as the preferred mode for convenience to study forensic science for diploma students working in the police force (87%, N=15; 57%, N=14; 86%; N=21 respectively) (Table 94).

**Comparative finding five.** Blended delivery was also selected by the majority of students, teachers and industry personnel (86%, N=15; 64%, N=14; 75%, N=20 respectively) in terms of confidence to study forensic science for diploma students working in the police force (Table 95).

**Comparative finding six.** Face-to-face mode was selected by both the majority of students (64%; N=14) and industry personnel (55%; N=20) as providing the best outcomes for diploma students working in the police force while most teachers (72%; N=14) chose blended mode for this academic level (Table 96).
Comparative finding seven. The majority of all three stakeholders selected blended mode for convenience for undergraduate students i.e., most students (54%, \( N=28 \)), teachers (72%, \( N=18 \)) and industry personnel (62.5%, \( N=8 \)) (Table 97).

Comparative finding eight. Blended mode was also selected by both the majority of all three stakeholders for confidence for undergraduate students to study forensic science with almost half all respondents choosing blended mode (Table 98).

Comparative finding nine. The majority of all three stakeholders prefer blended mode for best outcomes for undergraduate students i.e., most students (52%, \( N=25 \)), teachers (50%, \( N=16 \)) and industry personnel (72%, \( N=7 \)) (Table 99).

Comparative finding ten. The majority of all three stakeholders, students (68%; \( N=28 \)), teachers (75%; \( N=22 \)) and industry personnel (80%; \( N=5 \)) reported that blended mode provided undergraduate students with the best preparation for a career in forensic science (Table 100).

Comparative finding eleven. While most students (47%; \( N=15 \)) and teachers (40%; \( N=20 \)) prefer face-to-face mode for convenience for postgraduate students to study forensic science, most industry personnel (42%, \( N=7 \)) prefer online mode (Table 101).

Comparative finding twelve. Most of the three stakeholders perceived face-to-face mode as providing postgraduate students with the most confidence to study forensic science i.e., most students (50%, \( N=14 \)), teachers (47%, \( N=19 \)) and industry personnel (50%, \( N=8 \)) (Table 102).

Comparative finding thirteen. Blended mode was selected by both teachers (42%; \( N=19 \)) and industry personnel (37.5%; \( N=8 \)) as the delivery method providing the best outcomes for postgraduate students. However most students (53%; \( N=15 \)) selected face-to-face mode for the best outcomes for this academic level (Table 103). Being able to interact with their supervisor as well as their peers is important to the students.

Comparative finding fourteen. All three stakeholders identified the importance of industry involvement in tertiary forensic science delivery and stressed the need for teachers to have relevant industry experience.
Comparative finding fifteen. All three stakeholders agreed on the need to include practical and communication skills in forensic science courses.

This chapter has included a comparison of the findings of all three stakeholders in this study and formulated a summary of comparative findings. In the final chapter, Chapter Eight, assertions are derived from the relevant findings provided in Chapters Four to Seven inclusive. In turn, a discussion of the assertions in light of the literature is provided in an attempt to answer each of the Research Questions. Possible solutions to the key challenges identified by the different stakeholders for online delivery is presented. Chapter Eight concludes with the issues of the research rigour, limitations and ideas for future research.
CHAPTER 8: DISCUSSION AND CONCLUSION

This chapter is divided into six broad sections. The first three sections address Research Questions 1 - 3 respectively. For each Research Question, assertions are formulated based on the findings from Chapters 4 to 6 inclusive. In this way, a manageable number of assertions are linked to each Research Question. Common themes are extrapolated from the assertions and a discussion in light of the literature is presented. The fourth section develops best practice solutions based on the relevant literature and findings of this study. Section five presents an overview of the rigour of this research, a discussion of the limitations of the study, the contribution the research makes to the literature and ideas for future research into tertiary forensic science education. The chapter concludes with the sixth and final section that describes the researchers’ final reflective thoughts on her research journey in the first person.

8.1 Research Questions related to tertiary forensic science students

This study set out to compare the different delivery modes used in tertiary forensic science. This section will explore the experiences and perceptions of tertiary forensic science students for face-to-face, blended and online delivery. The relationship between the research questions, assertions and findings for all three stakeholders are presented in Table 104. The Student Assertions are presented in Table 105.
Table 104. Research Questions and related Assertions and Findings.

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Table 105. Student Assertions pertaining to RQ1a), RQ1b) and RQ1c)

Student Assertions 1 - 16

**Student Assertion 1 (RQ1a)** Some form of online delivery was experienced by approximately three quarters of participating students in Part A. Of the four subject categories (Samarji, 2010), criminalistics scientific was the most common type experienced.

**Student Assertion 2 (RQ1a)** Interactive online subjects were experienced by over half participating students in Part A with discussion forums being the most common interactive type of activity. The inclusion of interactive online activities is not a guarantee that students will participate.

**Student Assertion 3 (RQ1a)** A positive online or blended learning experience was reported by almost half of the participating students in Part A and only one tenth found it to be entirely negative.

**Student Assertion 4 (RQ1a)** The three main benefits of online learning experienced by participating students were flexibility, convenience and opportunities for revision.

**Student Assertion 5 (RQ1a)** The key challenges of online learning experienced by participants were feedback, motivation and IT access. Almost twice as many students reported problems with feedback than reduced motivation.

**Student Assertion 6 (RQ1a)** Based on the experiences of participating students, the three main benefits of blended learning reported were flexibility, access to both the teacher and learning resources.

**Student Assertion 7 (RQ1a)** The three key challenges of blended learning reported by participating students were limited feedback, access to the internet and or IT support and speed of feedback.

**Student Assertion 8 (RQ1b)** In terms of convenience to study forensic science, half the respondents perceived blended mode as the preferred method to study forensic science with the main reason being the flexibility of having online work available at all times.

**Student Assertion 9 (RQ1b)** Blended mode was selected by all three academic groups, students enrolled in industry-based, undergraduate and postgraduate courses for convenience to study forensic science.

**Student Assertion 10 (RQ1b)** In terms of confidence to study forensic science, almost half participating students selected blended mode because it gave them two options for working things out.

**Student Assertion 11 (RQ1b)** While almost three quarters of students enrolled in industry-based courses preferred blended mode in terms of confidence to study forensic science, undergraduate students were evenly divided between face-to-face and blended modes and half of the postgraduate students perceived face-to-face mode as the best mode for confidence.

**Student Assertion 12 (RQ1b)** All first year undergraduate students interviewed indicated they wanted all three adult learning styles; lecture-based, practice-based and problem-based, incorporated into their classes.

**Student Assertion 13 (RQ1c)** More than half participating students reported that face-to-face mode provided them with the best results in forensic science. Forensic students in both industry-based and postgraduate courses preferred face-to-face mode for achieving the best results while most undergraduate students perceived blended mode as the best mode in terms of results. The most commonly reported reason was the access to the teacher.

**Student Assertion 14 (RQ1c)** Blended delivery was perceived by approximately half the participating students as providing them with the best preparation for a career in forensic science. The most common reason provided was that forensic scientist students need practical skills in addition to technical knowledge.

**Student Assertion 15 (RQ1c)** The three most common ideas for future directions in forensic science education provided by participating students were industry partnerships, the importance of practical skills and communication and team work skills.

**Student Assertion 16 (RQ1c)** There is a perception amongst students that they are different to other tertiary students in that they are more career-focused and require practical and analytical skills in addition to an understanding of several different scientific disciplines.
Research Question 1a)

What are Australian tertiary students’ experiences of delivery mode (face-to-face, blended and on-line) for forensic science?

8.11 Emergent themes relating to Research Question 1a)

Three major themes emerged from student assertions 1-7 (Table 105) inclusive including flexibility and convenience, online learning resources, including access and interactivity, feedback and motivation. A discussion of these themes is presented in the following sections.

8.111 Flexibility and convenience

Flexibility and convenience were identified by tertiary forensic science students, in this study as the top two benefits for both online and blended learning (Student Assertions 4 and 6). This finding reflects one of the top trends in online learning for Australian tertiary education identified and reported by Johnson, Adams and Cummins (2012, p. 4) i.e. “people expect to be able to work, learn and study whenever and wherever they want to”. This was the case for both adults, many of whom were working, and school age children. Johnson, Adams and Cummin’s (2012) findings are consistent with those of Clark (2011) who reported that 52% of adult students (N=486), enrolled in literacy and basic skills (LBS) and academic upgrading (AU) courses, reported that additional online activities allowed them to organise their studies around outside commitments such as family and work.

8.112 Online learning resources

With the introduction of the internet, online learning tools and learner management systems, the proportion of online instruction and learning at all levels has increased. Just how much online teaching and learning students experience in any particular discipline probably varies, but the findings from this study gave some insight into the proportion of online learning in forensic science experienced by the participants at the time of data collection. Muilenburg and Berge (2005) conducted a factor analysis on students’ perceptions of online learning. Participants in Muilenberg and Berge’s (2005) study included adult students from conferences, distance programs, online subscription sites and educational institutions and 67% of these students (N=1046) reported that they had experienced online learning. In 2011, Clark found that 70% of
participating students (N=243), aged between 20 – 29 years and enrolled in literacy and basic skills (LBS) and academic upgrading (AU) courses, were using the internet to access online resources for their class work. Given the fact that the data for this study were collected from 2010 – 2013, and that online delivery has continued to gain popularity since previous studies were conducted (Muilenburg & Berge, 2005; Clark, 2011), it would seem feasible that, as reported in the findings, three quarters of the respondents in Part A had experienced some form of online delivery (Student Assertion 1).

8.1121 Access

One of the main benefits identified by students in Part A of this study was access to learning resources before and after class. The opportunity to access and review learning material online has also been reported in the literature as a success factor for learners of blended delivery (Walters, 2008). Williams and Farndon (2007), similarly found the main reason that students accessed recorded lectures was for revision purposes. Unlimited access in space and time is a major factor that differentiates online and blended teaching and learning from traditional delivery. In the traditional lecture format, for example, the lecture has a specific start and finish time and, regardless of the availability or disposition of the learners, that is the only time they have to access content, other than through secondary means of written annotations or lecture notes. Online delivery cuts across these traditions by making teaching and learning materials accessible at all times so that learners can participate at any time they are available and when they are in a suitable frame of mind for learning. Furthermore, they can access materials as frequently as they choose and stop and start when they are tired or more energised. The findings from this study clearly show that these factors were important to the participating forensic science students, many of whom were working in the industry and/or had busy working lives. Student expectations of access to digital teaching and learning materials are already high compared with a few years ago and are likely to continue to rapidly escalate in the near future.

8.1122 Interactivity

The inclusion of interactive activities was cited by Clark (2011) as being one of the factors that increases student engagement in a blended course. The findings in Part B
of this study do not fully support those of Clark (2011). Participating students in the teaching study in Part B were selective in their use of the interactive activities that were available in the forensic entomology course. Some interactive sites e.g., problem solving scenarios and discussion forums were reported as being the favourite types of activities whilst others e.g., crosswords were not even listed (Table 14). It should be noted that these activities were optional. The preference shown by participating students for non-interactive activities is in keeping with Means et al. (2010). Means et al. (2010) conducted a meta analysis of 84 studies that included learners in K-12, undergraduate, graduate, medical and teachers participating in professional development. Contrary to the findings of Clark (2011), Means et al. (2010, p. xii) found that the inclusion of media such as online quizzes, did not enhance student learning and did not appear to be any more effective than, for example, assigning homework.

Discussion forums were the most frequently used interactive sites for participants in Part A of this study (Student Assertion 2). Rovai (2004), Ellsworth (2005) and Haavind (2006) found that students were more likely to participate in discussion forums when student postings formed part of the assessment for that subject. It is not known whether or not the discussion forums formed part of the assessment for Part A participants. However, for the teaching study in Part B, the discussion forum did not form part of the assessment. This finding suggests that the participating students either enjoyed or saw some value in the use of discussion forums and the finding does not support Williams and Purvy’s (2002) assertion that only a minority of students enjoy discussion forums.

Just because a forensic science student can *hold their own* in a discussion forum doesn’t necessarily mean they are also able to perform mathematical calculations and grasp scientific concepts; all necessary skills for a forensic scientist. However, an important quality of forensic scientists is their ability to communicate, so there may be some inherent and relevant value in the use of discussion forums and blogs. This may have implications for the use of connectivist MOOCs (cMOOCs) in a *taster* forensic science course in which the students blog posts to discuss different aspects of the course.

Waha and Davis (2014) investigated student perspectives of a master’s course in library and information science, delivered through blended mode, and found the
students’ enjoyment of using a particular learning tool did not necessarily equate to their perception of whether or not it aided their learning. Student Assertion 2, indicated that some of the interactive tools provided in the teaching study in Part B were not used; however, it cannot be determined from this study if that was due to a perception that these tools would not be enjoyable or whether they would not aid in learning. Student Assertion 2 i.e. that the inclusion of interactive tools does not guarantee their use, is in keeping with Mean et al.’s, (2010) conclusion that the inclusion of interactive images, graphics and audio does not necessarily affect learning outcomes.

8.113 Feedback

Feedback is critical to the learning process because it affects goal persistence, disengagement and goal change (Fishbach & Finkelstein, 2012; Fishbach, Eyal & Finkelstein, 2010; Fong 2014; Braver et. al., 2014). According to the findings in Part B of this study, forensic science students are career-focused, so it would follow that difficulties encountered with feedback could impact on their career aspirations. Further to this, constructivist theorists view feedback as an essential aspect of information processing (Fong, 2014); an essential aspect of forensic science work.

Participating students in both Part A and Part B of the study identified difficulties with feedback as one of the main challenges in both blended and online learning (Student Assertion 7). This indicates that there are problems with either a lack of feedback, quality, quantity or timeliness of feedback with respect to the online component of blended courses. Although feedback was not listed as a problem in Waha and Davis’ (2014) study, 91% of students (N=23) reported that email was the most effective tool for communication because of the quick response by teachers.

One benefit of blended delivery identified by participating students was that access to the teacher during the face-to-face component allowed them to ask for help and to discuss the online component in more depth. Similarly, Waha and Davis (2014) found that most of their postgraduate participants enjoyed, not only the flexibility and convenience of the online component in their courses, but also the opportunities that the face-to-face classes provided for interaction with both teachers and peers.
The problem of feedback was addressed by Butt (2014) in a flipped class by providing question time at the beginning of each of the face-to-face components after the students had viewed the lectures online. In addition, an online feedback activity was provided on Moodle (a learning management system) so the students could pose questions. Students could ask questions online anonymously if they wished. The teacher could post the answer online or provide it during face-to-face class time. I support Butt’s (2014) use of question time at the commencement of the face-to-face lesson as one effective approach a teacher can use to address the feedback issue. Further approaches regarding feedback will be presented later in this Chapter (sections 8.212 and 8.311).

8.114 Motivation

Nearly half the participating students in Part A, and the vast majority of students in Part B of this study, found blended and/or online learning to be a positive experience (Student Assertion 3). Increased student engagement is sometimes cited as a consequence of blended delivery (e.g. Reaburn, Muldoon & Bookallil, 2009). However, Clark (2011) counters this optimism and states that it depends on the nature of the blended learning style e.g., proportion of online component, the pedagogy used, the inclusion of interactive activities, the level of difficulty etc.

Despite almost half the participating students reporting online learning to be a positive experience, motivation was listed as a major challenge. Learner motivation can be affected if students are forced into using an unfamiliar or their least preferred learning style. Clark (2011) reported that some students may be reluctant to embrace online active learning because they are used to face-face delivery mode using passive learning. Online delivery can take on a different format to traditional face-to-face delivery. For example, in online delivery there may not be sequential topics and students can move from one topic to another. The teacher is free to post additional relevant material, and as a consequence, the student may feel overwhelmed with the options available. If the teacher or facilitator is not communicating with the student or providing quality feedback on a regular basis, it would seem plausible that the student would become de-motivated. However, Means et al. (2010) found that online learning is enhanced if students are given control over their interactions with media such as videos and quizzes. I agree that students enjoy some degree of control regarding what
or how they learn but some degree of caution needs to be applied in order to avoid overloading the students with too many choices that may result in confusion, frustration and de-motivation.

The successful delivery of online courses depends on reliable information technology. Disconnections can be frustrating and de-motivating for teachers and students alike and it is important that educational institutions provide IT support. Another issue to be taken into account is that of internet access for remote students. Australia’s broadband network points to the growing availability of bandwidth (http://www.nbnco.com.au/content/dam/nbnco2/documents/nbn-corporate-plan-2016.pdf) which will alleviate some of the remote students’ technical problems over the next few years. However, at this point in time, I believe allowances should be made for students experiencing slower, less reliable internet access by providing additional technical support and more time, particularly for remote students to complete online exams.

8.115 The effect of feedback on motivation

Feedback impacts on motivation (Lepper & Chadabay, 1985; Fishbach, Eyal & Finklestein, 2010; Fishbach & Finkelstein, 2012). There is some debate regarding how positive and negative feedback affects motivation. While it is generally accepted that positive feedback increases motivation (Fishbach & Finkelstein, 2012; Fishbach, Eyal & Finklestein, 2010, Fong, 2014), there is some disagreement about whether negative feedback increases or decreases motivation.

Motivation can be intrinsic or extrinsic. Intrinsic motivation is a result of the participant’s enjoyment or satisfaction whilst engaging in a task (Deci & Ryan, 2000). In contrast, extrinsic motivation refers to “the neural and behavioural responses to extrinsically provided incentives” (Braver, et al., 2014 p. 9).

A recent meta-analysis, was conducted by Fong (2014) that involved 79 studies on the effect of feedback on motivation in both children and adult samples. Fong (2014) concluded that negative feedback had an overall negative effect on intrinsic motivation compared with positive feedback. An interesting finding of Fong’s (2014,) study, is that receiving negative feedback and no feedback seemed to have the same effect on
motivation i.e., no feedback has a detrimental effect on intrinsic motivation. The absence of feedback was a problem for some of the students in this study.

Braver et al. (2014) found negative feedback increased motivation when it was used to evaluate process and that it was more effective than positive feedback when goal commitment was high due to a large gap discrepancy to be closed. Similarly, Brunstein and Gollwitzer (1996) found that participants with pre-existing commitment to their choice of profession showed improved performances on work-related tasks after receiving negative feedback. According to the finding in Part B of this study, forensic science students are highly career focused and would, therefore, value constructive feedback that is focused on the learning task with information on how to ‘close the gap’. While participants in this study identified absence of feedback, timeliness and quality of feedback, negative feedback was not specified as a challenge.

According to Fishbach and Finkelstein (2012), the greater the level of expertise, the more the student seeks negative feedback. Based on this finding, it would be reasonable to expect that a final year forensic science student would be more likely to seek constructive, negative feedback than a first year student who would have a larger knowledge/skill gap to fill. For example, a first year student, particularly a recent Year 12 graduate, would not be expected to perform at the same level as a final year undergraduate student. Based on my experience, first year students require more encouragement and direction from the teacher than final year students. Many first year students lack public speaking experience. A first step could be for the student to prepare and present a PowerPoint presentation to his or her peers and teacher. This may be a daunting experience for some students and if the teacher is too critical at this stage, it may deter the student from proceeding with their forensic science studies. In contrast, at some educational institutions e.g., Canberra Institute of Technology and University of Western Australia, final year forensic science students are expected to act as expert witnesses in a mock trial and then evaluate their own performance in addition to receiving feedback from their teachers or qualified legal counsel. This rigorous, sometimes negative feedback, is crucial when they are employed in the forensic science industry, because there is a strong possibility they will be required to attend court as an expert witness.

8.116 Implications of student findings and assertions for Research Question 1a)
Many forms of blended delivery exist (Fee, 2009; Alammary, Sheard & Carbone, 2014). Even within a particular form of blended delivery, a teacher can change a number of variables e.g., pedagogy, the mix of synchronous/ asynchronous activities etc. However, regardless of the form or mix that is used, it is apparent that forensic science students expect timely guidance and quality feedback from their teachers. For example, rather than delivering lectures in the face-to-face component, they can be delivered in an online format freeing-up the teacher during this time to answer student questions, clear up misunderstandings and assist students with active learning tasks (Fulton, 2012; Davies, Dean & Ball, 2013). Student Assertion 6, in this study, indicates that students like the flexibility that blended learning provides and access to learning resources online. The flipped blended model has the potential to satisfy these student requirements.

As discussed in Chapter two, there are associated challenges using the flipped blended model. This model requires that the teachers are able to answer questions on the spot (Berret, 2012). I assert that this can be alleviated, to some degree, by asking students to post questions online prior to the face-to-face lesson to allow the teacher time to prepare an answer. Another challenge of the flipped model, according to Herreid and Schiller (2013), is that some students are resistant to active learning. In my opinion, this challenge is not unique to the flipped model and should not be used as a reason to avoid this model.

Although none of the participating students indicated that they had experienced MOOCs, Student Assertion 5, regarding problems with feedback, motivation and IT support in online learning, has implications for the delivery of MOOCs. As discussed in Chapter two, three main forms of MOOCs exist i.e., connectivist MOOCs (cMOOCs), content-based MOOCs (xMOOCs) and vocational MOOCs (vMOOCs). It is unlikely that training certain professionals that require scientific knowledge and practical expertise such as medical students, pharmacists and forensic scientists, could undertake a course through a cMOOC that has an open-ended curriculum i.e. lacks an end point and has no assessment process. There may be opportunities for xMOOCs and vMOOCs, however, motivation (Milligan, Margaryan & Littlejohn, 2013) and high withdrawal rates (Koutropoulos et al., 2013; Clow, 2013) have been identified as major problems.
Feedback in xMOOCs and vMOOCs could be provided via online tests with answers immediately provided after the students have completed the test. A drawback of multi-choice or true-/false questions often used in online tests is that such questions rarely encourage deep thinking because students are not engaged in creating or communicating their ideas. As stated previously, Means et al. (2010, p. xvi) found online quizzes to be no more effective at influencing the amount that students learn than other traditional tasks such as homework. Theoretically, even with large numbers of students, it would still be possible to provide personalised feedback to students. For example if there was 1000 students enrolled in an xMOOC, a team of 10 like-minded teacher/facilitators could ‘share the load’ with the economic advantage of more students and less teachers than the traditional approach. Teachers could use virtual classrooms, recorded lectures, post utube videos, PowerPoint presentations, readings etc.

The issue of feedback must be addressed in xMOOCs if it is to be used in tertiary forensic science education. Critics of xMOOCs claim that this form of delivery is nothing more than traditional teacher-centred delivery with the advantage of technology (Larry, 2012). I believe it is possible to incorporate student-centred learning using social constructivist principles into a course in a closed curriculum. The problem for forensic science education is that practical activities where students actually do the practical work of a forensic scientist cannot be delivered through xMOOCs.

A third type of MOOC has recently evolved i.e. vocational MOOCs (vMOOCs) where students are able to participate in practical activities through the face-to-face component. The logistics of co-ordinating face-to-face workshops involving large numbers of students would require a dedicated, focused approach from the co-ordinator and a co-operative effort from the teaching team. I understand the problems involved in dealing with large student numbers, having recently co-ordinated two residential workshops, each a week in duration, involving approximately 100 police personnel (students), 10 teachers (from four different disciplines) and 6 technicians. Although this was delivered through a knowledge and skill form of blended delivery (Fee, 2009), rather than a vMOOC, every staff member had to be kept informed and be onboard i.e. working as a team towards a common goal, in order for the students to achieve the required learning outcomes.
This section presented a discussion about the findings on participating students’ experiences of the different delivery modes used in forensic science education. The next section presents a discussion about the findings from Research Question 1b on the students’ perceptions of these different delivery modes.

**Research Question 1b)**

*What are Australian tertiary students’ perceptions of the advantages and disadvantages of face-to-face, blended and on-line delivery modes for forensic science?*

**8.12 Emergent themes relating to Research Question 1b)**

The major emergent themes from Student assertions 8-12 (Table 105) include adult learning styles and a choice of different options. A discussion of these themes is presented below.

**8.121 Adult learning styles**

The students’ preferred learning style can influence their level of confidence in a particular learning context. The majority of student participants, in both Part A and Part B of this study, fall within the age range for ‘digital natives’ described by Prensky (2001) i.e. those students born after 1980 who grew up with computers and the internet. Interviews conducted with the first year undergraduate students in Part B of the study revealed that they wanted all three adult learning styles (lecture-based, practice-based and problem-based) included in their forensic science degree. They did, however, disagree on the order of each adult learning style. This finding is neither in keeping with those of Prensky (2001), Oblinger and Oblinger (2005) and Gros (2003), who found that this generation prefer active rather than passive lecture-style learning, nor Margaryan, Littlejohn and Vojt (2011) who found such students favour passive, linear learning. The interviewees in this study appeared to value a variety of learning styles, including lecture-based learning.

The findings of this study, regarding preferred adult learning styles of forensic science students support the assertions of Samarji (2010); Lujan and Dicarlo (2006), and Muralidhara, Simbak and Nor (2013). Samarji (2010), asserted that forensic science is similar to medicine in that both disciplines are specific and include legal and ethical
issues. Furthermore, Lujan and Dicarlo (2006) found that almost 64% of medical students \((N=55)\) were multimodal learners i.e. students without a preference for either visual, auditory or kinaesthetic learning. Similarly, Muralidhara, Simbak and Nor (2013) reported that most of their participating medical students \((84\%; N=82)\) preferred multimodal inputs into their study.

Riffell and Sibley (2005) argued that lectures may be the only opportunity for students to gain scientific literacy and understand how science works. Conversely, Felder (1993) argued that with passive learning, such as lectures, there is no need for the students to think. These seemingly contrasting points of view in the literature make it difficult to make recommendations about effective approaches to pedagogy. It is apparent from the results of this study, however, that the participating forensic science students wanted lectures included in their courses in addition to active learning tasks. According to Panther, Wright and Mosse (2012), off campus first year biology and second year biochemistry students at Monash University selected combinations of resources to suit their learning styles, with some choosing recorded lectures and others preferring a more self-directed approach. Johnson, Adams and Cummins (2012) refer to student expectations of being able to learn where and when they like and described how today’s school age children are in contact with a constant flow of information. Some students view this connection as an opportunity to switch their expectations of what occurs in and out of class e.g., lectures and problems set as homework (Johnson, Adams & Cummins, 2012).

The challenge for course designers/online teachers is to ensure a sophisticated mix of different teaching and learning activities that draw on and enable learners to utilise different learning styles depending on their preferences at particular times for different content. This is a big challenge for teachers of forensic science as developing and enacting such learning activities requires high levels of pedagogical content knowledge and technical expertise and, most importantly, the time and willingness to do so.

8.122 Choice of learning options

The majority of participating students, in both Part A and Part B of this study, selected blended mode in terms of convenience and confidence to study forensic science.
(Student Assertions 9 and 10). It should be noted, however, that 43%; \(N=28\) of undergraduates selected face-to-face mode for convenience with one of the reasons being that they were most familiar with this mode of delivery. I predict that as more online and blended delivery is embraced by educational institutions, more online facilitation training will be undertaken by teachers and, as a consequence, student/teacher online communication will improve. Greater student familiarity with online learning is only a matter of time.

A familiar learning environment provides students with the confidence to learn. Most students in Part A of this study selected blended mode because it provided them with two options for working things out (Student Assertion 10). However, the online component needs quality, well organised resources and teachers need to ensure that students have the required research and computer literacy skills.

Klein, Noe and Wang (2006) made a direct comparison between face-to-face and blended classes and found blended learning facilitated motivation to learn because it provided additional tools to learn. It may also be the case that many students are using their own computers, laptops, iPads or mobile devices to study. According to Johnson, Adam and Cummins (2012), students gain comfort from performing research or giving presentations when they use their own technology for learning.

The finding that most of the postgraduate students who participated in Part A of this study perceive face-to-face mode as the best mode for confidence to study forensic science (Student Assertion 11) may be explained by the fact that many postgraduate forensic science students study via research that involves laboratory or field work that can only be conducted in a face-to-face environment.

**8.123 Implications of Student Findings and Assertions for Research Question 1b**

According to Johnson, Adams and Cummins (2012), there is now an emphasis on more challenge-based and active learning and there is a student expectation of flexibility of delivery and a preference to use their own technology for learning. Johnson et al. (2015) identified the blended flipped classroom as flexible and engaging for the students and having the potential to foster a change in pedagogy. Although there are many different forms of flipped classes, all incorporate active learning. Based on the preliminary findings of this study, i.e. that participating first year undergraduates want
active problem-based and practice-based learning in addition to passive lecture-style delivery (Student Assertion 12) and the supporting findings of Johnson, Adams and Cummins (2012), the use of flipped classes may be the most suitable approach to use for forensic science undergraduate students. Although flipped classes could be delivered via fully online mode, using virtual classrooms and lecture capture software, the students would not be able to participate in practical work such as laboratory, and crime scene field work. The participating students in Part A of the study emphasised the importance of practical skills in forensic science courses as one of the three most common ideas put forward for future directions in forensic science education, and for this reason, flipped classes via blended mode for forensic science undergraduates would address this need.

There is compelling evidence supporting the use of flipped classes using blended delivery mode (Bates & Galloway, 2012; Bishop & Verleger, 2013; Butt, 2014, Davies, Dean & Ball, 2013; Fulton, 2012; Johnson et al., 2015) but it is important to emphasise that pedagogy is paramount. Constructivist problem-based activities need to be incorporated into the face-to-face component thus allowing students time to use their critical thinking skills and give the teacher the opportunity to identify students experiencing problems.

Most participating students perceived the blended mode as the best mode in terms of convenience and confidence. The next research question focuses on their perceptions of the delivery modes in terms of outcomes, including results and career preparation.

Research Question 1c)

How do student outcomes (marks/grades) correlate with delivery modes for forensic science?

8.13 Emergent themes related to Research Question 1c)

Emergent themes related to Student assertions 13-16 (Table 105), include industry partnerships, skills required for a forensic scientist (practical, communication, teamwork and analytical). A discussion of each of these themes is presented in the following sections.

8.13.1 Industry partnerships
Industry partnerships were identified by the majority of participating students in Part A as a future direction in forensic science education (Student Assertion 15). Industry partnerships included access to forensic science experts for guest lectures, access to resources and some students reported the desire for work experience. The difficulties involved in allowing unqualified personnel access to a crime scene or evidence has been previously discussed.

8.132 Skills required for a forensic scientist

8.1321 Practical skills
Students in both Part A and Part B of this study recognised the importance of practical skills for forensic science education and, therefore, it follows that they do not view fully online delivery as suitable for forensic science education, particularly at undergraduate level. This is supported by the finding that online learning was the least preferred choice for the students in terms of convenience, confidence, results and career preparation.

Student Assertion 16 indicates that students in Part A believed they need practical and analytical skills as well as an overview of different scientific disciplines. Many participating students in Part B perceived themselves as being different to other tertiary students because they are career-focused, and stressed the importance of practical skills which suggest they do not believe fully online delivery is suitable for forensic science education.

8.1322 Communication, team work and analytical skills
Communication and team work skills were also listed as being important skills to include in forensic science courses (Student Assertion 15). These skills could be delivered via any of the three modes but using flipped classes would free up class time to include case-based team work and discussions.

8.133 Possible reasons for students’ perception that face-to-face mode achieves better outcomes.
Although most of the students in Part A of this study selected blended mode in terms of career preparation (Student Assertion 14), most of them perceived face-to-face
mode as providing them with the best outcomes (Student Assertion 13). This assertion seems to be at odds with the current literature. Means et al. (2010) found that blended mode leads to higher scores in both summative and formative assessment than either face-to-face or online delivery although Larson and Chung-Hsein (2009) found no significant difference in student performance between the three delivery modes. Based on the literature (Johnson, Adams & Cummins, 2012; Means et al., 2010; Larson & Chung-Hsein, 2009), Student Assertions 13 and 14 are somewhat perplexing. Why is there a perception amongst the majority of participating forensic science students that face-to-face delivery provides better outcomes than either blended or online delivery (Student Assertion 13) even though most students perceived blended mode as more convenient (Student Assertion 8); as providing them with more confidence to study forensic science (Student Assertion 10); and, better career preparation (Student Assertion 14). In the following paragraphs, I discuss three possible reasons.

Firstly, the answer could lie within Student Assertions 5 and 7. Students report having experienced problems with feedback, motivation and IT problems with both online and blended delivery. As previously discussed, problems with feedback from the teacher may lead to reduced motivation for the students.

A second possible reason for the disparity between Student Assertions 13 and 14 of this study and the findings of Johnson, Adams and Cummins (2012) is that forensic science students value relevant practical work during face-to-face classes (Student Assertions 15 and 16) and may perceive any reduction in face-to-face time as being detrimental to the acquisition of competency.

Third and finally, although there is a plethora of innovative software available for educational use, many academics have not undergone training on these digital teaching methods and are not using the new technologies available (Johnson, Adams & Cummins, 2012). As a consequence, many students may have not been exposed to the latest technologies for learning so they cannot make an informed, up-to-date evaluation of the learning outcomes and career potential developed through blended or fully online delivery.

8.134 Implications of student findings and assertions for Research Question 1c)
Of the three delivery modes, fully online was ranked the lowest for convenience, confidence, outcomes and career preparation by Part A participating students across all academic levels. A lack of social interaction was also listed as a challenge of online learning by students in Part A of this study and this is in keeping with the findings of Muilenburg and Berge (2005). Muilenburg and Berge (2005) investigated student perceptions regarding barriers to online learning including administrative issues, social interaction, academic skills, technical skills, student motivations, time and support, cost and access to the internet and technical problems. It is important to emphasise that Muilenburg and Berges’ (2005) study related to student perceptions. The respondents ranged from highly experienced users (14%) to those who had never experienced online learning (33%: N=1046). Lack of social interaction was found to be the predominant barrier for online learning perceived by the students.

According to the New Media Consortium (NMC) horizon report, budget cuts have forced educational institutions to seek alternatives to face-to-face delivery and are now exploring innovative digital teaching models because of the potential reduced costs of these modes of educational delivery (Johnson et al., 2013). In many tertiary institutions in Australia, there is a growing trend of fewer staff having to ensure the learning of more students with fewer resources. Furthermore, there is a global drive for more undergraduate students being educated in more financially efficient ways. In light of the “shift from mass production to knowledge economies”, governments are promoting higher education in order to improve skills and employment opportunities (OECD, 2013, p. 28), but the nature and quality of this higher education is questionable. Online and blended learning approaches can, indeed, be more cost effective; however, the quality of teaching and learning through these modes must be preserved to ensure the benefits of an education to flow to students and society.

The massive student attendance in MOOCs (Bond, 2013) is resulting in institutions considering how such courses can be used as a source of financial income. However, Clow (2013) states that MOOCs cannot replace undergraduate degrees because of both the open assessment processes, if they exist, and the curriculum. The findings from Part A of this study support those of Clow (2013) in that fully online delivery is the least preferred delivery mode for students across all tertiary academic levels, including undergraduate level. Siemens (2011) argues that the value for universities
lies in their point of difference between what they can deliver, that a MOOC cannot. MOOCs can offer institutions an opportunity for marketing and branding (Yuan & Powell, 2013). I assert that cMOOCs and xMOOCs cannot replace undergraduate forensic science courses, due to the fact that with current technology, they cannot provide opportunities for practical work that is adequate for the needs of the profession. However, there may be opportunities to capture potential students, particularly adult learners. Siemens and Downes (2008) offered an online MOOC course that offered two streams; formal and informal. Offering such a variety of enrolment types can provide opportunities for students to ‘purchase’ a certificate (Yuan & Powell, 2013) or possibly credit towards a degree upon successful completion.

8.2 Research Questions related to forensic science teachers

Research Question 2a)

*What are Australian tertiary teachers’ experiences of delivery modes (face-to-face, mixed and online) for forensic science?*

The following teacher assertions 1 – 6 inclusive (Table 106) are presented based on findings listed in Table 104.
Table 106. *Teacher Assertions related to RQ 2a), 2b) and 2c)*

Teacher Assertions 1 - 14

**Teacher Assertion 1 (RQ2a)** Of the four subject categories, criminalistics scientific was the most common one taught via online or blended mode.

**Teacher Assertion 2 (RQ2a)** Participants in Part A were almost evenly divided with respect to their exposure to interactive online facilitation and discussion forums were the most common sites experienced.

**Teacher Assertion 3 (RQ2a)** The main benefits of online delivery reported by teachers in Part A were being able to conduct classes across different time zones and convenience.

**Teacher Assertion 4 (RQ2a)** The main challenges for online delivery reported by teacher participants in Part A were technical difficulties, reliance on IT support and ensuring the authenticity of student work.

**Teacher Assertion 5 (RQ2a)** Flexibility was the main benefit of blended delivery reported by teacher participants in Part A of the study.

**Teacher Assertion 6 (RQ2a)** The main challenge of blended delivery reported by teacher participants in Part A was to make the online component relevant and interactive.

**Teacher Assertion 7 (RQ2b)** Most teachers in Part A selected blended mode as the most convenient method to teach forensic science as it allowed them to spend more time with the student and choose their own times to work online.

**Teacher Assertion 8 (RQ2b)** Most teachers in Part A chose face-to-face for confidence to teach forensic science because they could gauge the student’s understanding of the material and also build rapport with the students.

**Teacher Assertion 9 (RQ2b)** At diploma level, participating teachers in Part A perceived blended mode to be the best delivery method for students in terms of convenience and confidence to study forensic science. The main reason teachers selected blended for convenience was that diploma students could manage their time. Teachers reported that interaction between staff and students was easier with blended mode than online and this led to confidence for diploma students.

**Teacher Assertion 10 (RQ2b)** At undergraduate level, participating teachers in Part A perceived blended mode as the best delivery method in terms of convenience and confidence to study forensic science. Flexibility was the main reason that teachers chose blended mode for convenience. Opportunities for practical work and revisiting online work were the main reasons provided by teachers for choosing blended mode for undergraduate student confidence.

**Teacher Assertion 11 (RQ2b)** At postgraduate level, participating teachers in Part A perceived face-to-face mode as providing the best delivery method in terms of convenience and confidence to study forensic science. The most common reason for choosing face-to-face mode for convenience was that some projects were research-based and required the students to complete practical work. Teachers cited interaction and feedback as the main reason for selecting face-to-face mode for postgraduate student confidence.

**Teacher Assertion 12 (RQ2b)** Four out of five teacher interviewees in Part B used all three adult learning approaches; lecture-based, practice-based and problem-based.

**Teacher Assertion 13 (RQ2c)** Most of the participating teachers in Part A selected blended mode for the best outcomes for all three academic levels. Flexibility and support were the main reasons teachers chose blended mode for diploma students. For undergraduate students, teachers reported was that at this academic level, students still require support and interaction from their peers and the teacher. However, for postgraduate students, teachers selected blended mode for the best outcomes because these students require minimal supervision.

**Teacher Assertion 14 (RQ2c)** Blended mode was perceived by most teachers in Part A as the best mode for career preparation for undergraduate students due to the flexibility of the online component and that forensic scientists need to be able to work in both face-to-face and online environments.
8.21 Emergent themes relating to Research Question 2a)

Emergent themes related to teacher assertions 1-6 include convenience, feedback, information technology issues, interactive resources and student authenticity (who is doing the assessment?). A discussion of each of these themes is presented in the following sections.

8.211 Convenience and flexibility

The main benefits of online and blended delivery identified by teachers in Part A of this study were convenience and flexibility (Teacher Assertions 3 and 5). The flexibility of schedule that comes with online and blended teaching means teachers can establish work hours around their own work/life balance and this allows them to determine how much time, and when, they will spend interacting with their students (Walters, 2008). Another benefit of online delivery, cited by teachers in Part A, was the opportunity to deliver classes across different time zones. This finding is in keeping with Lothridge (2012) who found blended delivery provides adaptability and accessibility to a wide range of users. Educational institutions now recognise that expansion in online delivery means it is easier to capture potential students over a wider area. Online delivery can be used in a number of ways. It can be used to hone in on one specialist remote group e.g., a course to up-skill DNA specialists in a foreign country. Alternatively, educational institutions could offer a forensic MOOC course as a taster that potentially attracts thousands of students and provides a conduit into their regular diploma or degree programs. Yuan and Powell (2013) argue that MOOCs can augment access to education and provide opportunities for international delivery. The University of Strathclyde, for example, is currently offering a MOOC course in introductory forensic science that was launched on 6th January, 2014. http://www.strath.ac.uk/moocs/

8.212 Feedback

The increased flexibility that is associated with blended and online delivery means teachers now have a choice as to when they provide feedback (Walters, 2008). If a student asks a question in a face-to-face class, the teacher can answer on the spot, after class or even during the next lesson. If a student posts a question online, the window between the post and the response is dependent on when the teacher opens the course or email. To a large extent, this problem is alleviated in blended delivery
due to the face-to-face component. However, the face-to-face component of some blended courses often is not held until the end of the course.

The characteristics of the evaluator/teacher, the quality of the relationship between the teacher and students and the level of expertise of the teacher are all factors that can influence the effect of feedback on motivation (Fong, 2014). In a quality relationship between student and teacher, feedback is perceived as authentic and helpful (Henderlong & Lepper, 2002). However, I argue that it is difficult to forge good teacher/student relationships when there are large numbers of students, regardless of the delivery mode. The use of smaller classes in forensic science courses may be one way of addressing the challenges of feedback and motivation identified by students in this study.

The expertise level of the teacher can also influence how negative feedback is perceived (Bong & Skaalvick, 2003; Lepper & Chadabay, 1985). When the teachers are perceived as knowledgeable and reliable, the feedback is perceived as credible (Bong & Skaalvick, 2003). Conversely, when negative feedback is provided by a novice, it is not taken as seriously (Lepper & Chadabay, 1985). These findings support the use of teachers with forensic science industry experience; one of the ideas expressed by both students and industry personnel in this study.

The issue of feedback was addressed in a study by Warter-Perez and Dong (2012) who used a blended flipped model that incorporated various instructional strategies including lectures, problem-based, enquiry-based strategies. They emphasized how incorporating active learning into the in-class component meant the teacher could provide immediate feedback to the students (Warter-Perez & Dong, 2012). From my teaching experience, there are three important factors in the development and facilitation of blended delivery:

1) Training and support for course development;

2) Sufficient time allocated to develop the course; and,

3) A manageable number of students to allow for timely, quality feedback.
Each of these three factors is supported by current literature. Firstly, according to Johnson, Adams and Cummins (2012) digital media literacy is a key skill in the teaching profession; however, training is limited. Alammary, Sheard and Carbone (2014) recommend educational institutional support that includes time release, professional development, funding and technical support.

Secondly, with regard to blended courses, Alammary, Sheard and Carbone (2014) agree that teachers need to be able to invest sufficient course development time with Ragan (2007) recommending at least six months or preferably a year.

Finally, Warter-Perez and Dong (2012) also emphasized the importance of maintaining good student to teacher ratio and recommends a maximum of 25 students to one teacher. As a possible solution to improving the amount of time available for student feedback, Warter-Perez and Dong (2012) put forward the notion of designing a series of short how to videos so students could find solutions to some of their common problems. I support Warter-Perez and Dong’s (2012) solution to reducing the number of student questions and maximising feedback time with these short how to videos.

When information is available in bite-sized chunks it is suitable for mobile devices and particularly attractive to students who may have a busy schedule in terms of study and outside commitments.

On one hand, most student and industry personnel participants agree that feedback is an issue in both blended and online delivery and that a lack of social interaction is a problem with fully online delivery. Teacher participants, on the other hand, reported that students had unrealistic expectations of feedback. It is important that teachers are in touch with the experiences and perceptions of their clients i.e., students and other stakeholders i.e., industry personnel. Educators must listen to students for a number of reasons e.g., to make continuous improvements to existing courses and delivery styles, to ensure students complete their course and to attract new students. There are now funding issues associated with student completions in higher level qualifications. The Commonwealth government will offer payments based on performance improvements to states and territories that increase the completion of full qualifications (Skills for all Australians, p. 2, paragraph 6). In order to maintain the financial viability of courses, teachers need to ensure their students maintain motivation so they complete the subject.
Furthermore, it is important to distinguish between the different types of feedback. Feedback can range from multi-choice online practice tests that can generate an immediate web-based answer to an individualised response from a teacher. As previously cited in Chapter Two, Means et al. (2010) found the inclusion of multi-choice online quizzes did not enhance student learning and found evidence to suggest that individualised online instruction based on student responses was effective. This presents a challenge for teachers in what seems like ever increasing numbers of students per class. How can a teacher respond to every student’s questions if there are 100 students in an online class? I agree with Means et al. (2010) that individualised online instruction is effective but I think multi-choice online quizzes serve as one valuable tool in a range of feedback options including personalised feedback (teacher student), peer feedback and interactive computer mediated feedback e.g., games, quizzes, simulated workplaces.

Feedback can also exist at different levels. According to Hattie and Timperley (2007), feedback occurs at four different levels i.e., the task, the process, the self-regulation and self. At the task level, feedback identifies whether the work is correct or not. In the second level, the feedback focuses on the learning process required to finish the task. Third, feedback for self-regulation encourages self-reflection and at the fourth level, it provides a personal sense of value (Fong, 2014). The challenge for teachers is to ensure that they provide useful information on incorrect answers i.e. how to improve and also encourage self-reflection. At these levels, feedback is time consuming for the feedback-giver/teacher but according to the results of this study, forensic science students are highly goal or career-driven and, as such, are more likely to demonstrate improved performance on work-related tasks (Brunstein & Gollwitzer, 1996). I support the use of the milestone approach for formative assessment (Ladhani, 2014) that can provide useful feedback to the student regarding where they are placed in their level of training and how they can achieve a higher level of performance or milestone. Fong (2014, p. 31) also points to the characteristics of the task or task interestingness as one moderating effect on negative feedback and motivation. That is, if a task is uninteresting there is less intrinsic motivation to undermine. I believe tasks that are authentic and work-related are more likely to be perceived as interesting to forensic science students. However, based on the findings presented in this study I disagree with Fong’s (2014) assertions because the participating forensic science students did
not identify negative feedback as a problem. It is possible, however, that their career focus would mitigate some of the negative effects of negative feedback on their motivation.

8.213 Interactive learning resources

In Part A of the study, teacher participants were almost evenly divided regarding their experience with interactive online facilitation (Teacher Assertion 2). Although most had no experience with interactive online facilitation, there was only a four percent difference between those who had experienced it, and those who had not. This finding is in keeping with Johnson, Adams and Cummins (2012) who found that many academics have not undergone training and are not using new digital teaching methods. No doubt, with the global drive for flexible delivery, more teachers will avail themselves of the increase in professional development opportunities.

Discussion forums were reported to be the most commonly used interactive online activities by most teachers in Part A of this study (Teacher Assertion 2). I agree with Kim and Bonk (2006) in that teachers prefer easy to use resources and that online training should offer a range of examples of how to embed such activities into the online course. However, these commonly used interactive channels such as discussions forums/-boards and emails do provide a valuable function in terms of feedback.

The main challenge for blended delivery from the teachers’ perspective (Part A) is to make the online component interactive and relevant (Teacher Assertion 6). This may be due, in part, to a lack of skills by the teacher in using innovative technologies (Graham, 2013). Part of the solution lies in course development training and online support (Alammary, Sheard & Carbone, 2014). Interactive exercises need to be embedded in the course design (Warter-Perez & Dong, 2012). According to the NMC horizon report (Johnson, Adams & Cummins, 2012), the role of the tertiary educator is changing. Teachers have become online resource managers and must shift from teacher-led lecture-based approach to that of a facilitator.

8.214 Information technology issues

The main challenges for online delivery, identified by most teachers in Part A, were technical difficulties, technical support and ensuring the authenticity of student work (Teacher Assertion 4). Reliable Information Technology (IT) access is critical to the
success of an online course. In addition, educational institutions need to ensure that there is adequate technical support for teachers and students alike. Alammary, Sheard and Carbone (2014) conducted a literature review on three different blended delivery approaches i.e., low, medium and high impact, and concluded that institutional support to include time release, professional development and technical support is required for both medium and high impact forms of blended learning. I believe online courses (including the online component of blended courses) should be developed by teachers in unison with IT staff. Teachers also have a responsibility to take part in available IT professional development. Technical competence was identified as an important teaching skill by Kim and Bonk (2006) and Keengwee and Kidd (2010). In a study by Kim and Bonk (2006) teachers, instructional designers and administrators ranked the teaching skills required for online delivery. Kim and Bonk (2006) reported that approximately 66% of participants selected course development skills, 65% facilitator/moderator skills and approximately 33% selected technology trainer (N=562). Kim and Bonk (2006) also found that 15.3% of participants identified that the technical competency of the teacher had a significant effect on the success of the online program (N=562). More recently, Keengwee and Kidd (2010) listed technical skills as being one of the four roles of the online teacher.

8.215 Student authenticity
Ensuring the authenticity of students’ work online is a problem for teachers. Bond (2013) investigated the use of various biometric methods i.e., fingerprints, facial recognition and typing rhythm as possible remedies for this problem with regard to MOOCs. He concluded that although these methods could reduce the number of cases of frauding they could not entirely overcome it either. He went on to state that frauding also exists in traditional classes.

8.216 Implications of Teacher Findings and Assertions for Research Question 2a)
There was no indication from any of the teacher participants that they had experienced MOOCs, but the benefits and challenges cited by teacher participants with respect to online learning can be extrapolated to MOOCs. An important difference between a MOOC and other types of online delivery is the massiveness of the course and this means that teachers of MOOCs are unlikely to know their students. One of the challenges reported by teachers was ensuring the authenticity of student work, but
this is only relevant if there is summative assessment involved. For example, for many of the cMOOCs currently available, there is no assessment required of the students. However, if an xMOOC or vMOOC was used with a certificate of completion issued or a pathway into another course, then ensuring authenticity is important.

Although the focus of this study was on delivery rather than assessment, educators use assessment as one method to determine the effectiveness of their delivery. We need to look for new ways of assessing that are suitable to digital teaching environments. Prior to the internet, when students undertook research, they often had to wait for a hard copy of a journal article. Students can now access several online journals within a few minutes. Plagiarism is now easier with cut and paste. Although teachers are becoming better at detecting plagiarism, savvy students are also looking for new ways of overcoming this detection.

In order to ensure the authenticity of student work during online tests/exams, there are now companies that offer off-site proctors to monitor the exams. Students are required to confirm that they are completing the exams in private and their microphones and webcams are working (https://www.microsoft.com/learning/en-us/online-proctored-exams.aspx). Authenticity is particularly important in forensic science because qualifications or certifications indicate that the forensic scientist has expert knowledge in their particular discipline. Forensic scientists must meet minimum standards in order to conduct their jobs properly. Proctored exams are currently being used in the forensic science industry. For example in digital forensics, there are proctored exams that include both a written and performance exam, where the candidate conducts an examination of a simulated case (Lim, 2008).

In addition to assessment providing a measure of performance, several authors advocate its use as a way in which students learn (Biggs, 1996; Shepard, 2005; Brown, 2005). As discussed in Chapter Two, Biggs (1996) coined the term constructive alignment where the assessment tasks addressed the learning outcomes or objectives. Biggs (1999) was more concerned with the quality of performance rather than quantifying it and recommended the use of problem-based learning where the student solved authentic work-based problems. In this way, the students are required to interact with others to solve the problem, and in the process, learn where to seek out information and discuss their findings. This leads to feedback and encourages self-
reflection which not only informs the students but also provides a social and motivational purpose (Shepard, 2000; Brown 2005). Shepard (2000) discusses several assessment strategies to aid in the learning process; on-going assessment, prior knowledge, feedback, transfer of knowledge, explicit criteria, self-assessment and evaluation of teaching. If assessment is to be used in the learning process, it should not be delayed until the end of the course. Instead, assessment should be a dynamic process that occurs throughout the teaching period and “provides a means to scaffold next steps” (Shepard, 2000, p. 10). Shepard (2000) drew on his experience of observing teaching practices where teachers set pre-tests and post-tests but failed to use the results. Unfortunately, Shepard (2000) did not disclose how many classes he had observed. An alternative strategy to the pre-test / post-test approach could be for the teacher and students to have an open discussion with the students at the beginning of the course to learn about what the students already know (Shepard, 2000).

Feedback, from the teachers’ perspective, has been discussed in section 8.212, however Shepard (2000) pointed to an interesting finding by Lepper, Drake and O’Donnell-Johnson (1997). Effective tutors do not routinely provide feedback directly and often ignore minor student errors if they don’t affect the solution. In addition, errors are sometimes forestalled by offering hints or asking questions. I can provide an example of this forestalling strategy from my own teaching experience. One of the assessment tasks in a first year undergraduate Communication in Forensic Science class is to research a topic and then present a PowerPoint presentation to the class. Occasionally, a student presenter with no prior public speaking experience will opt to sit down and read notes during the presentation. Rather than focus on the negative aspects of the presentation, I will praise the student for their first effort and ask the student how they might improve next time. Only if the student fails to recognise the weaknesses in their presentation, will I provide direct feedback. I agree with Lepper et al.’s (1997) assertion that such indirect forms of feedback maintain the student’s confidence and motivation. Such an assessment task also satisfies Shepard’s (2000) other assessment strategies; self-reflection and transfer of knowledge. In the example provided, the students need to understand the material they are presenting because after the presentation, the audience (other class members) are invited to ask questions.
In terms of blended delivery, teachers in this study expressed the need to make the online component interactive as a challenge. Means et al. (2010) concluded that students preferred short videos and screencasts to PowerPoint presentations, graphics and audio tools. We also need to investigate the most motivating and effective tools in terms of aiding forensic science student learning and then provide the appropriate training for teachers.

The next two subsections examine the teacher perceptions of the different delivery methods.

**Research Question 2b)**

*What are Australian tertiary teachers’ perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?*

Teacher assertions 7 – 12 are based on the teacher findings listed in Table 104.

**8.22 Emergent themes related to Research Question 2b)**

Common themes to emerge from teacher assertions 7-12 include the teacher’s ability to gauge students’ understanding, adult learning styles and practical work. A discussion of these themes is presented.

**8.221 Teachers’ ability to gauge understanding**

Most teachers in Part A of this study selected blended mode for convenience and face-to-face mode for confidence to teach forensic science (Teacher Assertions 7 and 8). Teachers like the flexibility of choosing when and where they work in the online component and report that they are better able to gauge the students’ level of understanding when they are in a face-to-face environment. This interaction between staff and students is seen as a benefit of blended delivery. The interaction between students during the face-to-face component can lead to exchange of ideas, a broadening of knowledge of different discipline areas and this could contribute to increased student confidence. A flipped blended model would be in keeping with these reasons provided by teachers in this study. As Davies, Dean and Ball (2013) assert, when teachers post lectures online and use class time for constructivist activities using a flipped model, it frees up face-to-face time to assist struggling students. The teacher
can use class time to identify those students who are experiencing problems and help gauge the students’ understanding of the material. When more time is spent with individual students, there is more time to build rapport.

8.222 The adult learning styles used in the classes

The relationship between student confidence and preferred learning styles was discussed in Chapter Two and again in the student section earlier in this discussion chapter. Most of the interviewees in Part B of this study stated they use all three adult learning strategies in their classes i.e., lecture-based, practice-based and problem-based learning (Teacher Assertion 12). In a US study, Kim and Bonk (2006) reported that over half post-secondary instructors and administrators (N=562) predicted that the preferred online instructional methods would be case-based and problem-based learning. Whereas only 11% expected that online instructors would rely on lectures or teacher-directed activities in their online teaching. Furthermore, the New Media Consortium (NMC) Horizon report (Johnson et al., 2013) described the emphasis on more active or challenge-based learning as one of the top ten trends in online learning. It is now easier to prepare lectures via lecture-capture, podcasts etc. so students can view or listen to these before class and after class (Johnson, Adam & Cummins, 2012). The findings of Kim and Bonk (2006), NMC Horizon report (Johnson et al., 2013) and Johnson, Adam and Cummins (2012) support the use of flipped classes that can potentially incorporate lecture-based, practice-based and problem-based learning. Teacher assertion 12 from Part B of this study found that eighty percent of teachers interviewed (N=5) used all three adult learning approaches. This suggests that most participating teachers could use flipped classes as a teaching approach, given the appropriate online training.

8.223 Practical work

Practical work was reported as a reason that most teachers selected blended mode and face-to-face mode for undergraduate (Teacher Assertion 10) and postgraduate students (Teacher Assertion 11) respectively, in terms of convenience and confidence.

Teachers reported that the face-to-face component of blended mode was necessary for practical work and that the online component provided undergraduate students with the opportunity for revision. When teachers mention practical work there is no
way of knowing whether this involves the students following a laboratory procedure, practicing techniques in the crime scene house or activities involving higher order cognitive thinking e.g., designing experiments, problem-based work simulations.

A different approach was required for postgraduate students according to the majority of teachers in Part A. Most teachers reported that face-to-face mode was the best mode for postgraduate students for convenience and confidence because forensic science postgraduate study often involves practical laboratory or field research.

Opportunities now exist for virtual learning environments involving interactive online exercises e.g., setting up a *microscope* online (Bird, 2010; Muehlethaler, 2014). A comparative study was undertaken between two cohorts of first year undergraduate biology students; one undertaking a laboratory based microscopy course (*N*=282) and the other an online microscopy simulation (*N*=305) (Bird, 2010). Both cohorts were tested through a quiz and in-class observations. The online cohort achieved learning outcomes that were either equivalent or better than the laboratory program. Thirty four laboratory-based students and thirteen online students were observed setting up the microscopes late in the semester. No significant differences were found between the cohorts except for one question. Although 100% or nearly all the students in both cohorts could perform simple tasks such as securing the slide to microscope properly, being able to examine the slide on 10x or 40x magnification, none of the students in the virtual cohort (*N*=13) were able to correctly set the condenser and iris diaphragm of the microscope whereas 15% (*N*=34) of the laboratory-based group were able to do so. However, Bird (2010) makes the point that the use of microscopes in subsequent lessons allows the students to reinforce what they have learnt. Only 25 students provided feedback on the effectiveness and design of the online module, but one comment caught my attention:

> The easy understandable layout that allows you to choose which segment of the module you would like to go over.

Students value the flexibility to choose what they wish to learn. It means that they don’t have to spend time going over concepts they are already familiar with. A well designed layout means economy of time for the student. They can focus on learning new material. Virtual, practical activities may not provide all the answers for practical
training but I assert there are many benefits e.g., financial, time for both teacher and student providing there are opportunities for laboratory-based/field-based follow-up sessions so the students can practice what they learnt.

8.224 Implications of teacher findings and assertions for Research Question 2b)

Teachers reported a preference to teach forensic science through blended mode. From the teacher perspective, the face-to-face component of blended delivery provides opportunities for personal interaction, time to address any misunderstanding, answer questions etc. while the online component offered flexibility in terms of scheduling. These advantages also apply to the flipped blended model with the added advantage of the teacher being able to spend more face-to-face time providing feedback to students.

Blended mode was also chosen by most teachers in this study as the best mode for both diploma and undergraduates students, in terms of convenience and confidence, to study forensic science (Teacher Assertions 9 and 10). Diploma students are somewhat restricted in that work commitments, logistics may prevent them from attending regular face-to-face classes. In this case, the blended model used is usually one where most of the theory is delivered online and the face-to-face residential workshop is run towards the end of the subject. However, the flipped blended model could be applied to undergraduate classes. This is supported by the fact that most teachers in Part B of this study use all three adult learning approaches in their classes.

The face-to-face component of the flipped blended model would allow opportunities for practical activities. In the flipped blended model, the teacher exchanges hands-on learning for less lecture time i.e. videos and readings can be used as a substitute for face-to-face lectures (Johnson et al., 2015). However, I would argue that forensic science teachers need recent work experience in their chosen discipline in order to expose the students to authentic work tasks and allow them to reach their full potential.
Research Question 2c)

*How do teachers perceive student outcomes as a result of different delivery modes for forensic science?*

Teacher assertions 13 to 14 (Table 112) are based on teacher findings listed in Table 104.

### 8.23 Emergent themes related to Research Question 2c)

An emergent theme related to teacher assertions 13-14 (Table 106) is the skills required for forensic scientists.

#### 8.231 Skills required for forensic scientists

A career in forensic science involves both the application of the science discipline and communicating the findings. Teachers identified this need to be able to work in both a face-to-face and an online environment as a reason for choosing blended mode for the best career preparation for undergraduate students (Teacher Assertion 14).

Biggs and Tang (2007b) recommend aligning the assessment task to the learning outcomes. In this way, teachers can see how students perform these tasks in professionally appropriate ways e.g., designing experiments and communicating with legal counsel and the jury.

Biggs and Tang (2007b, p. 5) provide a description of the best assessment tasks.

> The best assessment tasks reflect real life by being “authentic” to the profession or discipline.

However, according to Richardson and Newby (2006), Biggs’ work has not been used in an online environment. Whilst Biggs’ studies may not have researched the online environment, I am of the opinion that constructive alignment can be applied to both face-to-face and the flipped blended model.

Most participating teachers, selected blended mode for the best outcomes for students, across all three academic levels (Teacher Assertion 13). *Outcomes* is a broad term that could include results, grades, employment and completion rates.
There is some evidence to suggest that blended mode leads to higher scores on both formative and summative assessment (Means et al., 2010), but as McCue (2014) points out, it is difficult to make comparisons between delivery methods without knowing the pedagogy that was used. In addition to the pedagogy used, Means et al. (2010) also point to differences in content and between academic disciplines as being confounding factors. Without knowing the background i.e., pedagogy, content etc., it is not possible to make a direct comparison between Teacher Assertion 13 and that found by Means et al. (2010), but it can be said that there is a perception amongst most of the teachers in Part A of this study, that blended mode provides better outcomes for forensic science students.

**8.232 Implications of teacher findings and assertions for Research Question 2c)**

Most teachers selected blended mode for the best student outcomes across the three academic levels. Furthermore, teachers selected blended mode as the best career preparation for undergraduate students. The findings of this study are in keeping with Means et al. (2010) who also found blended mode leads to higher scores and better student outcomes. Caution needs to be applied, however, as there may be differences in pedagogy used, type of discipline, content etc. Blended mode appears to be a clear winner from the teacher perspective but in order to prepare the students for a career in forensic science, teachers need to ensure that forensic science students gain more than a sound grasp of scientific facts.

By using a social constructivist approach e.g., encouraging students to work collaboratively on an authentic problem-based task, students learn to exchange ideas, weigh up different solutions to the problem and come up with the best possible solution. Rather than restrict students to the memorization of facts, educators should be encouraging students to use any available resource (Shepard, 2005; Brown 2005) and share this information with their peers and the teacher. This in turn, reflects the workplace and is particularly true of the forensic industry where team work is crucial to the outcome. Such tasks can be conducted in both a face-to-face and online environment (Johnson et al., 2014). Teachers in this study reported that forensic science students need to be familiar with both face-to-face and online environments as part of their job as a forensic scientist. The social constructivist approach in a flipped blended environment would meet these requirements.
Finally, online was the least preferred mode selected by forensic science teachers for both teaching and learning. The lack of practical work, ensuring the authenticity of student work and IT problems were listed as the main challenges. The lack of practical work in MOOCs suggests that teachers would not view the use of MOOCs in forensic science as a replacement for a degree.

8.3 Research Questions relating to forensic industry personnel

Research Question 3a)

What are Australian industry personnel experiences of delivery modes (face- to-face, blended and online) for forensic science?

Industry personnel assertions 1-6 inclusive (Table 107) are based on industry findings Table (104).

8.31 Emerging themes related to Research Question 3a)

An emerging theme based on industry personnel assertions 1-6 is feedback.

8.311 Feedback

Feedback issues including no assistance, limited assistance or delayed help and quality of feedback, were listed as the main challenge for both blended and online learning by industry participants. There are different forms of feedback including feedback from the teacher, computer-generated feedback and peer feedback and each of these will be discussed. According to Fong (2014), few researchers have tested the differences in feedback mode e.g., verbal, non-verbal, written in a single study.
Table 107. *Industry Personnel Assertions related to RQ 3a), 3b) and 3 c).*

**Industry Personnel Assertions 1- 15**

| Industry Personnel Assertion 1 (RQ3a) | The vast majority of participating industry personnel in Part A (90%; N=29) reported that they had experienced either or both online or blended learning however less than 4% of the courses they had experienced were interactive (N=25). |
| Industry Personnel Assertion 2 (RQ3a) | Most participants in Part A reported their online or blended learning experiences were positive. Less than one tenth indicated their online experience was entirely negative. |
| Industry Personnel Assertion 3 (RQ3a) | The three most common benefits of online learning, according to Part A industry personnel participants, were flexibility, convenience and access to resources. |
| Industry Personnel Assertion 4 (RQ3a) | The key challenges of online learning identified by industry personnel participants in Part A were a lack of assistance, demographics and delayed feedback. |
| Industry Personnel Assertion 5 (RQ3a) | The main benefit of blended learning according to industry personnel participants in Part A was flexibility. |
| Industry Personnel Assertion 6 (RQ3a) | The main challenge of blended learning reported by most Part A participants was a lack of assistance and the rushed nature of the residential workshops. |
| Industry Personnel Assertion 7 (RQ3b) | Blended mode was perceived by industry personnel participants in Part A as the best mode for both diploma students, working in the police force and undergraduate students for both convenience and confidence to study forensic science. |
| Industry Personnel Assertion 8 (RQ3b) | For postgraduate students, most industry personnel participants in Part A selected online learning for convenience but selected face-to-face mode for confidence. |
| Industry Personnel Assertion 9 (RQ3b) | Three out of the five interviewees in Part B stated that all three adult learning styles; lecture-based, practice-based and problem-based should be incorporated into forensic science courses. |
| Industry Personnel Assertion 10 (RQ3c) | Most industry personnel in Part A perceived face-to-face delivery for the best outcomes for diploma students working in the police force because it prevented students from procrastinating which lead to students ‘cramming’. |
| Industry Personnel Assertion 11 (RQ3c) | Most industry personnel in Part A perceived blended mode for the best outcomes for forensic undergraduate students because students benefited from both face-to-face classes and the back-up of online material. |
| Industry Personnel Assertion 12 (RQ3c) | Blended mode was perceived by over three quarters of industry personnel participants in Part A for undergraduate students as the best career preparation because forensic scientists are required to work in both face-to-face and online environments in their work. |
| Industry Personnel Assertion 13 (RQ3c) | Blended mode was perceived by most industry personnel in Part A as providing the best outcomes for postgraduate students because they believed the interaction experienced in face-to-face component led to increased motivation and provided opportunities for revision. |
| Industry Personnel Assertion 14 (RQ3c) | Most industry personnel participants in Part A reported that forensic science students have different educational needs to other tertiary students due to the requirement for practical skills. |
| Industry Personnel Assertion 15 (RQ3c) | Industry validation was recommended by over four fifths of industry personnel participants in Part A; the main reason being that such validation led to standardization and relevance to industry. |
Firstly, the issue of teacher feedback will be presented. If students are working on a particular problem or concept and ask the teacher for clarification, any delay can increase the risk of the student going down the wrong path or thinking they are correct when they are not. From the student perspective, these are wasted hours and the student may become demotivated. This is particularly important to students who are working in the forensic science industry as they are often time poor. Industry personnel interviewee, IB5, explained his/her frustration when asked about the challenges of online learning.

IB5....... Delay in getting feedback. You panic if on wrong track.

It seems there is a perception amongst industry personnel that the face-to-face component of blended delivery allows for feedback opportunities.

IB5.......to clarify problems rather than going back and forth online.

Similarly, Bracken, Jeffres and Nuenendorf (2004) found that negative feedback in text form had less effect on motivation compared with verbal criticism.

I believe there is a relationship between timeliness and quality of feedback, particularly with online delivery. The danger in a quick response via email may be the loss of quality. Vague feedback can be demotivating (Shute, 2008). Could it be that we now all expect an immediate response to an email? Students expect and deserve quality feedback i.e. a specific response to their question. However, now with increasing numbers of online students, can we realistically expect teachers to immediately respond to every student’s email with a comprehensive, accurate response to their question/s? We are never going to have an equivalent conversation via email as that encountered in a face-to-face situation. Possible solutions to this problem are discussed later in this chapter.

Feedback can also be in the form of computer-generated answers to online quizzes. In Part A of this study only 4% (N=25) of industry personnel had experienced interactive learning compared with 56% (N=84) of students and 48% of teachers (N=21). Prior to 2014, subjects in the Diploma of Public Safety at Canberra Institute of Technology (CIT) were delivered via distance mode using self-paced learning guides and a residential workshop towards the end of the course. Historically, the learning guides were hard
copy printed versions posted out to the students but with the introduction of blended delivery, the learning guides were posted online. Interactive activities are now being introduced in the new competency-based Advanced Diploma of Public Safety so it follows that the proportion of industry personnel who are experienced with interactive learning resources will increase. Learner technology interaction may be one way of addressing the feedback challenges reported by industry personnel.

Regarding peer feedback, this study found both students and industry personnel participants reported social interaction as a challenge in an online environment. This finding is in keeping with that of Irwin and Berge (2006). I believe that whilst opportunities for social interaction can be maximised through interactive channels such as virtual classrooms and discussion forums, it will always be a challenge in a fully online environment. As reported by Anderson (2004), if there is a reduction in flexibility of time, synchronous interpersonal interaction may conflict with convenience. By the very nature of their profession, industry personnel are not always available for synchronous personnel interaction. To some extent, peer feedback occurs during the residential workshops (face-to-face component of the blended courses) but these are usually held towards the end of the course after the students have completed the bulk of the theory component. Team work and communication skills are particularly important in forensic science, and it would follow that any educational activity that encourages these skills e.g., peer review, would be a useful addition to a forensic science course.

8.312 Implications of Industry personnel Findings and Assertions for Research
Question 3a)

Collectively, industry personnel assertions 1-6 show that while most participants reported a positive experience with online or blended learning, many participants reported problems with either a lack of assistance or delayed feedback from teachers. It is important that this issue is addressed because even though there is a small face-to-face component for many subjects in the Advanced Diploma of Public Safety, industry personnel report these workshops are intensive and ‘rushed’. This implies there is little opportunity for the teachers to provide in-depth feedback during the residential workshops. Feedback must be provided over time so students can build on their existing knowledge before the practical workshops are offered. Educators need
to investigate all forms of feedback including interpersonal (teacher-student and student-student) and computer-generated feedback.

**Research Question 3b)**

*What are Australian industry personnel perceptions of the advantages and disadvantages of face-to-face, blended and online delivery modes for forensic science?*

Industry personnel assertions 7-9 (Table 107) are based on industry findings listed in Table 104.

**8.32 Emergent themes related to Research Question 3b)**

An emergent theme related to industry assertions 7 – 9 is that of adult learning styles.

**8.321 Adult learning styles**

The preference for the incorporation of all three adult learning styles into their forensic science courses was reported by most of the industry personnel interviewees Industry Personnel Assertion 9). It was recognised that students need to receive knowledge through passive learning, practice their skills and take part in higher level cognitive thinking such as problem-based or case-based learning that is relevant to a forensic scientist.

The desire for the lecture style approach to be included in the *Advanced Diploma of Public Safety* may be due in part to the time constraints experienced by industry personnel. This can be easily addressed by incorporating videos of lectures into the online component. However, some degree of caution needs to be applied with respect to the duration of such videos. In a study on students’ perspectives of a Master’s program in library and information science, Waha and Davis (2014) reported that while short videos (91%; $N=23$) were the most enjoyable for students, PowerPoint presentations (65%) and video recordings (57%) were not rated as highly ($N=23$).

According to Johnson et al. (2014, p. 21), employers reported concerns regarding “the lack of real world readiness” of recent graduates. The incorporation of authentic professional tasks rather than relying on de-contextualised classroom activities could help address this problem.
8.322 Implications of industry personnel findings and assertions for Research Question 3b)

In the Training for the Future Report (Brightman, 2005), industry personnel reported their preferred or acceptable study mode to be part-time and most selected face-to-face mode over distance paper-based, distance-online or a mixture. The majority of industry personnel participants in this study selected blended mode for diploma students, working in the police force (Industry Personnel Assertion 7). The main reason was access to the teacher. There is a shift from face-to-face mode to blended mode, as reported in the Training for the Future Report (Brightman, 2005). It needs to be pointed out that in 2005, the respondents were asked for their preferred or acceptable delivery mode and were not asked to distinguish their preferred mode in terms of convenience, confidence and outcomes. Furthermore, education providers were predominantly offering forensic science programs in the face-to-face mode and according to the Training for the Future report (Brightman, 2005), only a limited number provided mixed delivery by two or more methods. According to this study, 80% of participants (N=20), had experienced blended mode and therefore, it would be feasible that with the increased use of online delivery, improvements in online tools and facilitation, students would shift their preferences from face-to-face to blended mode.

Blended mode was found to be the preferred mode for industry personnel in Part A and Part B of this study. Furthermore, most of the interviewees in Part B of this study wanted all three adult learning styles incorporated into their classes. This means we need to incorporate active learning in addition to passive lecture style learning. The inclusion of work-related problems that extend the students is important to encourage deep learning.

Research Question 3c)

**How do Australian industry personnel perceive student outcomes as a result of different delivery modes for forensic science?**

Industry personnel assertions 10-15 inclusive (Table 107) are based on industry findings listed in Table 104.
8.33 Emergent themes related to Research Question 3c)

Emergent themes based on industry personnel assertions 10-15 inclusive (Table 107) include the need for practical work and industry validation of forensic science courses. Each of these themes is discussed in turn.

8.331 Practical work

In terms of career preparation for undergraduate students, industry personnel selected blended mode (Industry Personnel Assertion 12). The main reason provided was that forensic scientists need to be able to work in both the face-to-face and online environment. Furthermore, most industry personnel interviewees stated that they would not employ a graduate who had only studied online, the main reason being the lack of practical work (Industry Personnel Assertion 14).

Whilst the inclusion of practical work has many benefits including teaching laboratory skills, familiarity with scientific method, stimulating interest in the subject (Gorst & Lee, 2005), it is not designed as a substitute for on the job training. As one interviewee IB4 stated

\[ \text{IB4 They get trained anyway industry. In (name of state) we use university graduates.} \]

In addition to the benefits described by Gorst and Lee (2005), I assert that the student’s aptitude for that kind of work can be determined, providing sufficient time is allocated to practice the required skills. This, in turn, provides the students with a taste or some understanding of the skills involved in their future career and whether or not they are suited to this line of work. Some aspects of forensic science are confronting. For example, police may witness injured or deceased victims of crime. When a forensic science student attends an autopsy or examines a decomposing pig, it gives them some understanding of what is to come. It is better that a student finds out they are not suited to this line of work in the first year of their study than to endure three years of full-time study (or its part-time equivalent) only to discover they are not suited to it.
8.3.3.2 Industry validation of forensic science courses

Industry personnel, in Part A of this study, expressed the need for validation and standardisation of tertiary forensic science courses (Industry Personnel Assertion 15). Furthermore, most participants report that forensic science students require practical skills. Both these findings are in keeping with the findings of the Training for the Future Report (Brightman, 2005).

The NIFS Training for the Future report (Brightman, 2005), made a clear distinction between training and education. While training is targeted towards an individual’s current job, education prepares a student for the future (Brightman, 2005, p. 18). This training can also be incorporated into an education program and an example is provided how a science student could be trained to use a specific piece of equipment during a forensic science course (Brightman, 2005, p. 18).

8.3.3.3 Implications of industry personnel findings and assertions for Research Question 3c)

The assertion that most industry participants recommend the validation of tertiary forensic science courses has implications for MOOCs. Yuan and Powell (2013) raised concerns about the quality and structure of cMOOCs. These open-ended, student-driven MOOCs lack an endpoint. Daniel (2012) suggests that MOOCs could be ranked by learners and educators by providing league tables but the author could not envisage how industry could validate this form of MOOC. Furthermore, they report that forensic science students require practical skills. However, these skills cannot be taught in a fully online mode such as a MOOC. It would, however, be possible to standardize the content of an xMOOC. Such courses could be used as taster courses to lure future students. It is important to ensure the content is authentic as it is in the interests of the forensic science industry, educational institutions and the general public to attract those students who have a genuine interest in realistic, professionally appropriate content.

When industry personnel interviewees, in Part B, were asked if they would employ a graduate who had studied a forensic science course entirely online, approximately three quarters of participants indicated they would not and the main reason for their decision was the lack of practical work. In the Training for the Future Report
(Brightman, 2005), one of the key themes that emerged was the relevance of the forensic science course to the industry with too much emphasis on the underpinning science and insufficient practical work or field skills being taught. Based on these findings, it seems unlikely that the forensic science industry would accept graduates from a fully online MOOC course.

### 8.4 Emerging challenges and possible solutions

A comparison of the experiences and perceptions between the three groups of participating stakeholders was presented in Chapter Seven. Blended mode was selected by the majority of all three stakeholders as the preferred method of delivery for diploma (Comparative findings 4 and 5) and undergraduate students (Comparative findings 7, 8, 9 and 10). However, this finding was tempered by the addition of a number of key barriers to forensic science education that were identified by the stakeholder participants in this study. In particular, stakeholders identified those barriers that relate to online delivery; either as a component of blended delivery or a stand-alone online course. Barriers for forensic science education included inconsistencies between forensic science programs and the need for forensic science teachers to have relevant, recent forensic science industry experience (Comparative finding 14). Challenges for online learning included problems with feedback (Comparative finding 1), a lack of social interaction (Comparative finding 3) and the need for practical work and communication skills to be taught at undergraduate level (Comparative finding 15). Based on the comparative findings from this study and the relevant literature, in the next section, I will develop and discuss some possible solutions to these challenges. My recommended practices were considered from three different perspectives; the education system, the educational institution and the classroom. My main focus is from the classroom perspective, but a few important points have been identified that relate to the other two perspectives.

#### 8.4.1 System level

All three stakeholders in this study agree that the forensic science industry should be involved in undergraduate forensic science courses in order to maintain relevance and
ensure a current approach. Industry involvement may include partnerships, research projects, work experience, guest lecturers and use of resources.

8.411 Industry partnerships

Industry partnerships already exist within forensic science e.g., the National Centre for Forensic Science (NCFS) includes the Canberra Institute of Technology, the University of Canberra and the Australian Federal Police. The NCFS collaborate in the design, and delivery of undergraduate and postgraduate forensic science programs, training and research opportunities for partner agencies and industry clients.

8.412 Industry validation

The Australian and New Zealand Forensic Science Society (ANZFSS), the professional organisation representing forensic scientists, does not accredit bachelor degree programs (Roux, Crispino & Ribaux, 2012). Instead, the quality of forensic degree programs in Australia is assessed through the relevant professional bodies and measured against the standards outlined in the Australian Qualifications Framework (AQF Council, 2103) (Horton et al., 2012). In this study, most industry participants reported that forensic science undergraduate courses should undergo industry validation.

8.413 Research culture

Industry involvement through research projects was identified by some teacher participants as a means of gaining access to equipment and providing valuable skills a future career in forensic science. The issue of research in forensic science programs was also identified by Roux, Crispino and Ribaux, 2012; Crispino et al., 2014. Roux, Crispino and Ribaux (2012) and Margot (2011) agree that there is a need for more research within the forensic science industry and raise concerns over some methods and technologies that are generic in nature. That is to say that much of the research relates to the core disciplines rather than for forensic science.

8.42 Educational institution level

8.421 Employing teachers with forensic science experience

Both students and teachers in this study agreed that forensic science educators need to be forensic practitioners or have forensic science experience. In addition, teachers
identified ongoing professional development into new technologies as being important.

8.43 Classroom level

8.431 Social interaction and feedback

Both student and industry personnel participants, many of whom were studying at the time of the survey completion, had concerns over a lack of social interaction (Comparative finding 3) and the timeliness of feedback (Comparative finding 4) in online learning. The use of different forms of ‘dialogue’ (Nicol & Macfarlane-Dick, 2006, p.6) or feedback, such as individualised or a class summary, peer feedback, self-reflection and automated feedback may address these challenges.

From the outset, feedback should be built into an online course. Teachers should inform students of their availability and how they can communicate with each other (Boetcher & Conrad, 2010). Boetcher and Conrad (2010) suggest the use of introductory videos, teacher participation in discussion forums, email reminders of impending assessments and regular virtual classrooms. The use of short how to videos may reduce the number of student questions and hence maximise teacher / student feedback time (Warter-Perez & Dong, 2012).

Summary feedback that is provided to the entire class online may include common mistakes or themes made by class members and provide a means of revision and further discussion (Bonnel, 2008). Such feedback may be too late for the students to change their submitted work, but this could be used for formative assessment as part of the learning process.

Peer dialogue (student/student) is another form of feedback that could be used in an online learning setting. In a forensic context, this exposure to other students who may work in a different discipline or jurisdiction provides students with a better overview of the forensic science industry.

By using the rubrics to assess their peers, students will be able to see what the teacher is looking for and will be able to reflect on their own work. However, students do not automatically know what constitutes good feedback and teachers need to provide training (Nicol & Macfarlane-Dick, 2006) or instructions and rubrics (Bonnel, 2008).
Automated feedback may be in the form of online multi-choice quizzes. Although Means et al. (2010) found that the use of automated multi-choice online quizzes did not enhance student learning, I see their value in consolidating what the students already know and identifying areas of weakness that require deeper study.

8.432 Need for practical work and communication skills
The use of online discussions and peer feedback would encourage the development of communication skills; crucial skills for a forensic scientist who would be expected to attend court as an expert witness.

Virtual online environments can aid in the acquisition of practical skills and allow the students more time to revisit the concepts they don’t understand.

8.5 Research rigour, limitations, contribution to knowledge and ideas for future research

8.51 Research rigour
This study employed a rigorous research process involving a pragmatic mixed method approach that combined quantitative and qualitative data (Brown & Hartrick Doane, 2006; Doyle, Brady & Byrne, 2009; Hall, 2003; Morgan, 2007). By combining both the survey and interview data it has been possible to draw on the strengths of both methods of data collection. The interviews provided descriptive examples that cross validated the numerical data. The study was further strengthened by a local longitudinal teaching study at the Canberra Institute of Technology that provided further insights and detailed perspectives to the numerical data.

This study includes a credible sample size of forensic science students (N=110) sampled from sixteen tertiary institutions across Australia. A further strength of this study is that the forensic educational needs of three different academic levels; Diploma/advanced diploma, undergraduate and postgraduate were investigated.

The inclusion of all three stakeholder groups in this study; students, teachers and industry personnel allowed for comparisons to be made and highlighted the need for improvements to be made in terms of student feedback in both online and blended
delivery and further online facilitation training for teachers. These recommendations are based on actual stakeholder experiences.

In addition to stakeholder experiences, the inclusion of their perceptions has added another layer, be it subjective, to this research. I believe that perceptions can influence decisions and behaviours. For example, if a student perceives online learning as unsuitable for forensic science, they are unlikely to enrol in such a course. If industry personnel perceive online learning as unsuitable they may choose not to employ a graduate who has studied forensic science entirely online.

8.52 Limitations

There are three main limitations of the research presented in this thesis; the definition used for blended delivery, the sample size and the dual role of the researcher.

The research was limited by the definition that was used for blended delivery i.e., blended learning/delivery is a combination of meeting in the classroom and completing coursework online. No distinction was made between the different types of blended delivery e.g., the sandwich, the milestone, knowledge and skills and complementary resources (Fee, 2009).

The sample size of both the teacher (N=29) and industry personnel (N=31) surveys in Part A was limited. This could possibly limit any generalisations made regarding the findings from these two stakeholders. However, this limitation is partially reduced by the fact that semi-structured interviews with teachers (N=7) and industry personnel (N=5) supported the findings of Part A.

My dual role as both teacher and researcher in the teaching study component of Part B of this study. This limitation was partially compensated for by the methodological approach used that combined both quantitative and qualitative research. The inclusion of quantitative data helps to compensate for the fact that the descriptive data found in the teaching study doesn’t necessarily hold for all forensic classes i.e. generalisations cannot be made. The inclusion of the qualitative data from the teaching study serves to provide valuable descriptive data and examples of the quantitative findings. On the issue of my dual role as researcher and teacher, another important point needs to be made. It is common for teachers to change their teaching practices. In fact, I would argue that a good teacher makes the necessary changes for continuous improvement
purposes. Whilst most teachers excel at responding to the needs of their students, few
teachers document or report their teaching practices. As teachers, we need to know
what works and what doesn’t. Providing the teacher/researcher is upfront and
declares any factors that may confound the interpretation of the findings, case/
teaching studies provide valuable information for other teachers to build upon.
Teachers should be encouraged to share their experiences through presentations and
publications.

8.53 Contribution to knowledge
The need to review Australian forensic science education (National Institute of
Forensic Science Education and Training for the Future Report (Brightman, 2005); NIFS
Education and Training Summit, 2008) and the gap in Australian forensic science
education, particularly from the student perspective (Samarji, 2010) was outlined in
Chapter One. A thorough literature search revealed that an instrument was designed
to assess Australian undergraduate student attitudes toward forensic science (Horton
et al., 2012; Horton, 2014; Horton, Southam & Lewis, 2016). This is further evidence of
the need to investigate the student perspective of forensic science education. The
research presented in this thesis is the first national study of forensic education that is
based on the experiences and perceptions of tertiary students.

As a result of this study, motivational factors for forensic science students have been
identified that can impact on course enrolment and retention/completion.
Motivational factors identified by participating students include feedback and social
interaction. Fong (2014) also found that a lack of feedback had a detrimental effect on
motivation. The desire by participating students for social interaction supports the
argument for the use of a pedagogy that is based on constructive alignment in forensic
science education (Biggs, 2003; Walsh, 2007, Reaburn, Muldoon & Bokallil, 2009).

Participant stakeholders identified skills that should be taught at the undergraduate
level in order to prepare them for a career in forensic science. These skills included
practical, communication, interpersonal, analytical, problem solving and the ability to
work independently as well as in a team. There are no surprises here. The
employability skills identified by participating stakeholders are in keeping with those
found in the literature (Kelty & Julian, 2010; 2011; Ferns, 2012; McGowan, 2011; Oliver
et al., 2011). However, what is new are the collective strategies/practices recommended by forensic science stakeholders on how best to teach/deliver these skills.

The present ‘norm’ for the accepted delivery mode is summarised by Alammary, Sheard and Carbone (2014, p.440),

The question now is not whether to blend or not; it is how to design an effective blend.

The results of this study provided evidence to support this view. The majority of participant stakeholders identified blended delivery as the preferred delivery mode for forensic science education. Although the survey used in this study did not directly address the different forms of blended delivery, I have proposed an appropriate form of blended delivery for two out of three academic levels of forensic science students. This was based on the need for the incorporation of work-based authentic practical work, preferences for the incorporation of all three adult learning styles, the challenges of a lack of social interaction and feedback in online courses and the relevant literature.

From the onset of this thesis, it was made clear that this study was designed to be of direct use to forensic science teachers in order to meet the needs of the tertiary forensic science industry and students. Based on the results of this study, a proposed best practice model for forensic science diploma/advanced diploma and undergraduate students has been developed and is presented in Appendix S. Best teaching practice guidelines provide a clear direction to forensic science educators to ensure that graduates are industry ready. Potentially all forensic stakeholders will benefit; students, teachers, forensic science industry personnel and ultimately the public.

8.54 Future research

The research limitations discussed provide opportunities for further research into forensic science education.

The limitation resulting from the use of the umbrella definition of blended delivery, points to the need for case studies and comparative research into specific variants of
blended delivery. However, it is imperative that researchers fully disclose the pedagogy used. For example, case studies into forensic science education using the blended flipped model with a social constructivist approach will provide useful information that can be used to refine and improve the delivery of forensic science courses.

Further research into the use of MOOCs in forensic science is recommended. Since this research began in 2010, advances in online delivery such as the onset of MOOCs have developed. Future research into the use of MOOCs in forensic science from the perspective of all stakeholders, but particularly from the teacher perspective, is recommended. According to Clow (2013), the emphasis to date has been on research into MOOCs from the student perspective with a lack of extensive research into xMOOCs from the teacher perspective. This study found that all stakeholders valued the incorporation of practical work into forensic science courses. In light of this, further research into the use of a vMOOCs in forensic science is recommended. Education is undergoing a revolution in terms of online delivery. The literature supports the use of flexible online delivery and as a result there is push at the system level to move towards more online delivery. We can determine the effectiveness of a MOOC course by examining data from a variety of sources including student surveys, the quantity and quality of online posts and, student attrition rates. However, teachers are now expected to teach increasingly large numbers of students and we need to find out if these system-level drivers are practical from a teacher perspective. For example, the optimum teacher-student ratio to ensure timely and quality feedback.

Further research regarding tertiary forensic science students’ experiences regarding the usefulness of online learning tools is recommended. Students, in Part A of this study, reported problems with feedback in online environments. Furthermore, with the global drive to promote higher education (OECD, 2013), and a trend towards online and blended learning (Johnson, Adams & Cummins, 2012), it would seem feasible that tertiary student enrolments will increase. An increase in student numbers has the potential to compound feedback problems for teachers. Educators need to investigate new ways of providing both timely and quality feedback to students that can be used in an online environment. e.g., online quizzes, interactive games. An additional reason to explore online instructional activities is that students in the teaching study (Part B)
did not use the interactive tools that were available. While I agree with Felder, Felder and Dietz (2002), that it is not always advisable to develop instructional activities just because students like them, if students are not using them, it seems to me to be a waste of time and resources. We need to find out which online learning tools are effective in terms of student learning, motivation and usage.

8.55 Summary

In this chapter, a total of 45 assertions were synthesised based on the findings presented in Chapters Four, Five and Six inclusive (Table 104). The findings show that the majority of all stakeholders selected blended mode, in terms of convenience, confidence and career preparation to study forensic science across all academic levels. In terms of the best outcomes for students, both teachers and industry personnel chose blended mode while most participating students selected face-to-face mode. The majority of stakeholders indicated that they were in favour of all three adult learning styles incorporated into forensic science undergraduate courses. The blended flipped model, using social constructivist principles could be used in undergraduate forensic science classes and address the findings of this study. The selection of the blended flipped model was based on the need for the incorporation of work-based authentic practical work, preferences for the incorporation of all three adult learning styles and the challenges of a lack of social interaction and feedback in online courses.

A fully online mode was the least preferred choice of the majority of all stakeholders in terms of convenience, confidence, best outcomes and career preparation; the only exception being that industry personnel chose online mode for postgraduate students in terms of convenience. The main barriers for online learning included a lack of social interaction and feedback issues and, to this end, recommended online practices were developed. The majority of all stakeholders expressed the need for practical work in forensic science education. These findings strongly suggest that cMOOC or xMOOC courses will not replace existing undergraduate forensic science courses. There may, however, be opportunities to explore the use of vMOOCs as a pathway into future study in the forensic science field. This chapter also presented the research rigour and limitations of this study, the contribution to the literature and ideas for further research.
8.56 Conclusion

The purpose of this study was to compare different delivery modes used in tertiary forensic science. Based on the results of this study, blended mode is the preferred delivery mode for tertiary forensic science. This study provides useful information on forensic science education that contribute to the literature including motivating factors and employability skills that are relevant to all forensic science stakeholders. Feedback from three stakeholders has created a holistic picture with respect to the challenges of online learning, either as a stand-alone course or a component of blended mode. The proposed model of best practice presented in Appendix S has been designed to address these challenges and to ensure that the theoretical findings are directly applicable and useful to forensic science educators. The best outcome for this study would be for forensic science educators to review and trial the recommendations presented but the real test of their usefulness is the employability of the forensic science graduates.

8.6 Self-reflection

I commenced this research in late 2009. At that time, I did not know how rapidly things would change within the education system e.g., the emergence of MOOCs. Regardless of the challenges encountered due to the rapidly changing digital environment, some consistent messages have emerged as a result of this study. Forensic science students are looking for flexibility and convenience regarding the time and place in which they learn, they want to use their own mobile devices, have access to resources, participate in practical work and still want timely, quality feedback. All these demands on top of unprecedented student numbers means teachers must look for new ways of teaching and assessing. The proposed best practice model presented in Appendix S was developed to address these challenges.

In late 2014, I presented some of my research findings at my workplace. During question time, one of my colleagues asked me if I had changed my teaching practices as a result of my findings. The question was unexpected but it forced me to reflect on what drove me to investigate different methods in the first place; the need to improve my online teaching practices. This research study has indeed prompted me to change
some of my teaching practices. This has been a slow evolution rather than a revolution and I have not yet implemented all the recommendations resulting from this study, but I now have a plan to work towards.

I have long been a proponent of life-long learning and I hope it may inspire some of my younger colleagues to take up the challenge of further study. Undertaking this research has ensured that I kept up-to-date with current trends in education and it is my belief that, as a result, my students have benefited.
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Singapore 2007. Retrieved from


The following questions frequently refer to three different delivery methods; face-to-face, blended and on-line delivery.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended delivery* is a combination of meeting in the classroom and completing coursework on-line.

*On-line delivery* means all course work is ‘fully on-line’ where students never meet their instructor in person as part of their regular lessons.

1. Which of the following delivery modes is the most convenient for you to teach forensic science: Why?

   i) Traditional face-to-face
   ii) Blended
   iii) On-line delivery?

2. Of the following delivery modes which makes you feel the most confident teaching forensic science. Why?

   i) Traditional face-to-face
   ii) Blended or
   iii) On-line delivery?

3 In your opinion which of the following delivery modes produces the best results (grades) for students. Why?

   i) Traditional face-to-face
   ii) Blended or
   iii) On-line delivery?

5. How can teaching in higher education forensic science (in general) be supported?
6. What specific development is required for those who have to teach and assess in forensic science programs?

7. How can teaching forensic science through on-line or blended delivery be supported?

8. What are the key challenges for teachers delivering forensic science?

9. What are the key challenges for a) teachers delivering forensic science through blended delivery?
   b) students who are taught through blended delivery?

10. What are the benefits to a) teachers delivering forensic science through blended delivery?
    b) students who are taught through blended delivery
    c) the forensic science industry if students are taught through blended delivery?

11. What are the key challenges for a) teachers delivering forensic science through on-line delivery?
    b) students who are taught through on-line delivery?

12. What are the benefits to a) teachers delivering forensic science though on-line delivery?
    b) students who are taught through online delivery?
    c) the forensic science industry if students are taught through on-line delivery?

13. In your experience, are students who do higher education programs in forensic science different from or similar to students who do other higher education programs? Please explain.

14. How do you see your own future as a teacher in forensic science?

15. Is teaching in higher forensic education programs different from or similar to teaching other programs? In what ways?

16. Do you have any other comments on delivery methods in forensic science?

Thank you for your participation
The following questions frequently refer to three different learning methods; face-to-face, blended and on-line learning.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended learning/delivery* is a combination of meeting in the classroom and completing coursework on-line.

*On-line learning/delivery* means all course work is ‘fully on-line’ where students never meet their instructor in person as part of their regular lessons.

1. Which of the following delivery methods do you think is the most convenient method of study for forensic science. Why?

   iv) Face-to-face classes
   v) Blended delivery or
   vi) On-line delivery

2. Please state which of the following delivery methods makes you feel more confident studying forensic science. Why?

   iv) Face-to-face classes
   v) Blended or
   vi) On-line delivery?

3. Which of the following delivery methods do you think gives you the best results (grades) in forensic science. Why?

   iv) Face-to-face classes
   v) Blended or
   vi) On-line delivery?
4. Which of the following delivery methods, do you think would best prepare you for your career in forensic science? Why?

   i) Face-to-face classes
   ii) Blended or
   iii) On-line delivery

5. How can learning in higher education forensic science be supported?

6. How are higher education programs in forensic science different from other courses offered in tertiary institutions?

8. In your experience, are students who study higher education programs in forensic science different from or similar to students who study other higher education programs? Please explain.

9. What are the key challenges for forensic science students in higher education programs?

10. What are the key challenges for studying through on-line learning?

11. What do you see as the benefits for on-line learning in forensic science?

12. What are the key challenges for studying through blended delivery?

13. What do you see as the benefits for studying through blended delivery?

14. Please provide any other comments on forensic science education delivery methods.

Thank you for your participation
The following questions frequently refer to three different learning/delivery methods; face-to-face, blended and on-line.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended learning/delivery* is a combination of meeting in the classroom and completing coursework on-line.

*On-line learning/delivery* means all course work is ‘fully on-line’ where students never meet their instructor in person as part of their regular lessons.

1. Which of the following delivery methods do think is the most *convenient* method of study for forensic science. Why?

   vii) Face-to-face classes  
   viii) Blended or  
   ix) On-line delivery

2. Please state which of the following delivery methods makes students more *confident* studying forensic science. Why?

   vii) Face-to-face classes  
   viii) Blended or  
   ix) On-line delivery?

3. Which of the following delivery methods do you think gives students the best results (grades) in forensic science. Why?

   vii) Face-to-face classes  
   viii) Blended or
ix) On-line delivery?

4. Which of the following delivery methods do you think would best prepare students for a career in forensic science. Why?

   iv) Face-to-face classes
   v) Blended or
   vi) On-line delivery

5. Do you think students studying higher education programs in forensic science have different educational needs than students in other higher education programs? Please explain.
If yes, how could these educational needs be addressed?

6. What are the key challenges for forensic science students in higher education programs?

7. What do you see as the key challenges for studying through on-line learning?

8. What do you see as the benefits for on-line learning in forensic science?

9. What do you see as the key challenges for studying through blended learning?

10. What do you see as the benefits for studying through blended learning?

11. Please provide any other comments on forensic science education delivery methods.

Thank you for your participation
The following questions frequently refer to three different delivery methods; face-to-face, blended and online delivery.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended learning/delivery* is a combination of meeting in the classroom and completing coursework online.

*Online learning/delivery* means all course work is ‘fully online’ where students never meet their instructor in person as part of their regular lessons.

### Section One: Personal Information

*Please circle the most appropriate answer for questions 1.1 – 1.6*

1.1 My age group is:

- Under 18
- 18-21
- 22-35
- 36-50
- Over 50
- Prefer not to answer

1.2 My gender/sex is:

- Male
- Female
- Prefer not to answer

1.3 I teach:
1.4 Have you ever worked in the forensic science industry?

Yes

No

1.5 Have you ever attended a crime scene?

Yes

No

1.6 Have you ever attended court as expert witness?

Yes

No

1.7 Please briefly outline your experience as a teacher, including areas outside forensic science.

1.8 Please provide your area of expertise?
Section Two: Information about your current course

For questions 2.1 – 2.2 please circle the most appropriate answers

2.1. The forensic program in which I am teaching is:

a) Generic degree course

b) Industry based course – Certificate level

c) Industry based course – Diploma level

d) Industry based course- Advanced diploma level

e) Industry based course- Masters level

f) Undergraduate Bachelor of Science with forensic science elective

g) Bachelor of Forensic Science

h) Bachelor of Forensic Science with Honours

i) Post graduate Diploma Forensic Science

j) Master of Forensic Science

k) PhD Forensic Science

l) Other. Please describe..............................................................................

For question 2.2 please circle one or more answers as appropriate.

2.2 The course in which I am currently teaching includes units taught through:

a) traditional face-to-face delivery

b) blended delivery

c) entirely online delivery

d) another method. Please describe.......................................................................

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2.3 Is there a computing unit included in your forensic course?

Yes

No

2.4 Please name the unit/s you are teaching in the forensic program and provide a brief (1 or 2 sentence) description. Is it delivered online?

Section Three: Experience with on-line delivery

3.1a) Please briefly outline your experience with online or blended delivery indicating the units and the program.

3.1b) Do you have experience with interactive online facilitation? Please circle your response.

Yes

No

If so, please describe the interactive component e.g., virtual classrooms, discussion forums etc.

For questions 3.2 – 3.5 please circle as many answers as you feel are appropriate to you.

3.2 Please circle the benefits of online delivery from the teacher perspective.

<table>
<thead>
<tr>
<th>The benefits of online delivery for teachers are that …</th>
</tr>
</thead>
<tbody>
<tr>
<td>a …they don’t have to deal with students who don’t want to be there.</td>
</tr>
<tr>
<td>b … they can conduct classes with students across different time zones without having to travel.</td>
</tr>
<tr>
<td>c …it provides a record of class participation.</td>
</tr>
<tr>
<td>d …it provides opportunities for immediate private feedback or correction.</td>
</tr>
</tbody>
</table>
3.3 Please circle the key challenges of online delivery/learning from the teacher perspective.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>… they can perform their teaching duties at their convenience.</td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>… another reason – please say what.</td>
<td></td>
</tr>
</tbody>
</table>

The key challenges for online delivery for teachers are that …

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>… there is a reliance on Information Technology (IT) support, technical difficulties and/or the students may not be able to use it properly</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>… they are on call all day because students expect an immediate response.</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>… it is difficult to know who is actually doing the assessment.</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>… they end up feeling more like a facilitator or trouble shooter than a teacher.</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>… they end up spending more time preparing on-line courses than face-to-face courses.</td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>… another reason – please say what.</td>
<td></td>
</tr>
</tbody>
</table>

3.4 Please circle the benefits of blended delivery mode from the teacher perspective.
The benefits of blended delivery for teachers are that …

a. ... it allows the teacher to cover more material e.g. have extra tutorials, use message boards etc.

b. ... it gives teachers the time and flexibility to work online when and where they want.

c. ... it provides a record of class participation for the online component.

d. ... all learning material / assessment guidelines are online so students can’t say they didn’t get a copy. There is no need to print out lecture notes.

e. ... it provides the “best of both worlds”; the convenience of online delivery and the personal approach of face-to-face delivery.

f. ... another reason – please say what.

3.5 Please circle the key challenges of the blended delivery mode from the teacher perspective.

I think the key challenges of blended delivery for teachers are that …

a. ... they may require IT training for the on-line component.

b. ... of increased preparation time for the on-line component.

c. ... it provides a structured learning package which includes support and feedback to students.

d. ... the online component must be relevant and interactive so the students see it as valuable and entertaining e.g. active discussions, self assessments etc. rather than a place to “dump” lecture notes.

e. ... they need to be a trouble shooter and facilitator as well as a teacher.

f. ... another reason – please say what.
### Section Four: Preferences for the different delivery methods

Questions 4.1 – 4.3a) Following is a list of reasons teachers have described for choosing their preferred delivery method.

**Completing the questionnaire**

For questions 4.1 to 4.3 a) you need to do two things:

**Step 1:** Read the statement for each item. Decide your preferred delivery mode and circle the best response for you.

**Step 2** Circle all the reasons which apply to you. If you change your mind, just put a line through the circle and circle another reason.

4.1 **It is most convenient for me to teach forensic science through….**

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because …</th>
<th>Online because …</th>
</tr>
</thead>
<tbody>
<tr>
<td>a  … it is easier to judge how the students are absorbing the information.</td>
<td>g …it allows for evolving course material where I am able make changes easily.</td>
<td>m …it is the easiest method to update course material.</td>
</tr>
<tr>
<td>b  …I am able to provide immediate feedback to students.</td>
<td>h …I enjoy spending time with students as well as the flexibility to choose when I want to do the online component.</td>
<td>n …I have more flexibility in my working day.</td>
</tr>
<tr>
<td>c  …I am most familiar with this method so there is less time spent on preparation.</td>
<td>i …it gives me the flexibility to catch up on work.</td>
<td>o …I can perform my teaching duties when and where I like.</td>
</tr>
<tr>
<td>d  … I am unfamiliar with computer technology.</td>
<td>j …there are multiple ways to meet the course objectives.</td>
<td>p …I can deliver classes to “distance” students.</td>
</tr>
<tr>
<td>e  …I live close to my work place.</td>
<td>k …I can deliver pre-work, assessments and reference material online.</td>
<td>q …there are less traditional time constraints.</td>
</tr>
</tbody>
</table>

4.2 **I am most confident teaching forensic science through….**
Questions 4.3 Following is a list of reasons teachers have described for choosing their preferred delivery method.

For question 4.3 you need to do two things:

**Step 1:** Read the statement for each item. Decide your preferred delivery mode and circle the best response for you.

**Step 2** Circle all the reasons which apply to you. If you change your mind, just put a line through the circle and circle another reason.

### 4.3 I feel that students would be best prepared for a career in forensic science if they study through…

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because …</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a  ... I can tell if the students are understanding the material.</td>
<td>g  ... it allows flexibility in content delivery and I can gauge how deeply I need to go in a particular area.</td>
<td>m  ... I can cover more material.</td>
</tr>
<tr>
<td>b  ... I am not confident with using computer technology for teaching forensic science.</td>
<td>h  ... I feel having access to both face-to-face instruction and online instruction gives me two options for working things out.</td>
<td>n  ... I don’t have to deal with conflict between students.</td>
</tr>
<tr>
<td>c  ... I find personally interacting with other students gives me confidence.</td>
<td>i  ... it gives me time to learn about online delivery without having to use it exclusively.</td>
<td>o  ... I don’t have to deal with students who don’t want to be in class.</td>
</tr>
<tr>
<td>d  ... I am able to build rapport with my students.</td>
<td>j  ... it promotes self-directed learning and students take responsibility for their own learning.</td>
<td>p  ... I am skilled with computer technology and this gives me confidence.</td>
</tr>
<tr>
<td>e  ... I find the face-to-face information and instruction gives me confidence.</td>
<td>k  ... computing skills are a new requirement for the teaching profession and this is a way of building up my computing skills.</td>
<td>q  ... it promotes self-directed learning so students take responsibility for their own learning.</td>
</tr>
<tr>
<td>f  ... another reason – please say what.</td>
<td>l  ... another reason – please say what.</td>
<td>r  ... another reason – please say what.</td>
</tr>
</tbody>
</table>
Face-to-face mode because…

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>… regular interaction means the teacher can establish rapport with the students and decrease communication barriers.</td>
<td>h</td>
</tr>
<tr>
<td>c</td>
<td>… this is the best way to participate in the practical aspects of the courses in forensic science.</td>
<td>i</td>
</tr>
<tr>
<td>d</td>
<td>… the students are provided with opportunities to meet forensic scientist guest speakers.</td>
<td>j</td>
</tr>
<tr>
<td>e</td>
<td>… this is the best way in which to provide a simulated workplace.</td>
<td>k</td>
</tr>
</tbody>
</table>

QUESTIONS 4.4 to 4.12 frequently refer to three different educational levels; diploma, undergraduate and postgraduate.

Diploma level forensic science students are those already working for the Police force or in the forensic industry and studying a two year full-time (or part-time equivalent) Diploma at TAFE.

Undergraduate forensic science students are undertaking a three year full-time or part-time equivalent Bachelor of Science (with forensic science electives) or Bachelor of Forensic science degree at a University or TAFE.

Post graduate forensic science students have already attained a Bachelor of Science or Bachelor of Forensic Science and are studying for a postgraduate diploma, honours, Master of Science or Master of Forensic science or a PhD.

QUESTIONS 4.4 to 4.6 refer to DIPLOMA STUDENTS WORKING IN THE POLICE FORCE OR THE FORENSIC INDUSTRY

4.4 Which of the following delivery methods is the most convenient method for diploma students working in the Police force of forensic science? Please circle your chosen response.

Face-to-face

Blended

Online
4.5 Which of the following methods do you think would make a diploma student working in the Police force or forensic industry feel more confident? Please circle your chosen response.

- Face-to-face
- Blended
- Online

Please provide a reason for your choice.

4.6 Which of the following delivery methods do you think would achieve the best outcomes for a diploma student working in the Police force or forensic industry? Please circle your chosen response.

- Face-to-face
- Blended
- Online

Please provide a reason for your choice.

QUESTIONS 4.7 to 4.9 refer to UNDERGRADUATE FORENSIC SCIENCE STUDENTS

4.7 Which of the following delivery methods is the most convenient method for undergraduates to study forensic science? Please circle your chosen response.

- Face-to-face
- Blended
- Online

Please provide a reason for your choice.
4.8 Which of the following delivery methods do you think would make undergraduate students feel more confident? Please circle your chosen response.

Face-to-face

Blended

Online

Please provide a reason for your choice

4.9 Which of the following delivery methods do you think would achieve the best outcomes for undergraduate students? Please circle your chosen response.

Face-to-face

Blended

Online

Please provide a reason for your choice

QUESTIONS 4.10 to 4.12 refer to POSTGRADUATE FORENSIC SCIENCE STUDENTS

4.10 Which of the following delivery methods is the most convenient method for postgraduates to study forensic science? Please circle your chosen response.

Face-to-face

Blended

Online

Please provide a reason for your choice

4.11 Which of the following delivery methods do you think would make postgraduate students feel more confident? Please circle your chosen response.

Face-to-face
Blended

Online

Please provide a reason for your choice

4.12 Which of the following delivery methods do you think would achieve the best outcomes for postgraduate students? Please circle your chosen response.

Face-to-face

Blended

Online

Please provide a reason for your choice

Section Five: Future directions

5.1 What are the five most important specific developments required for those who have to teach and assess in forensic science programs (in general)?

5.2 How can teaching in higher education in forensic science (in general) be supported?

5.3 How can teaching forensic science through online delivery be supported?

5.4 Do you have any other comments on delivery methods in forensic science?

THANK YOU FOR YOUR PARTICIPATION
The following questions frequently refer to three different learning methods; face-to-face, blended and online learning.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended learning/delivery* is a combination of meeting in the classroom and completing coursework online.

*Online learning/delivery* means all course work is ‘fully online’ where students never meet their instructor in person as part of their regular lessons.

**Section One: Personal Information**

Please circle the correct answer.

1.9  My age group is:

- Under 18
- 18-21
- 22-35
- 36-50
- Over 50
- Prefer not to answer

1.10  My gender/sex is:

- Male
- Female
- Prefer not to answer

1.11  I study:
Part-time

Full-time

1.12 Are you currently employed in the forensic science industry?

Yes

No

If you answered yes, how many years experience do you have? ……………..

1.13 I have computer access at home

Yes

No

1.14 I have internet access at home

Yes

No

Section Two: Information about your current course

For question 2.1 please circle the most appropriate answer

2.2. The program in which I am currently enrolled is:

m) General Bachelors degree course

n) Industry based course – Certificate level

o) Industry based course – Diploma level

p) Industry based course- Advanced diploma level

q) Industry based course- Masters level

r) Undergraduate Bachelor of Science with forensic science elective
s) Bachelor of Forensic Science

t) Bachelor of Forensic Science with Honours

u) Post graduate Diploma Forensic Science

v) Master of Forensic Science

w) PhD Forensic Science

x) Other. Please describe..............................................................................

For question 2.2 please circle one or more answers as appropriate.

2.3 The course in which I am currently enrolled includes units taught through:

e) traditional face-to-face delivery

f) blended delivery

g) entirely online delivery

h) another method. Please describe.......................................................................

2.3 Is there a computing unit included in your forensic course?

Yes

No

Section Three: Experience with on-line learning

Questions 3.1 – 3.8 relate to your experience with online or blended learning.

3.1 Have you had experience with online or blended learning?

Yes, online learning

Yes, blended learning

No, (Please go to section 4)
If so please indicate which subject.

3.2 Was the online component of your course interactive? i.e. you were involved in activities such as discussion forums or virtual classrooms where you could have input?

Yes

No

If so, please describe the types of activities e.g. discussions forums, virtual classrooms etc.

3.3 Overall, did you find online learning or blended learning a positive experience? Please circle a response and then explain.

Yes

No

Both Yes and No

If you have experienced online learning please answer questions 3.4 -3.6. If you have experienced blended learning please answer questions 3.7 and 3.9. If you have experienced both please respond to both sections.

3.4 In your experience what were the benefits of online learning?

3.5 In your experience what were the key challenges of studying through online learning?

3.6 Please provide a recent example of a subject/unit you took that involved online learning. In your answer provide if possible the online learning tool e.g. WebCT, Sakai.
3.7 In your experience what were the benefits of studying through blended learning?

3.8 In your experience what were the key challenges of studying through blended learning?

3.9 Please provide a recent example of a subject/unit you took that involved blended learning. In your answer provide if possible the online learning tool e.g. WebCT, Sakai

Section Four: Preferences for the different delivery methods

Question 4.1 to 4.4 comprise of a list of reasons that students have identified for choosing each delivery method.

For questions 4.1 to 4.4 inclusive you need to do two things:

Step 1: Read the statement for each item. Decide your preference and circle the best response (learning/delivery method) for you.

Step 2 Circle all the reasons which apply to you. If you change your mind, just put a line through the circle and circle another reason.

4.1 It is most convenient for me to study forensic science through…. 

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>On-line because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a  …the teachers are helpful and encouraging and this keeps me focused on my studies.</td>
<td>g  …I have to fit in my study around my work schedule.</td>
<td>m  …I have family commitments and don’t have time to attend classes.</td>
</tr>
<tr>
<td>b  …it gives me time away from my busy working life to focus on my study.</td>
<td>h  …I have a busy personal life and sometimes don’t have time to attend classes.</td>
<td>n  …I have a busy working life and don’t have time to attend classes.</td>
</tr>
<tr>
<td>c  …the classes are delivered close to my home.</td>
<td>i  …it gives me the flexibility to catch up on work that I miss in the face-to-face classes.</td>
<td>o  …I live a long way from where my course is delivered.</td>
</tr>
</tbody>
</table>
4.2 I am most confident to study forensic science through…

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>Online mode because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a  ...as an undergraduate student I need to acquire practical skills as well as learn the theory.</td>
<td>g  ...I know I am getting the necessary practical experience and I am not getting held back by the weaker students when learning the theory.</td>
<td>m  ...as a post graduate student I already have the required practical skills and I now wish to concentrate on learning the theory.</td>
</tr>
<tr>
<td>b  ...I am not confident with using computer technology for learning in forensic science.</td>
<td>h  ...I feel having access to both face-to-face instruction and online instruction gives me two options for working things out.</td>
<td>n  ...I’m more confident to interact with the instructor online.</td>
</tr>
<tr>
<td>c  ...I find personally interacting with other students gives me confidence.</td>
<td>i  ...this approximates the real world.</td>
<td>o  ...I’m more confident to interact with other students online.</td>
</tr>
<tr>
<td>d  ...I find the face-to-face information and instruction gives me confidence.</td>
<td>j  ...I can complete all my pre-work and review learning materials/class notes online.</td>
<td>p  ...I am skilled with computer technology and this gives me confidence.</td>
</tr>
<tr>
<td>e  ...I am most familiar with this form of study.</td>
<td>k  ...it promotes both self-directed learning and teacher-led activities.</td>
<td>q  ...I am an introvert and I participate more using this method.</td>
</tr>
<tr>
<td>f  ... another reason – please say what.</td>
<td>l  ... another reason – please say what.</td>
<td>r  ... another reason – please say what.</td>
</tr>
</tbody>
</table>
Question 4.3 comprises of a list of reasons that students have described for choosing each delivery method in order to achieve the best results.

### Question 4.3

**I feel I get the best results (grades) if I study forensic science through…**

<table>
<thead>
<tr>
<th>Delivery Method</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face mode</td>
<td>a. am able to “bounce” ideas off other students and get faster feedback from the teacher.</td>
</tr>
<tr>
<td>Blended or mixed mode</td>
<td>h. receive benefits from both learning methods i.e. the hands-on experience from face-to-face classes and the flexibility of self-paced online work.</td>
</tr>
<tr>
<td>Online mode</td>
<td>o. experience less social distractions from other students and can therefore concentrate on my study.</td>
</tr>
<tr>
<td></td>
<td>b. learn best when I interact personally with other students.</td>
</tr>
<tr>
<td></td>
<td>i. need the motivation of face-to-face classes but I also need the online information to support my learning.</td>
</tr>
<tr>
<td></td>
<td>p. learn best when I work by myself.</td>
</tr>
<tr>
<td></td>
<td>c. learn best when I have to turn up to class on a regular basis.</td>
</tr>
<tr>
<td></td>
<td>j. am better prepared for assessment.</td>
</tr>
<tr>
<td></td>
<td>q. learn best when I learn at my own pace.</td>
</tr>
<tr>
<td></td>
<td>d. learn best when I personally interact with my instructor.</td>
</tr>
<tr>
<td></td>
<td>k. learn best from the combination of face-to-face instruction with the back-up of online material for further study.</td>
</tr>
<tr>
<td></td>
<td>r. learn best when I interact with the instructor online.</td>
</tr>
<tr>
<td></td>
<td>e. learn best when I am able to participate in practical classes.</td>
</tr>
<tr>
<td></td>
<td>l. am an introvert and I can participate more.</td>
</tr>
<tr>
<td></td>
<td>s. learn best when I interact with other students online.</td>
</tr>
<tr>
<td></td>
<td>f. most familiar with this form of study.</td>
</tr>
<tr>
<td></td>
<td>m. must be organised to co-ordinate both learning environments.</td>
</tr>
<tr>
<td></td>
<td>t. learn best when I can choose the times I want to engage with the material I have to learn.</td>
</tr>
<tr>
<td></td>
<td>g. another reason – please say what.</td>
</tr>
<tr>
<td></td>
<td>n. another reason – please say what.</td>
</tr>
<tr>
<td></td>
<td>u. another reason – please say what.</td>
</tr>
</tbody>
</table>

### Question 4.4

**I feel that I would be best prepared for my career if I study forensic science through…**

<table>
<thead>
<tr>
<th>Delivery Method</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face mode</td>
<td>a. a forensic scientist needs excellent communication and team work skills as well as technical knowledge and skills.</td>
</tr>
<tr>
<td>Blended or mixed mode</td>
<td>g. need hand-on practical experience as well as the required knowledge to become a forensic scientist.</td>
</tr>
<tr>
<td>Online mode</td>
<td>m. one has to be self-motivated to ensure the work is completed and this is an excellent attribute for my future working life.</td>
</tr>
<tr>
<td>b</td>
<td>…the instructors are good forensic science role models.</td>
</tr>
<tr>
<td>c</td>
<td>…this is the best way to participate in the practical aspects of the courses in forensic science.</td>
</tr>
<tr>
<td>d</td>
<td>…there is more opportunity to work with people in person.</td>
</tr>
<tr>
<td>e</td>
<td>…there are opportunities for excursions related to forensic science.</td>
</tr>
</tbody>
</table>

**Section Five: Future directions**

5.1 Please provide any other comments on forensic science education delivery methods.

Thank you for your participation
APPENDIX F

Industry personnel questionnaire
(PART A – National Survey)

The following questions frequently refer to three different learning/delivery methods; face-to-face, blended and online learning.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended learning/delivery* is a combination of meeting in the classroom and completing coursework online.

*Online learning/delivery* means all coursework is ‘fully online’ where students never meet their instructor in person as part of their regular lessons.

### Section One: Personal Information

Please circle the correct answer.

1.15 My age group is:

- Under 18
- 18-21
- 22-35
- 36-50
- Over 50
- Prefer not to answer.

1.16 Please state your gender/sex.

- Male
- Female
- Prefer not to answer
1.17 What is your area of expertise?

1.18 Please briefly outline your experience in forensic science.

1.19 Are you currently studying? If so, please briefly describe the program.

Yes

No

Section Two: Information about your current course

If you are not currently studying please do not answer the questions in this section. Go to Section three.

For question 2.1 please circle the most appropriate answer

2.1. The program in which I am currently enrolled is:

y) Generic degree course

z) Industry based course – Certificate level

aa) Industry based course – Diploma level

bb) Industry based course- Advanced diploma level

cc) Industry based course- Masters level

dd) Undergraduate Bachelor of Science with forensic science elective
ee) Bachelor of Forensic Science

ff) Bachelor of Forensic Science with Honours

gg) Post graduate Diploma Forensic Science

hh) Master of Forensic Science

ii) PhD Forensic Science

jj) Other. Please describe..............................................................................

For question 2.2 please circle one or more answers as appropriate.

2.2. The course in which I am currently enrolled includes units taught through:

i) traditional face-to-face delivery

j) blended delivery

k) entirely online delivery

l) another method. Please describe.......................................................................

2.3 Is there a computing unit included in your forensic course?

Yes

No

Section Three: Experience with on-line learning

Questions 3.1 – 3.7 relate to your experience (directly or indirectly) with online or blended learning.

3.1 Have you had experience with online or blended learning?

Yes, online learning

Yes, blended learning
No (Please go to Section 4)

If so please indicate the subject and the program

3.2 Was the online component of your course interactive?

Yes

No

If so, please describe the types of activities e.g. discussion forums, quizzes, virtual classrooms etc.

3.3 Did you find your experience with online learning or blended learning a positive one? Please circle a response and then explain.

Yes

No

Both Yes and No

If you have experienced online learning please answer questions 3.4 and 3.5. If you have experienced blended learning please answer questions 3.6 and 3.7.

3.4 In your experience what were the benefits of online learning?

3.5 In your experience what were the key challenges of online learning?
3.6 In your experience what were the benefits of blended learning?

3.7 In your experience what were the key challenges of blended learning?

Section Four: Preferences for the different delivery methods

The following questions frequently refer to three different educational levels; diploma, undergraduate and postgraduate.

Diploma level forensic science students are those already working for the Police force or in the forensic industry and studying a two year full-time (or part-time equivalent) Diploma at TAFE.

Undergraduate forensic science students are undertaking a three year full-time or part-time equivalent Bachelor of Science (with forensic science electives) or Bachelor of Forensic science degree at a University or TAFE.

Postgraduate forensic science students have already attained a Bachelor of Science or Bachelor of Forensic Science and are studying for a post graduate diploma, honours, Master of Science or Master of Forensic science or a PhD.

QUESTIONS 4.1 to 4.3 refer to DIPLOMA STUDENTS WORKING IN THE POLICE FORCE OR THE FORENSIC INDUSTRY

Following is list of reasons industry personnel have described for choosing each delivery method for Diploma students working in the Police force or forensic industry.

For questions 4.1 to 4.3 inclusive you need to do two things:

Step 1: Read the statement for each item. Decide your preference and circle the best response (delivery/learning mode) for you.

Step 2: Mark with a tick all the reasons which apply to Diploma students working in the Police force or forensic industry. If you make a mistake cross the error and choose another option.
4.1 Which of the following delivery methods is the most convenient method for diploma students working in the Police force or forensic science?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a ... the classes are usually delivered close to home, work or on-site.</td>
<td>a ... students can complete the theory component in their own time and attend the practical sessions in a “block” of time e.g. summer school.</td>
<td>a ... anywhere you have a computer is your classroom.</td>
</tr>
<tr>
<td>b ... students learn collaboratively with their peers.</td>
<td>b ... students sometimes can’t make classes but do need some practical activities.</td>
<td>b ... students often don’t have time to attend classes.</td>
</tr>
<tr>
<td>c ... it provides immediate feedback from the teacher.</td>
<td>c ... it gives the students the flexibility to catch up on work that they miss in the face-to-face classes.</td>
<td>c ... some students live a long way from where my course is delivered.</td>
</tr>
<tr>
<td>d ... another reason please say what.</td>
<td>d ... this type of work is highly reactive/shift work and students can’t always attend classes.</td>
<td>d ... students can work when and where they like.</td>
</tr>
<tr>
<td>e ... another reason – please say what.</td>
<td>e ... another reason – please say what.</td>
<td>e ... another reason – please say what.</td>
</tr>
</tbody>
</table>

4.2 Which of the following learning methods do you think would make a diploma students working in the Police force or forensic industry feel most confident?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a ... the student can concentrate on learning the content and acquiring practical skills without having to worry about computer problems</td>
<td>a ... the student can gain the necessary practical skills without having to worry about weaker students impeding their progress.</td>
<td>a ... most students are skilled with computer technology and this gives them confidence.</td>
</tr>
<tr>
<td>b ... students have access to a lecturer and immediate feedback from the teacher.</td>
<td>b ... having access to both face-to-face instruction and online instruction gives students two options for working things out.</td>
<td>b ... some students are more confident to interact with the instructor online.</td>
</tr>
<tr>
<td>c ... they can interact with other students.</td>
<td>c ... this approximates the real world.</td>
<td>c ... students are more confident to interact with other students online.</td>
</tr>
<tr>
<td>d ... it gives the students an opportunity to practice under pressure.</td>
<td>d ... students can complete all their pre-work and review learning materials/class notes online.</td>
<td>d ... another reason – please say what.</td>
</tr>
</tbody>
</table>
4.3 Which of the following delivery methods do you think would achieve the best outcomes for diploma students working in the Police force or forensic industry?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because …</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>e  …students learn collaboratively with their peers.</td>
<td>e  …students have access to a lecturer and immediate feedback.</td>
<td>e  … another reason – please say what.</td>
</tr>
</tbody>
</table>

4.4 to 4.9 refer to UNDERGRADUATE FORENSIC SCIENCE STUDENTS

Following is list of reasons industry personnel have described for choosing each delivery method for undergraduate Bachelor of forensic science students.

For questions 4.4 to 4.7 inclusive you need to do two things:
**Step 1:** Read the statement for each item. Decide your preference and circle the best response (delivery/learning mode) for you.

**Step 2** Mark with a tick all the reasons which apply to first year and final year undergraduate students. If you make a mistake cross the error and choose another option.

### 4.4 Which of the following delivery methods is the most convenient method for undergraduates to study forensic science?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a ... classes are usually delivered close to home, work or on-site.</td>
<td>a ... students can complete the theory component in their own time and attend the practical sessions in a “block” of time.</td>
<td>a ... anywhere you have a computer in your classroom.</td>
</tr>
<tr>
<td>b ...students learn collaboratively with their peers.</td>
<td>b ...students sometimes can’t make classes but do need some practical activities.</td>
<td>b ...students often don’t have time to attend classes.</td>
</tr>
<tr>
<td>c ... it provides immediate feedback from the teacher.</td>
<td>c ...it gives students the flexibility to catch up on work that they miss in the face-to-face classes.</td>
<td>c ...some students live a long way from where my course is delivered.</td>
</tr>
<tr>
<td>d ... students could flounder with blended or online learning.</td>
<td>d ...students often have some level of employment and are too busy to attend classes.</td>
<td>d ...students can work when and where they like.</td>
</tr>
<tr>
<td>e ... another reason – please say what.</td>
<td>e ... another reason – please say what.</td>
<td>e ... another reason – please say what.</td>
</tr>
</tbody>
</table>

### 4.5 Which of the following learning methods do you think would make undergraduate students feel most confident?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a ... students can concentrate on learning the content and acquiring practical skills without having to worry about computer problems</td>
<td>a ...students can gain the necessary practical skills without having to worry about weaker students impeding their progress.</td>
<td>a ...most students are skilled with computer technology and this gives them confidence.</td>
</tr>
<tr>
<td>b ...students have access to a lecturer and immediate feedback from the teacher.</td>
<td>b ...having access to both face-to-face instruction and online instruction gives students two options for working things out.</td>
<td>b ...some students are more confident to interact with the instructor online.</td>
</tr>
</tbody>
</table>
4.6 Which of the following delivery methods do you think would achieve the best outcomes for undergraduate students?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a … students learn best when they interact personally with other students.</td>
<td>a … students need the face-to-face motivation but also need the online information to support their learning.</td>
<td>a … some students learn best when they can choose the times they want to engage with the material they have to learn.</td>
</tr>
<tr>
<td>b … students learn best when they have to turn up to class on a regular basis.</td>
<td>b … students are better prepared for assessment.</td>
<td>b … students learn best when they learn at their own pace.</td>
</tr>
<tr>
<td>c … students learn best when they personally interact with the instructor.</td>
<td>c … students learn best from the combination of face-to-face instruction with the back-up of online material for further study.</td>
<td>c … students learn best when they interact with the instructor online.</td>
</tr>
<tr>
<td>d … students learn best when they are able to participate in practical classes.</td>
<td>d … it allows more time to review the material.</td>
<td>d … students learn best when they interact with other students online.</td>
</tr>
<tr>
<td>e … it helps to prevent the student from procrastinating and “cramming”.</td>
<td>e … another reason – please say what.</td>
<td>e … another reason – please say what.</td>
</tr>
</tbody>
</table>
4.7 Which of the following delivery methods do you think would best prepare an undergraduate student for a career in forensic science?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a  …this is the best way to provide a simulated workplace.</td>
<td>a  …there are more opportunities for peer tutoring as the student community consists of experienced forensic scientists as well as inexperienced undergraduates.</td>
<td>a  …forensic scientists need to be able to work independently as well as in team situations.</td>
</tr>
<tr>
<td>b  … the instructors are good forensic science role models.</td>
<td>b  …forensic scientists need to be able to work in both face-to-face and online environments in their jobs.</td>
<td>b  …they need the practice at using computer technology in their work life.</td>
</tr>
<tr>
<td>c  …….this is the best way to participate in the practical aspects of the courses in forensic science.</td>
<td>c  …students need the practice at using computer technology in their chosen career but they also like to be able to participate in practical classes.</td>
<td>c  …it develops/ enhances time management skills.</td>
</tr>
<tr>
<td>d  …there is more opportunity to work with people in person.</td>
<td>d  …it develops time management skills.</td>
<td>d  … another reason – please say what.</td>
</tr>
<tr>
<td>e  … another reason – please say what.</td>
<td>e  … another reason – please say what.</td>
<td>e  … another reason – please say what.</td>
</tr>
</tbody>
</table>

4.8 Would you employ a forensic science degree graduate who studied a program that was fully online?

Yes

No

Please explain your response.
4.9 Would you employ a forensic science degree graduate who studied a blended program incorporating online and face-to-face practical sessions?

Yes

No

Please explain your response.

QUESTIONS 4.10 to 4.12 refer to POSTGRADUATE FORENSIC SCIENCE STUDENTS

Following is list of reasons industry personnel have described for choosing each delivery method for postgraduate forensic science students.

For questions 4.10 to 4.12 inclusive you need to do two things:

Step 1:
Read the statement for each item. Decide your preference and circle the best response (delivery/learning mode) for you.

Step 2
Mark with a tick all the reasons which apply to first year and final year undergraduate students. If you make a mistake cross the error and choose another option.

4.10 Which of the following delivery methods is the most convenient method for postgraduates to study forensic science?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because…</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a ... students can ask questions face-to-face.</td>
<td>a ... study is sometimes determined by geography.</td>
<td>a ... anywhere you have a computer is your classroom.</td>
</tr>
<tr>
<td>b ...students learn collaboratively with their peers.</td>
<td>b ...students sometimes can’t make classes but do need some practical activities.</td>
<td>b ...students can work when and where they like.</td>
</tr>
<tr>
<td>c ... it provides immediate feedback from the teacher.</td>
<td>c ...students often have some level of work.</td>
<td>c ... some students live a long way from where my course is delivered.</td>
</tr>
<tr>
<td>d ...this is the best method to teach practical skills.</td>
<td>d ...students may have personal commitments outside the classroom e.g. young children.</td>
<td>d ... students can work when and where they like.</td>
</tr>
<tr>
<td>e ... another reason – please say what.</td>
<td>e ... another reason – please say what.</td>
<td>e ... another reason – please say what.</td>
</tr>
</tbody>
</table>

4.11 Which of the following learning methods do you think would make postgraduate students feel most confident?
<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because …</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>... students have access to a lecturer and immediate feedback.</td>
<td>... students have access to a lecturer and immediate feedback.</td>
<td>... anywhere you have a computer is your classroom.</td>
</tr>
<tr>
<td>... it gives the students an opportunity to practice under pressure.</td>
<td>... there is a high level of interaction.</td>
<td>... students can work at their own pace.</td>
</tr>
<tr>
<td>... students learn collaboratively with their peers.</td>
<td>... students often have some level of work.</td>
<td>... students don’t have to demonstrate any practical skills.</td>
</tr>
<tr>
<td>... there is a high level of interaction.</td>
<td>... students may have personal commitments outside the classroom e.g. young children.</td>
<td>... another reason – please say what.</td>
</tr>
<tr>
<td>... another reason – please say what.</td>
<td>... another reason – please say what.</td>
<td>... another reason – please say what.</td>
</tr>
</tbody>
</table>

4.12 Which of the following delivery methods do you think would achieve the best outcomes for postgraduate students?

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because …</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>...students learn best when they interact personally with other students.</td>
<td>a</td>
</tr>
<tr>
<td>b</td>
<td>...students learn best when they have to turn up to class on a regular basis.</td>
<td>b</td>
</tr>
<tr>
<td>c</td>
<td>...students learn best when they personally interact with the instructor.</td>
<td>c</td>
</tr>
<tr>
<td>d</td>
<td>...students learn best when they are able to participate in practical classes.</td>
<td>d</td>
</tr>
<tr>
<td>e</td>
<td>...it helps to prevent the student from procrastinating and ‘cramming”.</td>
<td>e</td>
</tr>
<tr>
<td>f</td>
<td>... another reason – please say what.</td>
<td>f</td>
</tr>
</tbody>
</table>

Section Five: Future directions
5.1 Do you think students studying higher education programs in forensic science have different educational needs than students studying other higher education programs? Please explain.

If yes, how could these educational needs be addressed?

5.2 Do you think all undergraduate forensic science courses should undergo industry validation?
   Yes
   No
   Please provide reasons for your choice

5.3 Do you think a national accreditation board should determine the content of undergraduate forensic science courses?
   Yes
   No
   Please provide reasons for your choice

5.3a) If the national accreditation board determined the content of undergraduate forensic science courses would this affect the method of delivery? Please circle yes or no.
   Yes
   No
   Please provide a reason/s for your answer.

5.4 Do you intend to study in the future? If so, please circle your preferred learning method and provide the reason/s for your choice.
1) Face-to-face

2) Blended

3) Online.

5.5 Do you have any other comments or suggestions for the improvement of delivery methods in forensic science?

Thank you for your participation
APPENDIX G

Student Interviews
(PART B –CIT Case Study)

The following questions frequently refer to three different learning methods; face-to-face, blended and online learning.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended learning* is a combination of meeting in the classroom and completing coursework online.

*Online learning* means all course work is ‘fully online’ where students never meet their instructor in person as part of their regular lessons.

**Section One: Personal information**

1.20 Please provide your age group

- Under 18
- 18-21
- 22-35
- 36-50
- Over 50
- Prefer not to answer.

1.21 Please state your gender.

- Male
- Female
- Prefer not to answer.
1.22 Are you a part-time or full-time student?

1.23 What year level are you?

1.24 Do you think your year level has special needs with respect to teaching/learning methods? If so, what are they?

1.25 Are you currently employed in the forensic science industry? If so, how many years experience do you have?

1.26 Do you have computer access at home?

1.27 Do you have internet access at home?

1.28 Have you completed any of the following:
   a) computer course
   b) computing unit or units?

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Section Two: Your experiences with online learning

2.1 Please briefly outline your experience with blended learning

2.2 Can you please provide an example of a successful online lesson you were involved in?

2.3 In your experience what were the challenges of blended learning?

2.4 In your experience what were the benefits of blended learning?

2.5 Please briefly outline your experience with fully online learning

2.6 In your experience what were the key challenges for studying through online learning?

2.7 In your experience what were the benefits of online learning

2.7 Do you think that the latest technology is applicable to forensic science? Why?
Section Three: Your preferences for different delivery methods

3.1. Which of the following learning methods do you think is the most convenient method of study for forensic science. Why?

  x) Face-to-face classes
  xi) Blended learning or
  xii) Online learning?

3.2. Please state which of the following learning methods makes you feel more confident studying forensic science. Why?

  x) Face-to-face
  xi) Blended or
  xii) Online learning?

3.3. Which of the following learning methods do you think gives you the best results (grades) in forensic science. Why?

  x) Face-to-face
  xi) Blended or
  xii) Online learning?

3.4. Which of the following learning methods do you think would best prepare you for your career in forensic science. Why?

  vii) Face-to-face
  viii) Blended or
  ix) Online learning?

Section Four: Future directions

4.1 How can learning in higher education forensic science be supported?

4.2 How do you think learning forensic science in higher education should be organised and structured? Why?
4.3 How are higher education programs in forensic science different from other courses offered in tertiary institutions?

4.4 In your experience, are students who study higher education programs in forensic science different from or similar to students who study other higher education programs? Please explain.

4.5 What are the key challenges for forensic science students in higher education programs?

4.6 What are the key challenges for studying through online learning?

4.7 What do you see as the benefits for online learning in forensic science?

4.8 Do you have any suggestions on how forensic science education delivery methods could be improved?

Thank you for your participation
The following questions frequently refer to three different delivery modes/methods; face-to-face, blended and on-line delivery.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended delivery* is a combination of meeting in the classroom and completing coursework on-line.

*Online delivery* means all course work is ‘fully on-line’ where students never meet their instructor in person as part of their regular lessons.

### Section One: Personal Information

1.29 My age group is:

- Under 18
- 18-21
- 22-35
- 36-50
- Over 50
- Prefer not to answer

1.30 Please state your gender/sex

- Male
- Female
- Prefer not to answer

1.31 Do you teach full-time or part-time?
Section Two: Experience with on-line learning

2.1 Please briefly outline your experience with online or blended delivery.

2.2 Are you currently delivering any units through online or blended delivery? Please elaborate.

2.3 Can you describe an example of a successful lesson delivered online?

2.4 Can you provide an example of an unsuccessful lesson delivered online? How would you improve upon it next time?

2.5 What are the key challenges for teachers using online delivery?

2.6 What are the benefits of online delivery for forensic science?

Section Three: Preferences for the different delivery methods

3.1. Which of the following learning methods do you think is the most convenient method of teaching forensic science. Why?
3.2. Please state which of the following delivery methods makes you feel more confident teaching forensic science. Why?

   i) Face-to-face
   ii) Blended delivery
   iii) Online delivery?

3.3. Which of the following delivery methods do you think gives you the best results (grades) in forensic science. Why?

   i) Face-to-face
   ii) Blended
   iii) Online delivery?

3.4. Which of the following delivery methods, do you think would best prepare your students for a career in forensic science. Why?

   i) Face-to-face
   ii) Blended or
   iii) Online delivery

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**Section Four: Future directions**

4.1 What specific development is required for those who have to teach and assess in forensic science programs?

4.2 How can teaching in higher education in forensic science (in general) be supported?

4.3 How can teaching forensic science through online delivery be supported?

4.4 What are the key challenges for teachers delivering forensic science?
4.5 In your experience, are students who study higher education programs in forensic science different from or similar to students who study other higher education programs? Please explain.

4.6 How do you see your own future, in terms of delivery methods, as a teacher in forensic science?

4.7 Is teaching in higher forensic education programs different from or similar to teaching other programs? In what ways?

4.8 Do you have any other comments on delivery methods in forensic science?

Thank you for your participation
APPENDIX I

Industry personnel interview
(PART B – CIT Case Study)

The following questions frequently refer to three different learning methods; face-to-face, blended and online learning.

**Face-to-face classes** means to meet regularly in the traditional classroom setting.

**Blended learning/delivery** is a combination of meeting in the classroom and completing coursework online.

**Online learning/delivery** means all course work is ‘fully online’ where students never meet their instructor in person as part of their regular lessons.

**Section One: Personal Information**

1.37 My age group is:

   Under 18

   18-21

   22-35

   36-50

   Over 50

   Prefer not to answer.

1.38 Please state your gender/sex.

   Male

   Female

   Prefer not to answer

1.39 What is your area of expertise?
1.40 Please briefly outline your experience in forensic science.

1.41 Are you currently studying? If so, please briefly describe the program.

**Section Two: Experience with on-line learning**

2.1 Have you had experience with online or blended learning? If so please indicate which subject and the program.

2.2 What do you see as the benefits of online learning/delivery for
   a) the forensic science industry?
   b) teachers of forensic science programs?
   c) students of forensic science programs?

2.3 What do you think the disadvantages of online learning/delivery for
   a) the forensic science industry?
   b) teachers of forensic science programs?
   c) students of forensic science programs?

2.4 What are the benefits of blended learning/delivery for
   a) the forensic science industry?
   b) teachers of forensic science?
   c) students of forensic science?

2.5 What do you think are the disadvantages of blended learning/delivery for
   a) the forensic science industry?
   b) teachers of forensic science?
   c) students of forensic science?

**Section Three : Preferences for the different delivery methods**

3.1. Which of the following learning methods do think is the most convenient method of studying forensic science. Why?

   iv) Face-to-face classes
   v) Blended delivery or
3.2. Please state which of the following delivery methods you feel would make students more confident studying forensic science. Why?

iv) Face-to-face
v) Blended or
vi) Online delivery?

3.3. Which of the following delivery methods do you think gives students the best results (grades) in forensic science. Why?

iv) Face-to-face
v) Blended or
vi) Online delivery?

3.4. Which of the following delivery methods, do you think would best prepare students for a career in forensic science. Why?

iv) Face-to-face
v) Blended or
vi) Online delivery

3.5 Would you employ a forensic science degree graduate who studied a program that was fully online?

3.6 Would you employ a forensic science degree graduate who studied a blended program incorporating online and face-to-face practical sessions?

Section Four: Future directions

4.1 Do you think students studying higher education programs in forensic science have different educational needs than students in other higher education programs? Please explain.

If yes, how could these educational needs be addressed?

4.2 Do you intend to study in the future? If so what is your preferred learning method and why?

1) Face-to-face
2) Blended
3) Online.
4.3 Do you have any other comments on delivery methods in forensic science?

Thank you for your participation
APPENDIX J

DESIGN AND DEVELOPMENT OF AN ONLINE FORENSIC ENTOMOLOGY COURSE

Overview of chapter

This chapter outlines how the development of the online forensic entomology course, used in Part B of this study, was based on the principles of constructive alignment, a type of social constructivism. This chapter provides a description of pedagogy facilitation models for online learning and identifies the requirements of the course, including the justification for the development of the course, the technology employed, the professional development and length of time required to design and develop the course. The course design process and how it is based on the principles of constructive alignment is described and a list of the relevant content, learning outcomes, examples of the assessment tasks and the instructional sequence is included. Next, constructivism and online course design, with an emphasis on designing learning activities is reviewed and the key design features of the course and how they match with Salmon’s 5 step model and social constructivism is described. Evaluation of the online course, including the online survey and the choice of questions is also described. The chapter concludes with possible future innovations that could be used as an adjunct for the training of crime scene examiners, which is relevant to part B of this study.

1.1 Pedagogy Facilitation Models for Learning Online

Although there are numerous studies on the facilitation of social and collaborative online learning (Batovsky, 2002; Page & Parry, 2002; McPherson & Nunes, 2004; Sackville & Sheratt, 2006; Brinthaupt et al., 2011; Westbrook, 2012), few online facilitation models exist that are specifically designed to support teachers to facilitate online learning (Swann, 2010). Four models will be discussed in this study; the transactional distance theory (Moore, 1973), the ADDIE theory created by the Florida State University (Bransen et al., 2005), Salmon’s five step model (Salmon, 2000; Salmon, 2003; Salmon & Giles, 1997) and the Dialogic approach (Wegerif, 2007). Although the transactional distance theory (Moore, 1973) and the ADDIE theory
(Bransen et al., 1975), were proposed before computers came into common use in classrooms, researchers have identified implications from these theories for the delivery and design of online learning (Saba & Shearer, 1994; Shelton & Saltsman, 2006). These will be discussed under the relevant headings. Salmon’s (2003) model has been selected as it focuses on how teachers can support students through the learning process. I agree with Swann (2010) emphasises that there is a need for a practical approach that can be used by online teachers/tutors and therefore the dialogic approach to online learning also is considered.

1.11 Addie

ADDIE is an education process which was first introduced in 1975 by Florida State University and used by US Armed forces – originally called SAT (Systems Approach to Training). This model is a five step cyclical process of instructional design that can be used for both traditional and online instruction. The five steps are Analysis, Design, Develop, Implement and Evaluate. In the Analysis phase, course objectives are studied and gaps and the audience are identified. The Design phase is based around the syllabus which should be available at the start of the course so students are prepared for course expectations. Other information such as contact information, course objectives, attendance requirements, a late work policy, the course schedule, orientation information and grading rubrics should also be provided at the beginning of the course. In an online course, the teacher could produce a short video or podcast introducing themselves to the class. The Development stage is where the teacher/designer is most likely to require outside assistance and mentoring from a skilled graphical or multimedia person. Lectures should be broken down into smaller sections. Reading vast amounts of text online can be tedious and even stifle learning. The next phase, Implementation, includes delivering materials and initiating instruction. It is important that the course is engaging to motivate the learners. The final phase of instruction is Evaluation where the teacher can assess the students’ performance against the course objectives and to see what has worked well and what needs improvement (Shelton & Saltsman, 2006).

Lothridge (2012) uses the ADDIE model for the online component of blended learning to train members of the US military and educate forensic practitioners working in crime laboratories. According to Lothridge (2012), the ADDIE model is capable of
sustained flexibility and adaptation to meet the needs of users, domestically and abroad, can respond to the changing needs of industry, is able to accommodate all learner types and incorporates multimedia and technology. In my opinion, although the ADDIE theory provides an excellent overview for online learning from the design stage to evaluation, it lacks the detail required for a teacher to effectively facilitate or moderate a course online.

1.12 Transactional Distance theory

Transactional Distance was a theory formulated by Michael Moore (1973) to describe ‘the potential gap of misunderstanding that can occur when a teacher and student are separated by geographical or temporal distance’ (Wheeler, Townsend & Horton, 2004, p. 1.) Moore (1973) concluded that the two main factors in independent learning are structure (the design of the instructional program) and dialogue (the interaction through communication between the learner and the educator). Moore (1973) asserted there is an inverse relationship between the amount of dialogue and the level of structure within a course. For example, during a highly structured lecture there is little dialogue i.e. the transactional distance (mutual exchange between students) is maximised. Conversely, as the dialogue increases, the structure decreases and hence there is less transactional distance. Research by Saba (Saba & Shearer, 1994) supported Moore’s theory and found that the distance between the educator and learner was that of pedagogical distance determined by the balance between structure and dialogue rather than geographical distance. This has implications for instructional design. Regardless of the mode of delivery, care should be taken to account for the balance between structure and dialogue. Most educators believe that by including interactivity in an online course e.g., email, chat and online discussion, this will decrease the chance of transactional distance.

In my opinion, this theory identifies key factors associated with distance education, but like ADDIE, it lacks the detail a teacher needs for the ‘day to day’ online delivery.

1.13 Salmon’s 5 Step Model

Salmon and Giles (1997) describe a five-step model for supporting elearning processes (Figure 1). The five stages include 1) access and motivation, 2) online socialisation, 3) information and exchange, 4) knowledge construction, and 5) development. Mastery
of certain technical and emoderating skills is required at each stage (Liburd & Hjalager, 2010). From the model (Figure 1), it can be seen that Salmon is an advocate of early online socialisation for the student but the tutor must ensure that the students are firstly able to access the course. Students are provided with opportunities for networking, but to start with any, communication between the teacher and student is on an individual basis e.g., via email. Group postings and conferences only start to appear after the early stages one and two. Salmon (2003) emphasises the importance of intervention of the tutor/teacher to encourage the students along the learning process. It is not until stage four, knowledge construction, when the facilitator can ‘take a step back’ and take on the role of facilitator. At stage five (development) the student is becoming an independent learner and the facilitator progressively withdraws.

Figure 1. Salmon’s Five Step Model.

http://www.gillysalmon.com/five-stage-model.html
Issues that may arise using this model can include access, students progressing at different rates, ineffective collaboration between students and poor program design. Firstly, students need to access the system in order to learn via the online system (Moule, 2007). Technical support can be provided through the teacher or via help desks and it is important to maintain motivation during this time. Secondly, different learners may be at different stages in the learning process and the facilitator must be able to manage and support all students within the group. I believe that facilitation training in both asynchronous environments e.g., discussion forums, and synchronous environments e.g., virtual classrooms, provide the teachers with the confidence to know when to interject. Thirdly, online social collaboration and networking doesn’t always lead to effective collaboration (Moule, 2007). This issue can be encountered in any mode of delivery, particularly if the teacher is inexperienced. Lastly, the program design can influence how far the students’ progress. A poorly designed program can add to student frustration and hence decrease motivation.

Salmon (2009) acknowledges that her five step model of E-moderating (2003) was originally based on an asynchronous environment and that it is now used in synchronous environments such as Second Life. This has implications for the design of online courses. For example, if the course is set up in a linear fashion, then activities such as those in Second Life should not be posted before the students have mastered stages one to three.

1.14 Dialogic Approach

Wegerif (2007) suggested a dialogic model. He investigated how groups of 8-11 year olds solved problems together. Sets of spatial problems were used to test the students’ approaches to collaborative problem solving. Students were then retested on the same problems after class work encouraging reflective dialogue. Their dialogue was recorded and analysed in order to find out which parts of the dialogue helped them solve the problems. Possible solutions to the problems were discussed by the students which resulted in some students changing their minds. Wegerif’s model is represented by a Venn diagram of three overlapping circles representing, critical dialogue, creative dialogue and caring dialogue. Each of the three circles overlap and the area in common to all three types of dialogue is called reflective dialogue.
Critical thought is often encouraged at the university level and according to Swann (2010), students often find this type of thinking difficult and may be reluctant to express new ideas, possibly because of a lack of confidence i.e. they are uncertain their ideas are valid. Wegerif (2007) asserts that it is beneficial for emerging ideas to be able to develop in a dialogic space, without having to justify a case at the beginning. Creative dialogue, where any judgement is suspended, e.g., brainstorming, thought shower, opens up a reflective space where ideas can be discussed in an environment of trust and encouragement. Creative dialogue appears to have a role in discovery (Swann, 2010).

The third aspect of Wegerif’s (2007) reflective space aims to draw out the distinctiveness of others through caring reflective dialogue. This can be achieved through listening and understanding or reading and understanding in an asynchronous online environment. Wegerif’s model (2007) has identified key strategies to encourage reflective dialogue. This model can only work when the students have the access, confidence and motivation to participate.

Of the four facilitation models discussed, Salmon’s Five Step Model was chosen for the online forensic entomology course described in this chapter because it contains sufficient detail and direction for teachers and is in keeping with Constructive Alignment; the learning theory that underpins this thesis.

1.2 Identifying the requirements of the course

1.21 An educational need

The online forensic entomology course was designed as a result of an educational need identified by the author. An educational need is often described as a discrepancy or gap between what is and what should be (Caffarella, 2002; Dick, Carey & Carey, 2001). Such a discrepancy can form a focal point for the design of course. According to Caffarella (2002) these gaps can take many forms, for example, a TAFE institution might run a basic computing skills course for the long term unemployed who wish to find a job. At Canberra Institute of Technology (CIT), there was an educational gap between the existing Biology 1 unit and the needs of distance students seeking an exemption.
In this study, undergraduate biology students from institutions other than Canberra Institute of Technology (CIT) had enquired about the possibility of obtaining an exemption from *Biology 1*. *Biology 1* is a six month unit that includes a forensic entomology component. The unit forms part of the *Bachelor of Forensic Science (Crime Scene Examination)* at CIT and requires weekly attendance at the CIT campus. Many of the students requesting exemptions were ‘distance students’. They had successfully completed a generic biology course and therefore fulfilled many of the recommended prior learning requirements for *Biology 1*, but they did not have prior learning for the forensic component of the unit. Therefore, I decided to design a stand-alone online forensic entomology course. This course was also used as part of *Biology 1*.

There is very little research regarding the development of complete forensic entomology courses. Although there is literature available on the delivery of forensic entomology, which will provide useful comparisons to this study (McNiel, 2010; Voss, 2008), I was unable to find any published literature on an entire online course in this area. To this end, an online forensic science module was designed, using a range of digital learning resources and authentic practical activities were used that support learning. Having identified the need for such a course, I was also aware that I needed professional development in online course design and facilitation.

1.22 Professional development

I was the educational designer of the course. Prior to the development of the online course, the only experience I had of online delivery was limited to three years of posting word documents onto WebCT. I had no experience with online design. As purported by Scott, Asoko and Leach (2007) although increased attention is being given to the role of the teacher as a result of the social constructivist perspective, less attention is being given to the design of science instruction. To develop the skills necessary to design digital resources and to facilitate an online course, I undertook 84 hours of professional development. The technology employed at CIT was Elearn, a combination of Moodle, Equella and Wimba. Although some content had already been developed prior to the construction of the course, for example, Powerpoint presentations, I developed some interactive learning activities described in subsection 1.13.
In order to gain the skills necessary to develop and facilitate the online Forensic Entomology course, I enrolled in two units, *Developing Digital Resources* (100 hours) and *Facilitating Learning Online* (60 hours) as part of the *Advanced Diploma in Adult Vocational Education* at CIT. The training included the use and facilitation of virtual classrooms (Wimba). Online facilitation skills were developed using Soden’s Immersion Model (2006). Using this model, I was immersed in the forensic entomology learning environment which enabled me to learn how to facilitate online by being an online student myself. After 14 weeks there was a summative evaluation of the course as part of the teacher’s assessment, that is, I was a student in the unit *Developing Digital Resources*. The course was then used for the first year Biology students who were given the opportunity to complete an online survey on the forensic entomology course in addition to a course evaluation survey for *Biology 1* at the end of Semester.

### 1.23 Technology employed

The online course (Figure 5) was developed using Elearn, the Learning Management System (LMS) used at CIT. ELearn allows for a seamless transition between Moodle, Equella (a learning space repository) and Wimba (communication tools, chat room, email and virtual classrooms).

I developed interactive learning activities such as crosswords and sequencing activities using freely available software including ARED and HotPotatoes.

### 1.24 Summary

The online forensic entomology course was designed as a result of an educational gap. Since I lacked the skills necessary to design digital resources and facilitate an online course, I undertook 84 hours of in-house professional development and this included the development of the course. The technology employed at CIT was Elearn, a combination of Moodle, Equella and Wimba. Although some content had already been developed prior to the construction of the course, I developed some interactive learning activities using freely available software such as ARED and HotPotatoes.
1.3 Course design

1.31 An overview of the process

The course design for this study included a four stage approach, based on the literature review to follow: 1) select a course design model/philosophy, 2) choose an online course design, 3) develop learning activities, and 4) develop evaluation tools.

The first stage was to select an overall course design model suitable for all types of delivery in forensic science education. As outlined in Chapter 2, there is a vast body of literature to support the use of a social constructivist approach in science education. I used social constructivist classroom activities, such as problem-based learning to encourage deep thinking, problem solving and communication; all necessary skills for a forensic scientist. Constructive alignment was identified as a type of social constructivism where the focus was on deep transformational learning.

The second stage was to select a suitable model of online learning for forensic science students. As previously discussed in Chapter 2, Salmon’s 5 step model was identified as the most suitable model for online facilitation. Two major categories of online course design models will be discussed later in this chapter, including the community of learning model (Collison et.al, 2000) and the independent learning model (Anderson, 2004).

The third stage in the course design process focused on the development of suitable learning activities. I identified three constructivist writers (Ayoade, 2012; Cafferella, 2002; Rovai, 2004) who have provided practical guidelines for teacher/designers of online courses and these are discussed later in this chapter. The fourth and final stage was the development of the evaluation tool for the forensic entomology course. A description of how I addressed each of these steps is provided later in this chapter.

1.32 Selection of course design model

I selected the learner-goals driven design model (Krajnik, McNeil & Reiser, 2007) that was based upon the principles of constructive alignment (Biggs, 2003), covered in Chapter 2, and the backward design model (Fink, 2003; Wiggins & McTighe, 1998). Fink (2003) and Wiggins and McTighe (1998) refer to a backward design model where the course design begins with the teacher focusing on content retention of the students
within one or two years of completing the course. The goal is to develop and refine the course objectives by taking into account the expectations of external groups.

Krajcik, McNeill and Reiser (2007) built upon the backward design model of Wiggins and McTighe (1998) and Fink (2003). In addition to aligning the instructional materials and assessment items with the learner goals / outcomes (Figure 2), Krajcik, McNeill and Reiser (2007) use an innovative pedagogical approach to include strategies such as problem-based learning and took into account the order in which content was delivered (Figure 2). I selected this model because it was in keeping with the principles of constructive alignment and focused on the use of problem solving and contextual learning tasks which are suitable for forensic science students.

Figure 2. The learner goals driven design model (Krajnik, McNeill and Reiser, 2007) http://onlinelibrary.wiley.com/doi/10.1002/sce.20240/.

1.33 Relevant course content and learning outcomes

In this study, the course objectives for all subjects in the Bachelor of Forensic Science (Crime Scene Examination) had already been developed in consultation with industry stakeholders and academics from various Australian universities. Assessment items were already aligned with the learning outcomes in keeping with constructive
alignment principles (Biggs, 2003). In other words, the type of assessment items and weightings were already ‘set’ by the curriculum writers but the teachers still had to develop the assessment items and marking rubrics to address the required learning outcomes.

### 1.331 Learning Outcomes

The forensic entomology online course is part of a first year Biology course within the Bachelor of Forensic Science (Crime Scene Examination). Of the six learning outcomes in Biology 1, the following three are relevant to forensic entomology:

1. **Apply systems and describe characteristics for the classification of living things**
2. **Collect, preserve, identify and document biological materials, and discuss the potential forensic significance of these materials.**
3. **Use and discuss appropriate procedures for the visualisation and photographic recording of macroscopic and microscopic specimens.**

### 1.332 Course content

The relevant content of Biology 1 includes forensic entomology (insects associated with carrion, Diptera, Coleoptera, life cycles), dating decomposing remains (using succession remains and insects from terrestrial, aquatic and marine environments). Microscopy and micrometry are also included in the course content.

Both the relevant content and learning outcomes were used to develop the assessment items for the Forensic Entomology unit.

### 1.34 Assessment

#### 1.341 Types of assessment

Two types of assessment used in VET institutions will be discussed; formative assessment and summative assessment. Formative assessment is informal assessment given to the student to provide feedback and does not count towards the final grade. Summative assessment is formal assessment e.g., exams, that count towards the students’ final grade. Formative assessment is given to the student throughout the online course. For example, in the Forensic Entomology unit there is a Webquest on the role of forensic science professionals and a collaborative activity where the students were asked to determine the time since death. Informal assessment is very
important in an online environment with no face-to-face interaction and according to Rovai (2004) if feedback does not occur in a timely manner, it may be too late for the teacher to rectify any problems the students are experiencing.

The discussion forum enabled formative assessment in the online forensic entomology course for first year undergraduates. In addition, the third year students were required to participate in online tutorial discussion forums as part of their Research Methodology unit in the Bachelor of Forensic Science. A grading rubric was used for the summative assessment of the discussion forum (Table 1).

The summative assessment involved the students completing an assignment on the decomposition of a pig (Figure 3). This was included to develop the student’s understanding of the decomposition process and the relationship between decomposition and assemblages of insects. The students were required to collect, preserve and identify the insects and record their observations. Honebien, Duffy and Fishman (1993) recommend the use of authentic assessment tasks for which the students are being trained. The students were being trained to become crime scene examiners and tasks such as collection, preservation and recording of evidence would be part of their duties. The assignment could be completed by the face-to-face students using a sacrificed pig or the distance students using a piece of meat. Questions pertaining to forensic entomology were used in the mid-semester exam and in the final practical exam.

1.342 Development of Assessment Tasks

When developing assessment tasks, not only does the teacher need to take into account the objectives and learning outcomes but other factors need to be addressed. Fink (2003), an advocate of the constructivist approach to online learning, recommends that teachers should consider factors such as student characteristics, e-learning characteristics, and the mix of face-to-face and online learning.

1) Student characteristics - In this teaching study, there were two student cohorts, so the characteristics of the student group using the entomology course was difficult to determine. In one student cohort, the students were mature age, distance students who already held an undergraduate biology subject while the other student cohort included mainly local students who had recently passed
Year 12 and held at least one science subject. According to Knowles, Holton and Swanson (1998) adult learners have rich life experiences and need to be treated as capable of self-direction. Hansen et al. (1997) found distance learners to be self-motivated and possess a strong locus of control. Adult distance students are quite different when compared with first year undergraduates who are recent high school graduates and require considerable more teacher directed instruction (Otting et al., 2010).

2) E-learning characteristics – According to Jonassen (2000, p.82-83),

students can use technology to articulate what they already know, reflect on what they have learned, support the internal negotiation of meaning making, construct personal representations of meaning and support intentional, mindful thinking.

Rovai (2004) emphasises the importance of a designated university-wide faculty development centre with a learner focus to assist the teaching staff with course planning and development. In the development of the entomology course, technical assistance was available upon request from the CIT online support.

3) Mix of online and face-to-face - The designer must determine whether the course is fully online or blended (Rovai, 2004). As previously discussed, the entomology component of the Biology course was available to fully online distance students who were seeking a Recommended Prior Learning (RPL) exemption and in blended mode to the local Bachelor of Forensic Science students. In other words, I did not choose online or blended, but rather modified the summative assessment items so that they could be completed by either cohort.

Assessments had to be designed so that distance students could complete them off campus. This meant that the course was set up using topics rather than weekly lessons. In this way, the student could jump from one topic to another and skip any topics with which they were already familiar.
Table 1. *Marking rubric for tutorial discussion participation in the Biology 1 /Forensic Entomology course (Centre for Science, forensic and engineering, CIT).*

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Fail</th>
<th>Pass</th>
<th>Credit</th>
<th>Distinction</th>
<th>High Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributes to discussions</td>
<td>Does not contribute to class and online discussions</td>
<td>Contributes to class and online discussions in a limited capacity</td>
<td>Contributes adequately to class and online discussions; discussions are of a suitable quality and quantity; shares information minimally</td>
<td>Contributes valuably to class and online discussions; discussions are of good quality and quantity; shares information effectively</td>
<td>Contributes extensively to class and online discussions; discussions are of excellent quality and quantity; refers to other work in their discussions; shares information and resources</td>
</tr>
<tr>
<td>Provides feedback</td>
<td>No feedback was provided</td>
<td>Provides limited feedback; limited suggestions for improvement</td>
<td>Provides adequate feedback; some areas of improvement identified</td>
<td>Provides valuable constructive feedback; suggests a number of improvement areas</td>
<td>Provides extensive constructive feedback; suggests extensive improvement</td>
</tr>
<tr>
<td>Team work</td>
<td>Inadequate teamwork skills; cannot cooperate with others effectively to produce results</td>
<td>Demonstrates adequate teamwork skills; their ability to cooperate with others to produce results can be improved</td>
<td>Demonstrate good teamwork skills; cooperates with others to produce results</td>
<td>Demonstrate excellent teamwork skills; cooperates well with others to produce results</td>
<td>Demonstrate exceptional teamwork skills; cooperates exceptionally well with others to produce results</td>
</tr>
<tr>
<td>Communicates with others</td>
<td>No effective communication occurs between peers/teachers/supervisors/industry</td>
<td>Limited communication with peers/teachers/supervisors/industry, except when asked</td>
<td>Communicates adequately with peers/teachers/supervisors/industry</td>
<td>Communicates well with peers/teachers/supervisors/industry</td>
<td>Communicates effectively with peers/teachers/supervisors/industry</td>
</tr>
</tbody>
</table>
Entomology assignment

This assignment will develop your understanding of the decomposition process and the relationship between decomposition and assemblages of insects. Knowledge of this may allow an estimate of the minimum elapsed time since death.

1. Face-to-face students. Observe the decomposition of an animal (e.g. pig) from soon after death for at least three weeks. You are to work in groups of 2-3 students and collect samples of insect larvae, pupae and adults from the corpse at different stages of decomposition. You should also observe and record the process of decomposition of the corpse.

Distance students. Observe the decomposition of a large piece of fresh meat e.g. shoulder of mutton for at least two weeks. Ensure that you cover it with a wire cage if it is placed on the ground or suspend it from the branch of a tree by string (to reduce the risk of predators taking the meat). Photograph the meat and associated insects every day. You should also observe and record the process of decomposition.

All students must ensure they wear disposable latex gloves during this exercise. Always wash your hands with soap and water immediately afterwards.

2. Record:

The decomposition state of the remains on each visit. Photographs will be needed to support your description.

Date (actual and elapsed days) and time of visits

Environmental temperature and maggot mass temperature on each visit

Approximate (e.g. <5, 5-10, 10-20, 20-50, 50-100, 100s, 1000s):

Number and location of eggs on corpse (if any)

Number and types of flies around corpse/meat

Number and location of small, medium and large Dipteran larvae on corpse/meat

Number and location of beetle adults and larvae on corpse/meat

Other insects/invertebrates found on corpse/meat

Collect flying insects

Collect maggots (face-to-face students only)

Each group of face-to-face students must submit their insect collection to include examples of each type of specimen.

Temperature maximum and minimum and rainfall (from local paper – state the location of the relevant meteorological station) during the period the corpse was observed (ie from initial placement to the last visit).

3. Make an attempt to identify the collected insects

- Identification of specimens to family level for beetles, genus level for flies. NOTE: Please do not submit your samples to an expert forensic entomologist as they rapidly get fed up with identifying material of no real forensic significance.

4. Each person must submit their own written report of about 1000 - 2000 words that includes the following:

- **Introduction** – Sets the study in context.

- **Methods** - Outline of the methodology in brief.

- **Results** - A written summary of the major trends observed, relating the stage of decomposition to the types of insects found on the corpse. Table(s) and/or graph(s) that summarise the raw data. I suggest that you use a similar style to that used in the literature on forensic entomology to indicate the relative abundance of each species/group of insects over time.

- **Discussion** of the results of the study which includes a comparison of your data with that found in other published studies (see forensic biology readings) and reasons for similarities/differences.

  Include a consideration of the microhabitat, in which the corpses were located, that may affect the rate of decomposition (eg soil, shade, moisture, etc).

- **Conclusion** which is the finale to the discussion.
The forensic entomology assignment is a summative assessment item used for both face-to-face students and distance students in the Biology 1 and Forensic Entomology course.

1.35 Instructional sequence

The online forensic entomology course was developed over 14 weeks. I planned the course in the first three weeks. The course was divided into eight topics and within each topic there were various activities, both asynchronous and synchronous. Topic arrangement was set in linear fashion, with each topic building on the previous one. The eight topics were the introduction, decomposition, classification, structure of insects, collection and preservation of insects, forensic entomology, post mortem interval and accumulated degree days (Figure 4). The course was then built between weeks 3 and 14 by adding resources such as quizzes, wikis, virtual classrooms as I learnt the required skills (refer to appendix for sample screen shots). All lessons/topics were made available at once to facilitate self-paced learning and to allow the students to jump from one topic to another depending on the level of their prior knowledge in forensic entomology.


1.36 Selection of an Online Course Design

As discussed in Chapter 2, online learning falls into one of two categories: the community of learning model (Collison et al., 2000) and the independent study model (Anderson & Elloumi, 2004). The community of learning model is based on collaborative, interactive learning whilst the independent study model is designed for independent learners who have little or no peer interaction. As previously mentioned, the course was originally created as a ‘stand-alone’ online forensic entomology course to be used for ‘outside students’ who had already gained an undergraduate biology subject but had not had exposure to the forensic side of biology. However, the course was also used as part of Biology 1, a unit within the Bachelor of Forensic Science. These two student cohorts presented me with a dilemma. In one cohort the students were independent learners and in the other group the majority of students were recent college/high school graduates. I decided to proceed with the model that encouraged peer interactivity in keeping with social constructivism. Distance students could still participate in activities such as discussion forums if they wished although this was not mandatory.

1.361 Course design and Salmon’s five step model

Salmon’s five step model was chosen as the online facilitation model in this study. As discussed in Chapter 2, each stage of Salmon’s five step model (Salmon & Giles, 1997) requires the participants to master certain technical skills. These skills range from access, online socialisation, information giving and receiving, knowledge construction and finally independent learning. Initially the facilitator welcomes the student and ensures they can gain access. As the student becomes more confident the facilitator gradually withdraws to encourage independent learning. This staged withdrawal from the facilitator meant that the learning activities were designed to build on each other and become more complex as the course proceeded.

The theory from Salmon’s 5 step model (2003), constructive alignment theory (Biggs, 2003; Reaburn, Muldoon & Bookallil, 2009; Walsh, 2007) and constructivist online course designers (Caffarella, 2002; Rovai, 2004), discussed later in the chapter,
informed the design and development of the forensic entomology course/ unit used in this study, however, a pragmatic approach was taken.

### 1.36 Pragmatic approach

According to Rovai (2004), to use a course for online learning, without any change, that has been designed for a face-to-face class would be a serious mistake. I agree with the proviso that a pragmatic approach should be taken. For example, if visually appealing, informative power points have previously been used in a face-to-face class, they may be suitable for use in an online course. Although an advocate of constructivist teaching methods, I see no problem with including supplemental, previously developed relevant material such as readings and PowerPoint presentations in such a course. Teachers are often time poor. In an ideal world, teachers could start every course from scratch but if previously developed learning material is suitable either in its entirety or with a minimum of change, there is considerable economy to be gained with its inclusion into an online course. As purported by Rovai (2004) students need to make connection with course content that is organised in a logical manner in addition to interactive resources. Servonsky, Daniels and Davis (2005) make the point that from a teacher’s point of view, an online course takes more time and precise planning than that of a face-face course. For this reason, it would follow that if previously developed learning material is suitable for online delivery it could be included in the course.

### 1.37 Summary

The Learner-Goal-Driven design model (Krajcik, McNeill & Reisser, 2007) was selected as the most suitable model for forensic science students as it was based on constructive alignment, where the assessments and learning outcomes are aligned, and included problem based learning that encourages deep learning. The online design model chosen was the Communities of Learning model (Collison et al., 2000) that encourages peer interaction and learning through practice. Forensic scientists need to be able to communicate and work as part of a team, so peer interaction was identified as a suitable method to include in an online forensic course. As discussed in Chapter 2, Salmon’s five step model of online facilitation was selected to encourage the student to become an independent learner. A pragmatic approach was taken as the teacher
included some previously developed learning materials, such as PowerPoint presentations, into the online forensic entomology course as well as developing new digital resources.

### 1.4 Design and Development of Online Learning Activities

Ayoade (2012), Caffarella (2002) and Rovai (2004) and have all provided useful constructivist-based guidelines for teachers designing courses or units. Caffarella (2002), recommends that content should be relevant and practical with opportunities for application. Three important enhancers of program design and execution were identified by Cafferella (2002):

1) active learning, including application exercises, used extensively. For example students could be provided with a crime scene scenario involving the discovery of decomposing remains. They would be provided with weather data and asked to determine the time since death.

2) close match between the training environment and the application’s context. In a forensic context, the students could be given access to the decomposing remains of an animal and be required to collect insect specimens and soil samples, package evidence, record observations, complete running sheets to maintain chain of custody etc.

3) transfer of learning strategies that are useful and negotiable. Ayoade (2012) provided an example whereby some lectures were based on student questions. The students were first asked to read about a topic. The teacher could then provide a lecture on the topic (this could be in a virtual classroom) based on student questions. A learner’s prior knowledge can hinder prior learning (Ayoade, 2012). By basing lectures on student questions, the lecturer can correct any student misinterpretations before further new learning occurs.

Ayoade (2012) provides a useful list of principles that can be used as a constructivist guide to teaching. Ayoade’s (2012) guidelines complement those of Cafferella (2002). For example, both authors refer to active learning, application and negotiable learning strategies. In addition to suggesting that learning requires mental activity and requires application, Ayoade (2012) emphasises the social component of learning and argues
that learning occurs as a result of dissatisfaction with current knowledge. Whilst Ayoade (2012) refers to the social component of learning, Cafferella (2002) refers to a contextual approach where he recommends aligning the training environment with the learning approach. Teachers should also find out what students already know before they commence teaching (Ayoade, 2012).

I incorporated all the above principles into the course. For example, before the students begin the course they are required to complete a pre-test on forensic entomology to test their prior knowledge. Although I would argue that some learning occurs as a result of dissatisfaction with current knowledge, learning can also occur simply because it is of interest to the learner. In another activity students are required to work in pairs and calculate the time since death; an activity that has a social component, is applicable to forensic science and requires the students to problem solve. In this course, opportunities for social interaction are provided whereby the students can participate in discussion boards. If a student is unable to defend his/her opinion, they may become dissatisfied and, therefore, open to learning from their peers or teacher.

Rovai (2004) summarised the important learning elements of online courses (Figure 8). I agree with this model because it aligns the authentic assessment with the learning outcomes/course objectives, advocates the use a welcome page, encourages consistent interaction (teacher-student and student-student) and uses both individual and group activities in keeping with social constructivist principles. Although Rovai (2004) has not mentioned the terms constructive alignment or Salmons five step model, his model is consistent with both approaches. Figure 8 provides a user-friendly checklist for teachers to use when designing online courses using a constructivist approach. Furthermore, the inclusion of a variety of group activities outlined in Rovai’s (2004) list of important learning elements addresses the different learning styles of students.

1.41 Learning Styles

Students may have preferences as to how they learn. According to Felder and Silvermann (1988), most students have preferences for one of three modalities, that is, visual learning, auditory learning and kinaesthetic learning. Visual learners are said to prefer to see the information, for example, presented as flow charts and diagrams.
Auditory learners prefer to hear the information, for example, lectures and discussions. Kinesthetic learners prefer a multimodal way of learning i.e. they prefer to actually do the science and often use a combination of senses to process the information. Baykan and Nacar (2007) found that multimodal students like to talk and write about what they are learning and apply their knowledge. Multimodal learners do not have a preference for one type of learning. Lujan and Dicarlo (2006) found that 63.9% of the 155 medical students they investigated were multimodal, and based on this finding, suggested that the number of passive lecture hours should be decreased. I agree with Samarji’s (2010) assertion that forensic science is similar to medicine in that both professionals require discipline specific knowledge and have a direct relationship to both legal and ethical issues. If this assertion is correct, it would follow that Lujan and Dicarlo’s findings that the majority of medical students have multimodal learning preferences, could also be applied to forensic science students. Willingham (2005) challenges the theory that teachers should adapt the teaching activity to the learner’s preferred learning style and instead recommends that teachers focus on the content’s best modality. For example, if a forensic science teacher wants the students to be able to observe and recognise certain morphological features of an insect, the presentation should be visual. Neonaki and Branford-White (2008) refer to three learning approaches: learning through reflection, learning by doing and learning by conversation. One could say that learning by doing is comparable to Felder and Silvermann’s (1988) kinaesthetic learner style and learning by conversation is similar to Felder and Silvermann’s (1988) auditory learning style, but the learning by reflection is a different modality. I see the merit in learning by reflection, in terms of collaborative activities e.g., discussion forums and individual activities e.g., self-reflective reports.
Presentation of Content

Structured and sequenced by module, week, textbook chapter, and so forth. Includes instructor welcome page and course orientation, textbook assignments, and supplemental course materials, such as instructor notes, that contain multimedia content.

Instructor-student and student-student interactions

Includes required and consistent interaction, discussion forums for learning activities and socializing, immediate instructor behaviour, periodic discussion topics posted by the instructor, and use of students to summarize the results of key discussion topics.

Individual and group activities

Uses a balance of individual and collaborative group work and classwide and group discussions, and the Internet and library online resources to support learning activities.

Assessment of student performance

Incorporates diverse and authentic assessments, participation as a graded course component, a grading rubric, to identify specific expectations for each assessment tasks, immediate acknowledgement of instructor receipt of assignments, detailed and timely feedback, and opportunities for reflection.

Figure 8. Important learning elements of online courses (Rovai, 2004 p.91)
1.42 Summary

Three key constructivist writers (Ayoade, 2012; Caffarella, 2002; Rovai 2004) have been discussed as they have provided useful guidelines for online teacher/designers. Rovai (2004) in particular has produced a user-friendly checklist for teachers. Different students learn in different ways. Felder and Silverman (1988) referred to three learning modalities; visual, auditory and kinaesthetic. More recently, Lujan and Dicarlo (2006) found that the majority of first year medical students were multimodal learners. I speculate that the majority of forensic science students are also multimodal based on Samarji’s 2010 assertion that medicine and forensic science are professions that have specialist content and human ethical issues. In the next section, the key design features and how each of these features relates to the various stages of Salmon’s five step model, described in detail in Chapter 2, and Rovai’s (2004) recommended learning elements within online courses, are described.

1.5 Key Design Features

Six key design features were incorporated into the Elearn course in this study with the aim of making it an appropriate learning experience for the students. All these design features are in keeping with Salmon’s five step model and are examples of social constructivism (Ayoade, 2012; Biggs, 2003; Cafferella, 2002; Rovai, 2004). The six key design features were orientation and support, visual appeal, collaborative learning experiences, opportunities for enquiry, interactive activities and problem-based learning. Rather than simply posting learning tools into the course, I provided succinct written instructions for the students to read in the first screen before they opened the learning tools or information bites. This is similar to the way a teacher would instruct students in a face-to-face class before handing out a worksheet. Considerable attention was given to implementing a student-centred approach. Table 2 shows examples of how these design features were implemented in the course.
<table>
<thead>
<tr>
<th>Key Design Features</th>
<th>Examples of how the design features were implemented into the course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation and support</td>
<td>Use of an introductory letter and photo of the lecturer and an audio recording of the lecturer’s voice</td>
</tr>
<tr>
<td>Visual appeal</td>
<td>Use of coloured text, emoticons, utube videos and graphics for each topic, PowerPoint presentations, discussions, assessment items etc.</td>
</tr>
<tr>
<td>Collaborative learning experiences</td>
<td>Discussion forum</td>
</tr>
<tr>
<td>Opportunities for enquiry</td>
<td>Webquest</td>
</tr>
<tr>
<td>Interactive activities</td>
<td>Virtual classroom, discussion forum, game, word closes, quizzes, crosswords, matching exercises, sequencing activity, diagram to label</td>
</tr>
<tr>
<td>Problem based learning</td>
<td>Camtasia PowerPoint presentation (interactive) so students can integrate the learning and solve the problem presented in an assignment</td>
</tr>
</tbody>
</table>
1.51 Orientation and support

Students can experience confusion, anxiety and frustration from ambiguous instructions and according to Hara and Kling (2000) feelings of isolation are an additional stress factor. Rovai (2004) agrees and recommends the use of a welcome Web page to help minimise feelings of isolation and to promote a sense of community when designing an online course. To prevent or reduce such stress factors, students in the entomology course were given an online orientation and provided with a subject guide at the start of the course. Students were provided with a subject guide that included the learning outcomes, schedules, topics, assessment descriptions, rubrics and due dates. In this way, the students can plan and manage their study time.

Orientation and support was achieved through an introductory “welcome” letter with my photograph and contact details (Figure 5). An audio recording of my voice was also included at the beginning of the course. This is in keeping with Salmon’s stage one features of access and motivation. Visual appeal was enhanced with the use of coloured text, emoticons, utube videos and the extensive use of graphics for each topic heading, PowerPoint presentations, discussions, assessment items etc. Swan (2002) recommended the use of emoticons, humour and self-disclosure by the online teacher due to the lack of non-verbal cues that would normally be experienced in a face-to-face class.
Figure 5. The welcome letter used in this forensic entomology course complemented an audio podcast.

1.52 Collaborative learning

Collaborative learning is when two or more students learn something together (Dillenbourg, 1999). An example of a collaborative learning experience was the discussion forum where students posted their ideas onto a wiki. The discussion topic was “Should animals be used in scientific research?” (Figure 6). This topic was chosen because most people have strong opinions about it, people don’t have to be scientists in order to make a comment and nor does the question have a correct answer. According to Weimer (2010), one of the keys to more effective class discussions is to develop a very limited set of discussion questions that do not have known answers. Rovai (2004) also supports the use of open-ended questions that promote dialogue among students. In the entomology course, students were encouraged to find existing literature, not available in their text book, to support their argument. According to Atkin and Neal (2007) this approach can promote lively discussion and has the
advantage of the students sharing literature sources. This discussion forum activity involved several technical skills i.e. some online socialisation (stage two of Salmon’s 5 step model), information giving and receiving (stage three of Salmon’s 5 step model) and knowledge construction (stage four of Salmon’s 5 step model). The discussion forum was trialled with ten teachers, who were studying units in online facilitation and developing digital learning resources, over a five day period in September 2010.

1.521 Discussion forums/ boards

A major difference between discussion forums and other online collaboration tools is that discussion forums are asynchronous (Horton, 2000). In asynchronous discussion, participants can post a comment anywhere and anytime. In this way, discussions can extend outside class hours (Lehmann, 2004; Yip & Mark, 2007). Another advantage of using discussion boards is that the comments supplement classroom discussion in the virtual space and encourage participation from usually reserved students (Lehmann, 2004; Thompson & Ku, 2005). This is in keeping findings of Mark et. al. (2011) who report that students have plenty of time to research and refine their comment or answer before making a posting thus removing the fear of making the wrong response. According to Hu and Fell-Eisenkraft (2003), culture can impact on learning styles. For example, Chinese learners are generally shy and afraid to make mistakes (loss of face). This is supported by Mark et al. (2011) who found the use of asynchronous discussion boards allows Chinese students to overcome their tendency to avoid being the centre of attention and to express their opinions in a considered and well-presented way. Socialisation outside the classroom was another benefit of asynchronous discussion boards (Mark et al., 2011). Asynchronicity is also a bonus for some teachers. Mazzolini and Maddison (2007) assert that for some teachers, an asynchronous learning environment can make them feel more comfortable and provide sufficient time to respond to students’ postings. They also acknowledge that some outgoing instructors may find it challenging in such an asynchronous environment without the benefit of being able to see the students’ non-verbal responses.

Traditionally the number of posts in a discussion board is the quantitative index of online discussion participation. Mark et al. (2011) recommend that the number and duration of visits should be considered when determining the level of online discussion participation. I assert that a novice user will spend more time online so the duration of
The post is not an ideal indicator. Instead, a grading rubric is recommended (Table 2). Participation in the discussion forum was not part of the summative assessment for the first year biology students i.e. participation in the discussion forum did not count towards the student’s final grade. However, a grading rubric was used for the third year students in a different forensic subject.

The instructor’s moderation on discussion boards can have a strong influence on students’ participation (Mark et al., 2011). According to Mazzolini and Maddison (2007), the ways in which instructors post to discussion boards can influence student discussions and perceptions. That is, frequent postings by a facilitator does not necessarily lead to more student postings and neither does the invisible presence of an facilitator online. This is in contrast with the findings of Yeh (2005) who reported that students were found to have more collaboration and participation when they were told the facilitator would comment on the posts. However, when students were not informed about the facilitator’s presence beforehand, there was minimal collaboration even though the instructors participated and commented on the discussions.

According to Haavind (2006), if the collaborative dialogue is part of the assessment, participants are more likely to participate. Rovai (2004) supports this finding and found higher levels of sense of community and more discussions per student per week when discussions were graded. Ellsworth (2005) found that students did more than the required work and were more inclined to do further research because she graded the results on the quality and quantity of the discussion board responses. As previously mentioned in Chapter 2, Ellsworth’s study was based on preliminary observations only and further research was needed. In the online forensic entomology course used in this study, the discussion forum was not part of the summative assessment.

Socialization and purpose have been identified as factors that influence students’ online participation experience (Cotterill et al., 2010; Mark et al., 2011; Martyn, 2005; Williams & Pury, 2002). In a longitudinal study of discussion board usage, Williams and Pury (2002) found that only a minority of students perceived the online discussion as ‘fun’, while some perceived it as a ‘total waste of time’. Cotterill et al., (2010) state that students tend to separate academic social networks from the private social network. According to Martyn (2005), best practice is to facilitate collaborative learning through discussion boards because this integrates both social and purposeful
instructional interaction online. In the online forensic entomology course, the students were only given one week to post their comments in a discussion forum. They were asked to make at least one posting and to provide references.

Figure 6. The discussion topic used in the forensic entomology course.

1.53 Opportunities for enquiry

Opportunities for enquiry were achieved through a Webquest where students were provided with a crime scene scenario then split into groups of five. According to Roberts and McInnerney (2007, p.259), both small and large groups can work well in an online environment, depending on factors such as the context and complexity of the task. Rovai (2004) asserts that group work is more likely to appeal to students who are interested in people, events and the external world. It is also possible to suggest that mature age students are more likely to take an interest in the external world and
be less self-centred because mature age people often have more responsibilities such as dependents and work commitments. Each student researched a particular role e.g., crime scene investigator, pathologist, entomologist, anthropologist etc. and searched for useful websites before reporting back to their group. The group then gave a PowerPoint presentation to the class and made up a timeline to show when each of the forensic discipline/ professionals arrived at the crime scene. This was followed by a class discussion. Muirhead (2001) reported that group work can sometimes lead to a few individuals doing most of the work. I have observed this during my previous teaching experience and advocate close monitoring of students. If the task is assessable, students could be asked to provide a score from zero to five for the contribution of their team members (A score of zero meaning no work and a score of five meaning maximum contribution). This activity was in keeping with stage five of Salmon’s five step model, that is, knowledge construction where students begin to work independently online. They also work collaboratively (stage 4) towards the end of the activity.

In a Webquest activity (Figure 7), when the students research the different relevant forensic professions, the students are learning through doing and reflection (Neonaki & Branford-White, 2008). When the students give a PowerPoint presentation followed by a class discussion, learning by conversation is addressed. Such group work can contribute to a collaborative learning environment and enhance communication and negotiation skills that are required in the forensic science industry.
Interactive learning tools were used for each topic including virtual classrooms, discussion forums, word closes, quizzes, a game, crosswords (Figure 8), matching exercises, sequencing activities, diagrams to label and an interactive PowerPoint presentation using Camtasia (Figure 10). I acknowledge that activities such as crosswords, sequencing activities and diagrams to label do not encourage the deeper thinking recommended for social constructivist learning to occur. Although Brooks and Brooks (1995) point out that the constructivist approach is more than just activities, these were included both to motivate the student and so he or she could gauge their own level of understanding of the topic.
The interactive learning tools used in this course e.g., Camtasia PowerPoint presentation and an activity, where the students work out the time of death, would more likely to appeal to the kinesthetic learner who prefers to ‘do something’ because here the emphasis is on process rather than content.

Figure 8. An example of one of the interactive learning activities used in the forensic entomology course.

1.541 Virtual classroom

A virtual classroom was used to show power points and also to provide demonstrations of insect structure using the Universal Serial Port (USB) microscope (Scope Capture 11, compatible digital microscope 2.0MP, maximum magnification 230x). The USB microscope is a low powered microscope that uses USB as an interface between the computer and the microscope. The operator can either hold the microscope or attach it to a stand. In the virtual classroom, students could write
questions in the chat room or use their microphones to pose verbal questions. The instructor had the option of disenabling live talk via the microphones. Figure 9 is a screen shot of a maggot being measured using the USB microscope in a live virtual classroom. During the virtual classroom session prior to using the USB microscope, the students were given a brief PowerPoint presentation to focus on what they should expect to see under the microscope. The lessons were archived/recorded and posted onto Elearn for students to view at a later date if they wished.

![Screen shot showing a maggot being measured with the use of the USB microscope (Magnification 50x) in the virtual classroom (Wimba).](image)

**Figure 9.** A screen shot showing a maggot being measured with the use of the USB microscope (Magnification 50x) in the virtual classroom (Wimba).

There is limited literature available on the use of USB microscopes in science classrooms (Dickerson & Kubasco, 2007). In Dickerson and Kubasco’s study (2007), however, the students were trained in the use of the USB microscopes and created electronic laboratory reports to include digital images. In this study, only the teacher used the USB microscope and the students, who were located in a separate computer laboratory, viewed the ‘live’ images during a virtual classroom session using Wimba (Figure 9). In addition to the use of the virtual classroom, the forensic entomology course also included an interactive CSI game.
1.542 Interactive Games

The inclusion of games in an education program could increase student’s enjoyment and encourage them to take risks in a safe environment. According to Spring-Keller (2010) if people are not enjoying learning, they will only learn the minimum required to accomplish standardised goals such as tests and exams. However, focussing on the forensic science industry, it is important to have students who are able to think outside the box. Spring-Keller (2010) asserts that people dare to take risks through play. Learning happens through several communication channels around a game e.g. chat forums and not only directly between the game and the player (Spring-Keller, 2010). A CSI game was included in the forensic entomology course used in this study but I asked the students to focus on one aspect of the game to ensure they remained focused.

1.55 Problem-based learning

Problem-based learning was included through an interactive PowerPoint presentation using Camtasia. According to Caffarella (2002), program design and execution should include relevant, useful, practical content with a focus on application. In this online course, the students were given a practical formative assignment (that did not contribute towards their final grade) to determine the time since death. I gave a tutorial via a Camtasia PowerPoint presentation to explain how to perform the required calculations. The students can actually see the calculations as they are being written and hear my commentary (Figure 10). The following lesson the students worked in pairs to determine the time since death. As purported by Reaburn, Muldoon and Bookalill (2009), the emphasis in social constructivism should be on process rather than content, as was the case with this activity.

This problem-based activity of determining the time since would appeal to the visual and auditory learners in the class and is in keeping with Ayoade’s (2012) constructivist guide including mental activity and application with a social aspect. This activity was also in keeping with Salmon’s stage five of the 5 step model (development) and was placed at the end of the online entomology course as it was the most difficult and the second part of the activity required the students to be self-directed.
Figure 10. Students were able to observe the facilitator writing on the Smartboard and could hear her voice during a PowerPoint presentation using Camtasia.

1.56 Summary

Key design features of the forensic entomology course are orientation and support, visual appeal, collaborative learning experiences, opportunity for enquiry, interactivity and problem-based learning. Orientation and support was addressed at the beginning of the course with a welcome letter from the teacher and an audio recording of her voice. A subject guide outlining contact details and assessment requirements was also provided at the commencement of the course. Throughout the course, visual appeal was addressed with pictures, emoticons and use of coloured text. Collaborative activities such as discussion forums were included. A Webquest provided an opportunity for student enquiry and there were activities for the students to complete online such as crosswords, sequencing activities and a diagram of an insect to label. In a problem-based activity, the students worked in pairs to calculate the time since death.
1.6 Course Evaluation

A six question online student survey, using Survey Monkey, was included at the end of the forensic entomology course (Figure 11). In addition, the results of the course evaluation for Biology 1, informal student feedback and the number of ‘hits’ were taken into account for continuous improvement purposes.

Only six questions were included in the online survey to increase the chances of the students completing it. The forensic entomology course is a subset of the Biology 1 course and students are also requested to complete a unit evaluation at the end of semester. The researcher was trying to avoid the students experiencing ‘survey burnout’. Question one was included to find out which online activities were being used and which activities required further development/improvement. Question two and Question three (part 3) were included to give the researcher an indication as to the student’s preferred delivery method. Question three (parts one and two) pertained to the teacher and were included so the teacher was able to see where her teaching could improve. Question three (part four) focused on the value students placed on interacting with others. As this is the foundation upon which social constructivism is based, was considered important to ascertain whether the students actually value peer interaction. Question four referred to the content and organisation of delivery. This question was included so the teacher could see if there was any way the order or organisation of the instruction could be improved. Question five pertained to the instructions posted online and to see whether or not they were clear enough for the students to know what to do and/or to complete the assessments. Finally, question six was included in case the students had further suggestions on how to improve the online entomology course.
## Forensic entomology survey

Please complete the following survey. The results will be anonymous. We value your comments and they will be used for the continuous improvement of the course.

1. What were your favourite types of activities?

   a) Crosswords  b) Picture and text matching  c) Games  d) PowerPoints  e) Problem solving scenarios  f) Discussions  g) Other (please specify)

2. Did you enjoy learning through elearn?  

   Yes/No

3. Which of the following factors do you think impact on your engagement in this course

   - encouragement from the teacher  
     - No value (1)  
     - Very high value (10)
   - prompt feedback from the teacher  
     - No value (1)  
     - Very high value (10)
   - type of delivery method (face-to-face or online)  
     - No value (1)  
     - Very high value (10)
   - interaction with your fellow students  
     - No value (1)  
     - Very high value (10)

4. Please rate the following comments

   - Most of the content seemed relevant  
     - No value (1)  
     - Very high value (4)
   - The delivery was well organised  
     - No value (1)  
     - Very high value (4)
   - The unit allowed me to use my own initiative  
     - No value (1)  
     - Very high value (4)
   - The facilitator was helpful  
     - No value (1)  
     - Very high value (4)

5. Was there sufficient information and clear instructions posted online in order to complete the assessment items?

   Yes  No  Other (please specify)

6. Please describe what would you recommend to improve the course.

---

*Figure 11. Forensic entomology course evaluation (Survey Monkey)*
According to Rodriguez, Ooms and Montanez (2008), the success of an online course should be viewed from both the teacher and student experiences. In this study, I was the teacher and my experiences were recorded in a journal over a three year period. Bernard et al. (2004) investigated the quality of online versus face-to-face delivery and focused on student achievement, attitudes and retention. Small significant differences favoured distance online delivery. In this online survey, the emphasis was on student attitudes. Student achievement was tested by comparing the pre-test and post-test and also through summative assessments such as the assignment and exam. Retention could have been included by asking a question such as that first proposed by Richmond, Gorhan and McCroskey (1987) who asked the students how much they learnt on a scale of zero to nine. A score of zero meaning the students learnt nothing and nine meaning the students had learnt more than any other course. I believe such a question is more about student perception and there are too many other factors that come into play, for example, teacher popularity, how much they enjoyed the experience, personalities of fellow students rather than what the students actually retained. For this reason, I believe it would be better to actually test the student’s knowledge twelve months after completing the course.

1.61 Summary

Course evaluation was considered from both the teacher and student point of view. I recorded my teaching experiences in a journal for three years. The course was presented to other teaching staff for their comments. Feedback from the students was provided through online surveys, test results, the number of ‘hits’ and informal student comments. The student evaluations were used to make improvements to the course. In addition, I found some useful, innovative ideas for future improvements as a result of this literature review.

1.7 Innovative ideas for the future

Time and financial constraints often impede the inclusion of innovative learning tools into online courses. However, I identified two key learning activities that could be used in the forensic course in the future: 1) the use of a cognitive tool such as an online dichotomous key, 2) the use of a pre-existing second life program in forensic science education.
1.71 Cognitive tools

Songer (2007) makes a distinction between digital resources and cognitive tools. A digital resource is any computer-available information source containing facts, perspectives or information on a topic of interest (Songer, 2007, p.474). In contrast a cognitive tool is designed to be used in particular ways to achieve certain learning goals. According to Rovai (2004) cognitive tools allow learners to build on what they think and engage in meaningful learning. Digital resources and cognitive tools can be compared in three major areas: audience/ knowledge, learning activities and learning performances (Songer, 2007). Whilst digital resources are designed for a general audience, cognitive tools are designed for a particular audience and focused on a particular knowledge goal. Secondly, digital resources do not specify how the resource is to be used in learning. In contrast, cognitive tools are designed to be used in particular ways. The third area of comparison is that of learning performances. Digital resources do not specify the types of products that learners produce as a result of using the resource. In contrast, the products resulting from the use of cognitive tools can be evaluated and compared to the initial learning goals. According to Songer (2007), it might be advantageous to redesign digital resources into a cognitive tool following steps in the Cognitive Tools Framework. This framework takes into account the learning goals and target audience as well as the learning activities and learning outcomes produced as a result of using the resource.

There are opportunities in forensic science to develop or use pre-existing cognitive tools. For example, in entomology, rather than using a paper-based dichotomous key or one of the numerous dichotomous keys available on the web, the LucID program is an interactive computer-based training tool which can be designed to allow the construction of a dichotomous key for identification (Voss, 2008).

1.72 Second Life

Crime Scene workers need sound problem solving skills and the ability to think “on their feet” (Kelty & Julian, 2010). According to Spring-Keller (2010), the inclusion of games in an education program can encourage a student to take risks in a safe environment. Second Life is an open ended game with hardly any rules or roles. Some games, for example Physicus, are specifically developed for learning certain subjects such as biology or physics. Second Life can provide a virtual learning space for
repetitive experiments and investigations which are either not possible or can only be carried out once due to costs and limited space. For example, the Canberra Institute of Technology has a crime scene house that is used to set up crime scene scenarios so the students can learn the skills required of crime scene examiners. The crime scene house is located inside the forensic building and is a furnished house without a roof so the teacher has a ‘bird’s eye view’ from a platform and can watch the students collect evidence, take photographs, record evidence, package samples etc. The crime scene house is very much in demand and used by different teachers in courses ranging from Diploma level to Bachelor level as well as short commercial courses. Such demand means students cannot maximise the use of such a valuable facility and may miss out on valuable practical experience. By using a Second Life space such as the one created by the University of East London (UEL) would lessen the demand for the crime scene house. [http://www.trainingzone.co.uk/topic/learning-technologies/learning-doing-using-immersive-environments/163698](http://www.trainingzone.co.uk/topic/learning-technologies/learning-doing-using-immersive-environments/163698)

The UEL virtual second life space/ house has two sections: a wet laboratory and a crime scene investigation space.

1) The wet laboratory is on the ground floor and is set up for polymerase chain reactions (PCR) for analysing DNA. Before the student’s avatar can enter the laboratory they must be conform to Occupational Health and Safety (OHS) standards and ensure they wear the correct personal protective equipment (PPE). All written procedures must be followed but students are permitted to work in a collaborative manner with other ‘workers’ in the same room.

2) The Crime Scene Investigation (CSI). The second floor of the building is a crime scene house which can be set up for various scenarios (much like the one used at CIT). The students can learn about the role of crime scene examiner by processing various scenarios. In this simulation, the students take notes, collect evidence and photographs. There is an opportunity for a debrief with the scene of crime manager at a later stage.

A virtual crime scene using was also used by Lehman and Jeffers (2012) in a study involving 217 medical students. Lehman and Jeffers (2012) designed a collaborative assignment; consistent with constructivist pedagogy for a unit in Introduction to Forensic Science. Students were required to visit two virtual crime scenes and in pairs
collect and document the evidence. For the interactive assessment students were asked multi-choice questions but they were allowed to discuss the evidence with their partner. Finally, the students were given the DNA results of blood-stained material and each pair submitted a written report including photographs, description of the scene and analysis of the DNA. The majority of student respondents (64%; N=14) either agreed or strongly agreed that the assignment in second life contributed to their understanding of the material in the course. However, some of the comments to the open-ended questions indicated that they did not find the assignment useful. A limitation of this study was that the survey instrument wasn’t described in detail and although 217 students used the collaborative assignment, there were only fourteen respondents. It wasn’t clear how many students were offered the questionnaire. As alluded to in Chapter 2, virtual workplaces are more about testing students thought process rather than testing their skill level. Although this type of learning could never replace real practical experience, the inclusion of a Second Life grid such as the one developed by UEL and Lehman and Jeffers (2012) could provide a useful adjunct for the crime scene training that already occurs at CIT.

1.73 Summary

Two ideas for future learning activities have been identified: an interactive computer based key for insect identification and a Second Life program similar to the one developed UEL and Lehman and Jeffers (2012) that uses a virtual crime scene house. The inclusion of such tools is dependent on funding.

1.8 Further questions arising from the literature

I have identified further questions related to the literature on designing online courses based on social constructivism.

1) Do forensic science students value peer interaction related to online content e.g., discussion forums, if such activities are not part of the summative assessment? In other words, do students perceive that they have learnt something as a result of such an experience?

2) How frequently do the students use the interactive learning tools such as crosswords, sequencing activities?
3) How do the students perceive the contextual activities such as determining the
time since death?

These questions could be addressed by analysing the number of hits, reading the
discussion threads in the discussion forums, reviewing the online forensic entomology
survey and end of course Biology 1 survey. Answers to these questions will provide
improvements to the forensic entomology course and further insights into the
conclusion section of the study.

1.9 Conclusion

The design and development of the online forensic entomology course that was used
in the teaching study in Part B of this study was discussed in this Chapter. The overall
course design was based on the Learner-Goals-Driven Design Model (Krajnik, McNeill &
Resier, 2007) because it was based on the principles of constructive alignment and
included problem solving activities suitable for forensic science students. The type of
online design was the Communities of Practice model and the facilitation model was
based on Salmon’s 5 step model, as both these are in keeping with the principles of
social constructivism. As outlined in Chapter 2, social constructivism is considered to
be the most suitable educational theory upon which to base forensic science
education. Three key constructivist writers (Ayoade, 2012; Cafferella, 2002; Rovai,
2004) have provided useful guidelines for online teacher / designers. The key design
features in the forensic entomology course were orientation and support, visual
appeal, collaborative learning activities, opportunities for enquiry, interactivity and
problem-based learning. A six item online evaluation survey, the number of hits, unit
evaluations and relevant summative assessment items were used to evaluate the
online forensic entomology course. Finally, innovative ideas for the future such as
virtual learning spaces e.g., crime scene house were discussed.
APPENDIX K

Pre-Test for Post Mortem Interval (PMI)

201010

1. Provide a definition for the following terms:
   - Post Mortem Interval (PMI)
   - Entomology
   - Carrion
   - Insect Succession
   - Cadaver
   - Rigor mortis

2. List and provide a brief explanation for 3 different methods for determining the time since death.

3. List 3 factors that influence the determination of the time since death.

4. List 5 stages of decomposition of a cadaver and provide a brief description of each.
APPENDIX L

PMI SKILL TEST

Your task is to use the information below together with the raw weather data to determine the post mortem interval (PMI). Once you have calculated the PMI complete the statement below and submit it to me for marking.

Statement

Dr

Address

Date

Attention: Dr

RE: ESTIMATE OF TIME OF DEATH

Post Mortem Case Number

The samples were collected at Monkey Mia, WA on the am/pm 29th April 2010, from the body and around the body of ................., consisted of a mixture of 1st, 2nd and 3rd instar fly larvae and some fly pupae.

A sub-sample of these larvae and pupae were placed in 70% alcohol solution and the rest reared to adult flies (Table 1).

Table 1.

<table>
<thead>
<tr>
<th>Comment</th>
<th>Number of Calliphora dubia</th>
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<tbody>
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Calliphora dubia (the blue bodied blowfly) is endemic to western and southern Australia. This fly species is classified as a primary species, being the first species of insects in a succession to laviposit live larvae on carcasses or wounds.

Determination of the post-mortem interval is generally based on the oldest specimen. In this case it was ................... larvae, which on microscopic examination were confirmed as ............................ ssp.

Subsequent adult emergence from rearing larval samples collected from the body confirmed that they were.................................
The closest weather station to the scene of crime at is the local airport. A temperature data logger (mini weather station) was positioned where the body was found and temperatures were recorded hourly from 29th April 2010 to 7th May 2010. The maximum and minimum temperatures from both sites are presented in Table 2.

The temperatures experienced at Monkey Mia during the period the data logger was recording were on average........... °C (maximum) and .......°C (minimum) lower than those measured at the closest weather station over the same period (see Table 2). Hence, the average maximum and minimum temperatures that the body was exposed to at Monkey Mia were...........°C and .......°C (average daily temperature of ....°C). Laval development under fluctuating temperature regimes typical of those experienced at the nearest weather station indicate that the duration of each life history stage would be as follows:

<table>
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<tr>
<th>Stage</th>
<th>Duration</th>
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<tr>
<td>Time to lay on corpse</td>
<td>hours</td>
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<tr>
<td>1st instar laval stage</td>
<td>hours</td>
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<tr>
<td>2nd instar laval stage</td>
<td>hours</td>
</tr>
<tr>
<td>??? laval stage</td>
<td>hours</td>
</tr>
<tr>
<td>Total</td>
<td>days</td>
</tr>
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</table>

Given all the above information, then we would estimate the time of death of ........................ to be between........................ and ........................ 2010.
Table 2: Maximum and minimum temperatures extracted from both the nearest station at the airport and the temperature data logger placed at the scene of the crime. The adjusted maximum and minimum temperatures were calculated from the differences between the weather station and the temperature data logger.

<table>
<thead>
<tr>
<th>Date</th>
<th>Nearest Weather Station at Airport</th>
<th>Datalogger on site at Monkey Mia</th>
<th>Monkey Mia onsite temperatures</th>
<th>Daily average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max Temp</td>
<td>Min Temp</td>
<td>Max Temp</td>
<td>Min Temp</td>
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<td>Average</td>
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</table>
Instructions

If the body was found on Thursday 29 April at 1.30pm calculate the time of death using both Weather bureau temperature readings and adjusted temperature readings. Justify your answer.

Post Mortem Interval (PMI) calculations using Accumulated degree days

Accumulated degree hours (ADH) and Accumulated Degree Days (add) refers to the duration of temperatures above and below the upper and lower lethal maggot developmental thresholds, respectively.

For *Calliphoradubia* (the blue bodied blowfly) the laboratory data shows that development times are:

- Egg to 1\textsuperscript{st} instar 0 hours at 24C
- 1\textsuperscript{st} to 2\textsuperscript{nd} instar 20 hours at 24C
- 2\textsuperscript{nd} to 3\textsuperscript{rd} instar 35 hours at 24C
- 3\textsuperscript{rd} instar to prepupa 82 hours at 24 C

The body was found with maggots of *Calliphoradubia* determined to be 3\textsuperscript{rd} instar (18mm long)

3\textsuperscript{rd} instar = 82 hours

ADD in lab to reach mid 3\textsuperscript{rd} instar = 82 x 24 = 1968 hours

Example

Using Weather bureau temperature readings

Body was found Thursday 29/4/01 at 1.30pm

Av temp Wednesday midnight to Thursday 1.30pm was 18.8C = 13.5 hours x 18.8 = 253.8 hours

Wednesday midday 28/04/10 to Wednesday midnight, Av temp was 17.4C = 12 x 17.4C = 20.8 Hours

Keep calculating backwards until you reach a total of 1968 hours and that will give the time of death.
APPENDIX M

Entomology assignment

This assignment will develop your understanding of the decomposition process and the relationship between decomposition and assemblages of insects. Knowledge of this may allow an estimate of the minimum elapsed time since death.

3. **Face-to-face students.** Observe the decomposition of an animal (e.g. pig) from soon after death for at least three weeks. You are to work in groups of 2-3 students and collect samples of insect larvae, pupae and adults from the corpse at different stages of decomposition. You should also observe and record the process of decomposition of the corpse.

**Distance students.** Observe the decomposition of a large piece of fresh meat e.g. shoulder of mutton for at least two weeks. Ensure that you cover it with a wire cage if it is placed on the ground or suspend it from the branch of a tree by string (to reduce the risk of predators taking the meat). Photograph the meat and associated insects every day. You should also observe and record the process of decomposition.

All students must ensure they wear disposable latex gloves during this exercise. Always wash your hands with soap and water immediately afterwards.

4. **Record:**

- The decomposition state of the remains on each visit. Photographs will be needed to support your description.
- Date (actual and elapsed days) and time of visits
- Environmental temperature and maggot mass temperature on each visit
- *Approximate* (e.g. <5, 5-10, 10-20, 20-50, 50-100, 100s, 1000s):
- Number and location of eggs on corpse (if any)
- Number and types of flies around corpse/meat
- Number and location of small, medium and large Dipteran larvae on corpse/meat
- Number and location of beetle adults and larvae on corpse/meat
- Other insects/invertebrates found on corpse/meat
- Collect flying insects
- Collect maggots (face-to-face students only)
  
  Each group of face-to-face students must submit their insect collection to include examples of each type of specimen.
- Temperature maximum and minimum and rainfall (from local paper – state the location of the relevant meteorological station) during the period the corpse was observed (i.e. from initial placement to the last visit).

4. **Make an attempt to identify** the collected insects

- Identification of specimens to family level for beetles, genus level for flies. **NOTE:** Please do not submit your samples to an expert forensic entomologist as they rapidly get fed up with identifying material of no real forensic significance.

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5. **Each person must submit their own written report** of about 1000 - 2000 words that includes the following:

- **Introduction** – Sets the study in context.
• **Methods** - Outline of the methodology in brief.

• **Results** - A written summary of the major trends observed, relating the stage of decomposition to the types of insects found on the corpse. Table(s) and/or graph(s) that summarise the raw data. I suggest that you use a similar style to that used in the literature on forensic entomology to indicate the relative abundance of each species/group of insects over time.

• **Discussion** of the results of the study which includes a comparison of your data with that found in other published studies (see forensic biology readings) and reasons for similarities/differences.

  Include a consideration of the microhabitat, in which the corpses were located, that may affect the rate of decomposition (eg soil, shade, moisture, etc).

• **Conclusion** which is the finale to the discussion.
APPENDIX N

Plan for the Results Section 13/04/13

Use the Research Questions as ‘headings’. First use quantitative survey results for Part A and then use Part B interview responses, case study, documents, journal entries etc. as examples.

Research Quest. 1a) What are students experiences?

A 3.1 Experience with OL or blended (link with) B 2.1 and B 2.4
A 3.2 Interactive? (link with) ? Could use % use of forensic ento. Interactive OL
A 3.3 Was OL or blended +ve experience? (link with) B 2.2
A3.4 Benefits of OL (link with) B 2.6
A 3.5 Challenges of OL (link with) B 2.5
A 3.6 Recent example OL (link with) B 2.2
A 3.7 Benefits blended (link with ) B 2.3, CIT student feedback??
A 3.8 Challenges blended (link with) B2.2, CIT student feedback??
A 3.9 Example blended (link with) None for B Questionnaire but ? could use % use of interactive forensic ento.? B 2.7 Latest technology applicable to FSc

13/4/13 Research Question 1b) What are student perceptions?

A 4.1 Convenience (link with) B 3.1
A 4.2 Confidence (link with) B 3.2 Also need to split in qual levels
A 4.3 Outcomes (link with) B 3.3 Also need to split in qual levels. A 4.4 Best prepared for a career (link with) B 3.4 Also need to split in qual levels. Case study at CIT ?

Research Question 1c) How do student outcomes correlate with delivery modes for forensic science?

Case study at CIT ? Could look at results for Biol1 2012 cf blended and OL students?, - pretest/post tests? For Forensic ento Mid Semester results, prac exams, PMI results
Extra question for some Part B Preferred learning method-lecture-based, practice-based, problem-based
APPENDIX O

Data Analysis Plan 18/03/13

Student Questionnaire – National Survey

The following questions frequently refer to three different learning methods; face-to-face, blended and online learning.

*Face-to-face classes* means to meet regularly in the traditional classroom setting.

*Blended learning/delivery* is a combination of meeting in the classroom and completing coursework online.

*Online learning/delivery* means all course work is ‘fully online’ where students never meet their instructor in person as part of their regular lessons.

Section One: Personal Information

Please circle the correct answer.

**Q 1.1 Frequency. Percentage distribution**

1.42 My age group is:

- Under 18
- 18-21
- 22-35
- 36-50
- Over 50
- Prefer not to answer

**Q 1.2 Frequency. Percentage distribution**

1.43 My gender/sex is:

- Male
Female

Prefer not to answer

**Q 1.3 Frequency. Percentage distribution**

**1.44 I study:**

Part-time

Full-time

**Q 1.41st part Frequency. Percentage distribution; 2nd part Mean, median, mode**

**1.45 Are you currently employed in the forensic science industry?**

Yes

No

If you answered yes, how many years experience do you have? .................

**Q 1.5 Frequency. Percentage distribution**

**1.46 I have computer access at home**

Yes

No

**Q 1.6 Frequency. Percentage distribution**

**1.47 I have internet access at home**

Yes

No
Section Two: Information about your current course

Question 2.1 Frequency. Percentage distribution

For question 2.1 please circle the most appropriate answer

2.3. The program in which I am currently enrolled is:

kk) General Bachelors degree course

ll) Industry based course – Certificate level

mm) Industry based course – Diploma level

nn) Industry based course - Advanced diploma level

oo) Industry based course- Masters level

pp) Undergraduate Bachelor of Science with forensic science elective

qq) Bachelor of Forensic Science

rr) Bachelor of Forensic Science with Honours

ss) Post graduate Diploma Forensic Science

tt) Master of Forensic Science

uu) PhD Forensic Science

vv) Other. Please describe.................................................................

Question 2.2 Frequency. Percentage distribution

For question 2.2 please circle one or more answers as appropriate.

2.4. The course in which I am currently enrolled includes units taught through:

m) traditional face-to-face delivery

n) blended delivery
o) entirely online delivery

p) another method. Please describe.................................................................

**Question 2.3 Frequency. Percentage distribution**

2.3 Is there a computing unit included in your forensic course?

Yes

No

**Section Three: Experience with on-line learning**

Questions 3.1 – 3.8 relate to your experience with online or blended learning.

**Q 3.1 1st part Frequency. Percentage distribution; 2nd part ?Content analysis**

3.10 Have you had experience with online or blended learning?

Yes, online learning

Yes, blended learning

No, (Please go to section 4)

If so please indicate which subject.

**Q 3.2 1st part Frequency. Percentage distribution; 2nd part ?Content analysis**

3.11 Was the online component of your course interactive? i.e. you were involved in activities such as discussion forums or virtual classrooms where you could had input?

Yes

No

If so, please describe the types of activities e.g. discussions forums, virtual classrooms etc.

**Q 3.3 1st part Frequency. Percentage distribution; 2nd part Content analysis**

3.12 Overall, did you find onlinelearning or blended learning a positive experience? Please circle a response and then explain. .
Yes

No

Both Yes and No

If you have experienced online learning please answer questions 3.4 - 3.6. If you have experienced blended learning please answer questions 3.7 and 3.9. If you have experienced both please respond to both sections.

Q 3.4 Content analysis

3.13 In your experience what were the benefits of online learning?

Q 3.5 Content analysis

3.14 In your experience what were the key challenges of studying through online learning?

Q 3.6 Content analysis

3.15 Please provide a recent example of a subject/unit you took that involved online learning. In your answer provide if possible the online learning tool e.g. WebCT, Sakai.

Q 3.7 Content analysis

3.16 In your experience what were the benefits of studying though blended learning?

Q 3.8 Content analysis

3.17 In your experience what were the key challenges of studying through blended learning?

Q 3.9 Content analysis

3.18 Please provide a recent example of a subject/unit you took that involved blended learning. In your answer provide if possible the online learning tool e.g. WebCT, Sakai.
Section Four: Preferences for the different delivery methods

Question 4.1 to 4.4 comprise of a list of reasons that students have identified for choosing each delivery method.

2-Tiered questions Q 4.1 4.2 4.3 4.4 1st tier Frequency. Percentage distribution; 2nd tier Percentage distribution

For questions 4.1 to 4.4 inclusive you need to do two things:

Step 1: Read the statement for each item. Decide your preference and circle the best response (learning/delivery method) for you.

Step 2 Circle all the reasons which apply to you. If you change your mind, just put a line through the circle and circle another reason.

4.1 It is most convenient for me to study forensic science through….

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because …</th>
<th>On-line because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a …the teachers are helpful and encouraging and this keeps me focused on my studies.</td>
<td>g …I have to fit in my study around my work schedule.</td>
<td>m …I have family commitments and don’t have time to attend classes.</td>
</tr>
<tr>
<td>b …it gives me time away from my busy working life to focus on my study.</td>
<td>h …I have a busy personal life and sometimes don’t have time to attend classes.</td>
<td>n …I have a busy working life and don’t have time to attend classes.</td>
</tr>
<tr>
<td>c …the classes are delivered close to my home.</td>
<td>i …it gives me the flexibility to catch up on work that I miss in the face-to-face classes.</td>
<td>o …I live a long way from where my course is delivered.</td>
</tr>
<tr>
<td>d …I am most familiar with this method of study.</td>
<td>j …the pre-work and learning materials are delivered online.</td>
<td>p …I can work when and where I like.</td>
</tr>
<tr>
<td>e …the teacher tells me what do and I don’t have to plan as much.</td>
<td>k …I gain computer skills whilst learning subject content.</td>
<td>q …I gain computer skills whilst learning subject content.</td>
</tr>
</tbody>
</table>
4.2 I am most confident to study forensic science through...

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because …</th>
<th>Online mode because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a ...as an undergraduate student I need to acquire practical skills as well as learn the theory.</td>
<td>g ...I know I am getting the necessary practical experience and I am not getting held back by the weaker students when learning the theory.</td>
<td>m ...as a post graduate student I already have the required practical skills and I now wish to concentrate on learning the theory.</td>
</tr>
<tr>
<td>b ...I am not confident with using computer technology for learning in forensic science.</td>
<td>h ...I feel having access to both face-to-face instruction and online instruction gives me two options for working things out.</td>
<td>n ...I’m more confident to interact with the instructor online.</td>
</tr>
<tr>
<td>c ...I find personally interacting with other students gives me confidence.</td>
<td>i ...this approximates the real world.</td>
<td>o ...I’m more confident to interact with other students online.</td>
</tr>
<tr>
<td>d ...I find the face-to-face information and instruction gives me confidence.</td>
<td>j ...I can complete all my pre-work and review learning materials/class notes online.</td>
<td>p ...I am skilled with computer technology and this gives me confidence.</td>
</tr>
<tr>
<td>e ...I am most familiar with this form of study.</td>
<td>k ...it promotes both self-directed learning and teacher-led activities.</td>
<td>q ...I am an introvert and I participate more using this method.</td>
</tr>
<tr>
<td>f ...another reason – please say what.</td>
<td>l ...another reason – please say what.</td>
<td>r ...another reason – please say what.</td>
</tr>
</tbody>
</table>

Question 4.3 comprises of a list of reasons that students have described for choosing each delivery method in order to achieve the best results.

4.3 I feel I get the best results (grades) if I study forensic science through...

<table>
<thead>
<tr>
<th>Face-to-face mode because I…</th>
<th>Blended or mixed mode because I…</th>
<th>Online mode because I…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a ...am able to “bounce” ideas off other students and get faster feedback from the teacher.</td>
<td>h ...receive benefits from both learning methods i.e. the hands-on experience from face-to-face classes and the flexibility of self-paced online work.</td>
<td>o ...experience less social distractions from other students and can therefore concentrate on my study.</td>
</tr>
<tr>
<td>b ...learn best when I interact personally with other students.</td>
<td>i ...need the motivation of face-to-face classes but I also need the online information to support my learning.</td>
<td>p ...learn best when I work by myself.</td>
</tr>
<tr>
<td>Face-to-face mode because I…</td>
<td>Blended or mixed mode because I…</td>
<td>On-line because I…</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>c ...learn best when I have to turn up to class on a regular basis.</td>
<td>j ...am better prepared for assessment.</td>
<td>q ...learn best when I learn at my own pace.</td>
</tr>
<tr>
<td>d ...learn best when I personally interact with my instructor.</td>
<td>k ...learn best from the combination of face-to-face instruction with the back-up of online material for further study.</td>
<td>r ...learn best when I interact with the instructor online.</td>
</tr>
<tr>
<td>e ...learn best when I am able to participate in practical classes.</td>
<td>l ...am an introvert and I can participate more.</td>
<td>s ...learn best when I interact with other students online.</td>
</tr>
<tr>
<td>f ...am most familiar with this form of study.</td>
<td>m ...must be organised to co-ordinate both learning environments.</td>
<td>t ...learn best when I can choose the times I want to engage with the material I have to learn.</td>
</tr>
<tr>
<td>g ...another reason – please say what.</td>
<td>n ... another reason – please say what.</td>
<td>u ... another reason – please say what.</td>
</tr>
</tbody>
</table>

4.4 I feel that I would be best prepared for my career if I study forensic science through...

<table>
<thead>
<tr>
<th>Face-to-face mode because…</th>
<th>Blended or mixed mode because …</th>
<th>Online because…</th>
</tr>
</thead>
<tbody>
<tr>
<td>a ...a forensic scientist needs excellent communication and team work skills as well as technical knowledge and skills.</td>
<td>g ...I need hands-on practical experience as well as the required knowledge to become a forensic scientist.</td>
<td>m ...one has to be self-motivated to ensure the work is completed and this is an excellent attribute for my future working life.</td>
</tr>
<tr>
<td>b ...the instructors are good forensic science role models.</td>
<td>h ...forensic scientists need to be able to work in both face-to-face and online environments in their jobs.</td>
<td>n ...forensic scientists need to be able to work independently as well as in a team situation.</td>
</tr>
<tr>
<td>c ...this is the best way to participate in the practical aspects of the courses in forensic science.</td>
<td>i ...I need the practice at using computer technology in my chosen career but I also like to be able to participate in practical classes.</td>
<td>o ...I need the practice at using computer technology in my working life.</td>
</tr>
<tr>
<td>d ...there is more opportunity to work with people in person.</td>
<td>j ...it develops time management skills.</td>
<td>p ...it develops/ enhances time management skills.</td>
</tr>
<tr>
<td>e ...there are opportunities for excursions related to forensic science.</td>
<td>k ...it promotes problem solving skills.</td>
<td>q ...it promotes problem solving skills.</td>
</tr>
</tbody>
</table>
Section Five: Future directions

Q 5.1 Content analysis

5.2 Please provide any other comments on forensic science education delivery methods.

Thank you for your participation
INFORMATION SHEET

TITLE OF PROJECT: A comparison of delivery methods in tertiary forensic science education

CHIEF INVESTIGATOR: Professor Grady Venville

PHD CANDIDATE: Barbara Larkin

What the research project is all about

This project will investigate different teaching methods in tertiary forensic science education in Australia. The study has come about as a consequence of the recommendations from the National Institute of Forensic Science (NIFS) Education and Training for the Future Report 2005. Only limited research has been conducted in forensic science education in Australia. This study will compare different delivery methods, including traditional face-to-face, blended and online delivery from the student, teacher and industry personnel perspective. The study will be of benefit to forensic science educators as it will improve teaching and learning in the long term and findings will be applicable to worldwide forensic education.

What it will involve

This project consists of two parts: Part A and Part B. Part A is a national survey of Australian educational institutions delivering forensic science in addition to various Australian forensic science industries. Part B is a local case study conducted at the Canberra Institute of Technology (CIT). This project will gather information about your experiences and preferences for the different delivery methods.

PART A NATIONAL SURVEY

This will gather information from the student and teacher perspective. It will involve 2 parts; preliminary interviews and a national questionnaire.

1) Interviews Six staff and six students from UWA and University of Canberra (UC) will be involved, in addition to six industry personnel from the Australian Capital Territory. These two
institutions are suitable because UWA offers post graduate courses in forensic science and UC offers a Bachelor of Forensic Science in addition to post graduate level. Specifically, it will involve face-to-face or telephone interviews of 20 minutes duration with you at a time and place that is acceptable to you. For ease of gathering and analysing the information provided, these interviews may be audio recorded with your permission. If you do not wish for the interview to be audio recorded, your answers will be recorded using a written recording sheet. You will be sent a copy of the questions and your responses for your verification before any of your data is used for analysis.

2) Questionnaire The participants in the survey will be forensic science students and teaching staff from 20 Australian tertiary institutions and industry personnel from each State/Territory. Teachers will be contacted by telephone a few weeks prior to the survey to ascertain whether or not they are willing and able to participate. It is anticipated that a sample of two staff members per institution will complete the survey (n=40). The student sample size will be approximately 560 students (i.e. 20 students in two classes in two institutions in seven states/territories). It is anticipated that about six industry personnel from each State / Territory will complete a questionnaire (n=40). The 30 item questionnaire will be trialled and administered to students and staff at UC before the national survey commences. The questionnaire will be issued by hard copy or electronic copy depending on the preference of the recipient. The author will have made prior telephone contact with the lecturers. Lecturers will be asked to distribute the questionnaire to the class and then post copies of the questionnaires to the author. Completion of the questionnaire is considered evidence of consent to participate in the study.

PART B CASE STUDY This will gather information from the student and teacher and industry personnel perspective and involves a number of different methods of data collection including the following:

1) Interviews Participants include forensic degree teaching staff (n=6), first, second and third year forensic degree students (n=6) and related industry personnel (n=6). It will involve face-to-face interviews of about 45 minutes duration to be held at CIT or the relevant workplace at a time suitable to you. With prior consent, the interviews will be recorded using an audio-recording device. You will have a choice whether or not you wish to have your responses recorded. For those people who feel uncomfortable being recorded, the author will handwrite the responses using a recording sheet. The researcher will send a copy of the questions and responses to you for your verification.

2) Comparative teaching study First year forensic biology students from the CIT will be recruited as these students will be taught by the researcher. They will be fully informed about the research, in particular, the voluntary nature of the research and that there will be no consequences should they choose not to participate will be emphasized. This study involves two different forensic biology classes. There will be ~ 30 students per year in the case study. All the students will be taught through blended delivery mode the first year and the following year another class of students will be taught through on-line delivery mode. One skill and one concept will be tested. A pre test will be given prior to the eight weeks of delivery and a post test will be given to each student to determine how the student outcomes compare with different delivery modes. Confidentiality and anonymity will be preserved as personal names will not be used in the thesis or any publications that arise from the research.

How your interests will be protected

Informed consent is required for your participation in this project. Your contributions to this project will remain anonymous and confidential. All the information will be in the safe keeping of the researcher. No identifiable information will be left in the educational institute/ workplace once it has been gathered from you. Also no information will be made available to your employer or anyone else.

You are free at any time to withdraw consent to further participation without prejudice in any way. You need give no reason nor justification for such a decision. In such cases, your record will be destroyed, unless otherwise agreed by you. You have the right to contact the Chief Investigator or researcher about any aspect of your involvement. However, given the efforts taken by the researcher to maintain your
anonymity and treat any information in confidence, it is not anticipated that you will be discomforted or put at risk by the research project.

**Compensation Clause:**

Your participation in this study does not prejudice any right to compensation, which you may have under statute or common law.

The researcher gratefully acknowledges the support you have provided for this research initiative.

Thank you

Barbara Larkin For Chief Investigators 02 620 74367 barbara.larkin@cit.act.edu.au
CONSENT FORM

Research Project - A comparison of delivery modes in tertiary forensic science education

Chief investigator - Professor Grady Venville

PhD Candidate- Barbara Larkin

Important Information

The participant is free at any time to withdraw consent to further participation without prejudice in any way. The participant need give no reason nor justification for such a decision. In such cases, the record of that participant is to be destroyed, unless otherwise agreed by the participant.

To satisfy the requirement of its ethics process it is necessary that you give consent to the following statement

Agreement

I ________________________________ have read the information provided and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising that I may withdraw at any time without reason and without prejudice.
I understand all the information provided is treated as strictly confidential and will not be released by the investigator. The only exception to this principle of confidentiality is if documents are required by law. I have been advised as to what data is being collected, what the purpose is, and what will be done with the data upon completion of the research.

I agree that research data gathered for the study may be published provided my name or other identifying information is not used.

________________________________________________________________________
Participant                                                         Date

If the participant is under 18, the parent/ legal guardian must also sign below

________________________________________________________________________
Parent/ Legal Guardian                               Date

________________________________________________________________________
Investigator                                              Date
Translating theory into practice: Curriculum and teaching staff

1.0 Introduction

The Australian Qualifications Framework is a national system that links the learning that occurs in schools, vocational colleges and universities. The authorities responsible for outlining the standards involved for university level qualifications and vocational colleges are the Tertiary Education Quality Standards Agency (TESQA) and Australian Skills Quality Authority (ASQA) respectively. These standards include curriculum, delivery and assessment. I acknowledge that the strategies identified in this section fall under these guidelines and that the classroom teacher has little influence over such standards. The themes of curriculum and teaching staff are presented with respect to both the advanced diploma and undergraduate levels and are based on the evidence provided by this doctoral research.

2.0 Curriculum

It is important to ensure that the quality of forensic science programs meet the needs of the future employers. A holistic course experience that provides opportunities to integrate theory and practice is recommended. In addition, the inclusion of transferable skills e.g., communication and team work, are considered to be an important element of employability.

2.1 Best Practice

1. The curriculum is designed according to quality education standards.

2. The curriculum at undergraduate level is validated by forensic science industry e.g., Australian and New Zealand Forensic Science Society (ANZFSS), the professional body representing forensic scientists in this country.

3. The curriculum is reviewed periodically to ensure currency and relevancy of knowledge and skills are maintained.
4. Graduates at bachelor level will have specialised knowledge in addition to a broad knowledge of other science disciplines and be able to apply that knowledge in a contextual setting.

5. In addition to technical knowledge, bachelor programs will include:
   - interpersonal content and skills e.g., communication skills, team work skills.
   - a practical component.
   - cognitive content and skills e.g., critical thinking and problem solving skills.
   - research opportunities.

3.0 Teaching Staff

Effective teaching is fundamental to forensic science education. Teachers should be able to develop the students’ understanding of the content and demonstrate competency in the practical component with a focus on delivering the material in the context of the working environment.

3.1 Best Practice

1. Teachers are qualified and competent both as teachers and forensic practitioners.

2. Teachers have forensic science industry experience. At a minimum, forensic science teachers require forensic science experience at a postgraduate research level.

3. Teachers avail themselves of ‘return-to-industry’ opportunities to maintain currency of skills.

4. Teachers are trained in online facilitation and ensure they make use of professional development opportunities to keep up-to-date with technology.

   Professional development should focus on new technologies the teachers have not already used (Alammary, Sheard and Carbone, 2014).

5. Teachers provide written documentation of their contact details and their availability to their students via a face-to-face situation and/or technology.
6. A range of feedback mechanisms are employed by the teachers and teachers ensure that teacher/student feedback is provided in a timely manner.
TRANSLATING THEORY INTO PRACTICE: COURSE DESIGN, ASSESSMENT AND DELIVERY

This chapter outlines a model of best practice based on the strengths of the study and the original contribution that these findings make to the existing knowledge on forensic science education.

1.0 Best Practice Model

The best practice model presented here applies to diploma/advanced diploma and undergraduate level. In this study, no distinction was made between the different types of postgraduate study e.g., research-based, course work etc. It is, therefore, beyond the scope of this study to make generalisations regarding delivery at this academic level. I accept that there is more than one way to achieve positive outcomes but the ‘best practice’ strategies proposed here are based on the evidence provided by this doctoral research.

The approach taken when designing this model was to identify five key themes that relate to the challenges raised by the participating stakeholders. These themes include curriculum, teaching staff, course design, contextual delivery and assessment. The main focus of this study is at the classroom level therefore the following sections include the proposed best practice model relating to course design, assessment and delivery. The themes of curriculum and teaching staff requirements are presented in Appendix R. For the themes of contextual delivery and assessment, some examples are presented.

1.1 Course Design

Forensic courses must be designed to enable graduates to achieve/demonstrate the educational objectives/learning outcomes. Individual subjects can vary in content but the principles outlined below provide some guidelines to course designers to achieve
the quality standards required for appropriate curriculum coverage and student engagement.

1.11 Best Practice

The following list of recommendations pertaining to course design is based on the findings of this study.

1. The blended course is built from scratch for the best chance to rethink and redesign the entire course with the learners’ needs in mind (Alammary, Sheard & Carbone, 2014, p. 447).

2. The course is based on the pedagogy of social constructivism.

3. For diploma/advanced diploma level, the knowledge and skills blended model (Fee, 2009) is recommended. An example is provided in subsection 1.32. Diploma students, working in the police force, are restricted with respect to the timing of the face-to-face classes. Factors such as the geographic location, the reactive nature of their work and safety issues relating to the release of large numbers of police at one time for residential classes need to be taken into account when choosing a suitable blend. The knowledge and skills model (Fee, 2009), provides these students with the flexibility to complete the online theory component first and then plan ahead for the face-to-face residential workshops. A choice of different sessions for the ‘residential’ workshops is recommend so students can plan their work schedules around the face-to-face component.

4. For undergraduate forensic degrees, the flipped blended model is recommended. An example is provided in subsection 1.33. There is now an emphasis on challenge-based active learning (Johnson, Adams & Cummins, 2012). In addition Johnson et al. (2014), outlined how flipped classes help to students to acquire employability skills such as critical thinking, digital and collaborative skills. Participating stakeholders in Part A of this study emphasised the importance of practical skills. By using a flipped approach, it frees up the teacher to deliver more work-related practical sessions and provide immediate feedback. The interviewees in Part B of this study indicated
that they wanted all three learning styles incorporated into their course e.g., lecture-based, practice-based and problem-based. All three learning styles can be incorporated into the flipped blended model.

5. For both the undergraduate and diploma/advanced diploma level, feedback opportunities are built into the course.

6. Written documentation outlining the teacher’s contact details and availability is provided at the commencement of the course.

7. Formative and summative assessments are used for both undergraduate and diploma/advanced diploma level to continuously monitor student progress. This is expanded upon in Sections 1.32 and 1.33.

8. Teachers are trained in online course design and work closely with the Information Technology (IT) department and course designers.

9. Courses are reviewed
   • by the IT department or trained course designers once the course has been developed.
   • periodically within the department to ensure they meet ‘best practice’ standards.

10. Use is made of both synchronous and asynchronous activities.

11. Online resources meet the following standards:
   • Fast access to learning resources. Although much of the literature points to chunking information, diploma students need to be able to quickly locate learning resources. Posting a learning guide, online text or a set of power points in one location online is easier for the student to locate than placing notes under different headings.
   • Quality resources. Learning resources should be of high quality both aesthetically and content-wise. Online material should be easy to read (high resolution), relevant and succinct.
• Consistency of terminology. Terms used throughout the course need to be consistent. For example, if the term *atomic structure* is used the subject guide, avoid using a closely related term *molecular structure* in the learning guide.

• Communication between teachers of the same course. In some subjects, several teachers may be teaching different components. It is easier for the students if all teachers use the same approach.

12. Tasks should include interactive activities where possible.

1.2 Assessment

Assessment should be viewed as a means not only to monitor progress but a way in which students learn. This applies to both diploma/advanced diploma and undergraduate level. Authentic work-related assessment tasks such as mock courts, crime scene scenarios and laboratory simulations provide the learner with opportunities to apply their knowledge. Different assessment methods are used to continuously monitor student progress.

1.21 Best Practice

The following list of recommendations pertaining to assessment is based on the findings of this study.

1. Both summative and formative feedback is included in the course.

2. Regular constructive feedback is provided for formative assessment to allow the student to build on their current knowledge. This needs to be provided in sufficient time to allow the students to close the *knowledge gap* in time for summative assessment to foster learning.

3. A variety of feedback practices are employed including teacher to student, peer (student to student), automatic responses to online quizzes and summary feedback.

4. Teacher feedback is considered to be most helpful in a contextual setting when it is provided in a timely manner and in close proximity to the learner (Evans et al., 2012, p.22).
5. ‘Milestone-based’ assessment (Friedman, 2013; Ladhani, 2014) is used to provide opportunities for students to practice their skills in a workplace or simulated workplace setting and receive feedback on where they are situated in their training.

6. Annual moderation/benchmarking occurs between institutions that deliver subjects within the same discipline to ensure teachers are marking to the same standard. This also prevents tunnel vision and provides opportunities for networking. Teachers can gain an insight into the other institutions and develop fresh ideas.

7. Flexibility for deadlines is provided particularly for advanced diploma/diploma students working in the police force.

8. Student reflective practice is encouraged.

1.22 Examples of Diploma/Advanced Diploma Competent/Not Competent

The Vocational Education and Training (VET) system assesses students using the competency/non competency approach according to learning outcomes. Currently the Canberra Institute of Technology (CIT) offers the Advanced Diploma of Public Safety. One of the units within this program is called Apply Core Science within a Forensic Investigation/Environment which is delivered in a blended format. The underpinning theory is available online and towards end of the year, students are required to attend a week long residential workshop. Students are given the opportunity to complete a variety of formative assessment tasks such as online quizzes, discussion forums. Feedback is provided in a number of ways including automated responses, detailed written feedback to individual students, summary feedback and peer feedback.

Summative assessment includes four open book online tests and work-based simulations. Questions in the online tests are randomised. Students are encouraged to use whatever resources are available to answer the questions in the online tests. This reflects what happens in the real world. Feedback to the test items includes both automated and written responses. Student performance on contextual, work-based tasks is observed throughout the week of the residential workshop and students are given immediate verbal feedback on their performance.
1.23 Examples of Bachelor level Graded Assessment

a) Summative assessment

Mock courts are used to prepare students for their role as expert witnesses. Preferably, the simulation takes place in front of qualified legal counsel. Where legal counsel is unavailable, teachers with court experience may play the role of the lawyers and magistrate. Fellow students form the jury. The assessment involves three phases; a written court report, a mock court appearance where the student ‘expert witness’ presents their case and defends their findings and a post report. Immediately following their court appearance, students receive feedback from legal counsel and/or their teachers. Students write a post report that identifies how their presentation could be improved.

b) Formative assessment

The example of formative assessment used here was designed by Charmaine McGowan, a final year student at the Canberra Institute of Technology (CIT) in 2011, in consultation with two forensic science teachers and a forensic industry employee, all of whom had crime scene experience. This practical assessment formed part of Charmaine’s third year research project in the Bachelor of Forensic Science. In this example, we will focus on one of the four crime scene scenarios that were designed and tested (McGowan, 2011). The aim of the project was to facilitate student learning by developing ‘soft skills’ e.g., communicating with influence, problem solving and responding positively to challenging situations (McGowan, 2011, p.20); skills found to be in common with ‘good crime scene officers’ (Kelty & Julian, 2010; 2011). Transferable skills such problem solving, teamwork and communication were also found to be a critical element of employability (Ferris & Summers, 2013). When first year student participants in McGowan’s (2011) study were asked if they would like more assessments in this format, they all agreed that it would challenge their skills and build their confidence (N=9). Educator respondents suggested replacing the numbers on the rubrics with pass, fail (required development) and exceptional. They also
pointed to the subjective nature of allocating an exceptional grade emphasising that it was dependent to a large extent on the experience and knowledge of the facilitator.

In my opinion, McGowan’s (2011) assessment rubric (Table 2) is an example of a ‘milestone-based’ evaluation; a recent development in medical education and several other applied sciences. The rubric provides some discriminatory ability and opportunities to provide several forms of feedback including immediate verbal feedback and written feedback from the teacher, peer feedback and self-reflection.

**One week prior to the assessment**

A week prior to the assessment, the students are given a one hour brief to discuss the expectation of the initial scenario/investigation (Table 1) and are provided with the assessment rubric (Table 2). Each rubric assesses three behaviours; problem solving, communicating with influence i.e. assertiveness and multitasking. According to McGowan (2011), these behaviours were described in selection criteria model for the New South Wales police, Australian Federal Police and Australian Public Service websites. The behaviours are scored between 1-5. A score of 1 equates to the behaviour not being observed, a score of 3 is allocated when the behaviour is observed and a score of 5 is given when the behaviour is exceptional. A comment box is provided for additional teacher comments on the observed behaviour.
Table 1. *Description of scenario and evidence types (McGowan, 2011, p. 31).*

<table>
<thead>
<tr>
<th>Location of incident in the Crime Scene House (E030)</th>
<th>Crime scene 2: Living room</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description of scene</strong></td>
<td>Malicious damage</td>
</tr>
<tr>
<td><strong>Materials used/evidence</strong></td>
<td></td>
</tr>
<tr>
<td>Shoe print</td>
<td></td>
</tr>
<tr>
<td>Tyre impression (secondary scene)</td>
<td></td>
</tr>
<tr>
<td>Fingerprints</td>
<td></td>
</tr>
<tr>
<td>Broken glass</td>
<td></td>
</tr>
<tr>
<td>Petrol</td>
<td></td>
</tr>
<tr>
<td><strong>Situation of initial investigation</strong></td>
<td>Perpetrators try to throw a petrol bomb into a church. Get-away car was involved. The persons who live in this household are the family members of a witness that is in a witness protection program that will be giving evidence in a high profile clandestine drug investigation.</td>
</tr>
<tr>
<td><strong>Second scene</strong></td>
<td>A police officer spots an outside tyre print and it’s about to rain. Fire hazard allows them to process the other scene.</td>
</tr>
<tr>
<td><strong>Problem solving</strong></td>
<td>Fire investigators have notified that the area needs to be evacuated due to a chemical hazard in the area involving a clandestine drug laboratory. This might cause issues with getting a sample from the petrol.</td>
</tr>
<tr>
<td><strong>Multi-tasking</strong></td>
<td>A second scene needs to be processed outside due to a tyre impression found. (the fire hazard allows the CSO to process the second scene) and too many people gives the person an opportunity to process the second scene and come back to</td>
</tr>
<tr>
<td><strong>Assertiveness</strong></td>
<td>Too many people at the scene and need to manage people and tell them to go away or help out in some other way to aid the investigation.</td>
</tr>
</tbody>
</table>
Table 2. Assessment rubric describing the three assessable behaviours (McGowan, 2011, p.38).

<table>
<thead>
<tr>
<th>Participant number:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant role:</td>
<td></td>
</tr>
</tbody>
</table>

### Soft Skill: Problem solving under pressure (curve ball)

<table>
<thead>
<tr>
<th>Description of action/task</th>
<th>Criterion one</th>
<th>Criterion two</th>
<th>Criterion three</th>
<th>Criterion four</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documents issues and changes in notes</td>
<td>Uses initiative to access or create alternative equipment to process the crime scene.</td>
<td>Identifies and communicates with team the issues of the problems and solutions.</td>
<td>Demonstrates awareness of the problem/issue situation.</td>
<td></td>
</tr>
<tr>
<td>1 Does not document actions</td>
<td>1 Does not take actions</td>
<td>1 Does not engage in discussion of problems or solutions.</td>
<td>1 Does not demonstrate awareness</td>
<td></td>
</tr>
<tr>
<td>3 Documents actions</td>
<td>3 Discusses actions with team</td>
<td>3 Identifies problems and solutions with team.</td>
<td>3 Demonstrates awareness</td>
<td></td>
</tr>
<tr>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td></td>
</tr>
</tbody>
</table>

**Comments**

### Soft Skill: Communicating with influence (assertiveness)

<table>
<thead>
<tr>
<th>Description of action/task</th>
<th>Criterion one</th>
<th>Criterion two</th>
<th>Criterion three</th>
<th>Criterion four</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negotiates confidently by listening, considering and acknowledging other’s ideas.</td>
<td>Creates a credible discussion without aggravation.</td>
<td>Adjusts tone/language relevant to the audience.</td>
<td>Ability to clarify concerns to others and discuss resolutions (two way feedback).</td>
<td></td>
</tr>
<tr>
<td>1 Does not acknowledge others</td>
<td>1 Ignores the situation</td>
<td>1 Does not acknowledge language relevant to the audience.</td>
<td>1 Leaves the communication unresolved</td>
<td></td>
</tr>
<tr>
<td>3 Demonstrates negotiation skills</td>
<td>3 Demonstrates negotiation skills</td>
<td>3 Adjusts tone/language relevant to the audience.</td>
<td>3 Clarifies concerns to others and discusses resolutions</td>
<td></td>
</tr>
<tr>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td></td>
</tr>
</tbody>
</table>

**Comments**

### Soft Skill: Multitasking (round robin)

<table>
<thead>
<tr>
<th>Description of action/task</th>
<th>Criterion one</th>
<th>Criterion two</th>
<th>Criterion three</th>
<th>Criterion four</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responds positively to changing situations/tasks.</td>
<td>Responds to situations in a positive/flexible manner.</td>
<td>Takes on responsibilities and shares knowledge on expertise.</td>
<td>Monitors task progress and shares knowledge with others.</td>
<td></td>
</tr>
<tr>
<td>1 Does not take actions</td>
<td>1 Does not take actions</td>
<td>1 Does not take on any responsibilities</td>
<td>1 Does not engage with others.</td>
<td></td>
</tr>
<tr>
<td>3 Discusses actions with team</td>
<td>3 Discusses actions with team</td>
<td>3 Discusses individual skill set with team</td>
<td>3 Discusses actions for task and shares knowledge with team</td>
<td></td>
</tr>
<tr>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td>5 Exceeds expectations (uses innovative (creative ideas))</td>
<td></td>
</tr>
</tbody>
</table>

**Comments**

### During the assessment

The mock crime scene scenario (Figure 1) is set up under the supervision of the forensic science teacher. Students work in teams and have one hour to process the evidence e.g., impression, physical and ‘simulated’ biological evidence. During this time, a team of two supervisors is required; one teacher/assessor and another staff
member to introduce challenging situations or change the dynamics of the group. At different stages throughout the scenario the staff member responsible for introducing challenging situations e.g., informing student that they had to evacuate the building, will let the teacher/ assessor know immediately beforehand. In this way the assessor will be informed and ready to assess how the student deals with the new challenge.

**Post assessment**

The teacher/ assessor provides both individual and group/ team feedback and advises students on how to improve their performance.

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*Figure 1. Crime Scene Scenario (McGowan, 2011, p.109).*

**1.3 Delivery in context**

Blended delivery that is underpinned by social constructivist principles and incorporates authentic work-based tasks is recommended for higher-order learning
and student engagement. A different form of blended delivery is required for undergraduate students i.e. flipped blended (Berret, 2012; Butt, 2014; Herreid & Schiller, 2013; Johnson et al., 2014), as opposed to advanced diploma students who are working in the police force i.e. knowledge and skills (Fee, 2009). Feedback, both formal and informal is provided in a timely manner. For the practical component, feedback is given at the time.

1.31 Best Practice

The following list of recommendations pertaining to delivery is based on the findings of this study.

For both the advanced diploma and undergraduate academic levels, the face-to-face component involves:

1) work-related tasks
2) opportunities for practice and problem-solving

For both the advanced diploma and undergraduate academic levels, the online component includes:

1) details of teacher’s contact details and availability
2) assessment requirements
3) easy to find/ follow, quality resources
4) a choice of learning styles e.g., explanatory videos (visual and auditory), interactive tools (kinaesthetic)
5) online resources that are reviewed annually. Under-used resources are either improved or removed
6) motivating tools such as short 10 minute videos, instructional screencasts
7) one channel for feedback email
8) Information technology support
9) formative quizzes
10) interactive virtual tools e.g., microscopes
11) opportunities for peer discussion

1.32 Example at Advanced Diploma level

The example presented here is a ‘knowledge and skill’ form of blended delivery (Fee, 2009) where the theory component is delivered online throughout the year and the skills are delivered in a face-to-face residential workshop towards the end of the course. This example was designed by Moir Holmes at the Canberra Institute of Technology. The online component of this course includes a workbook that contains problems. The answers are presented in two different ways; written answers and a video (lesson using Camtasia) explaining the answers. The student evaluation in 2014 for the online component was overwhelmingly positive. Most of the students found the course interesting (90.63%, N=32) and liked the video presentation and workbook style (84.38%, N=32). The choice of learning styles was embraced by the students. Of the thirty two respondents, 59.38% looked at most of the explanation videos to answer the questions and 40.63% looked at the written answers and some explanation videos to answer the questions.

**Did she fall? – The physics of projectiles**

Online component

The students are given a scenario via a video lecture (Camtasia) where a car wreck is found at the bottom of the cliff. Using vector analysis, students are required to determine whether someone parked the car at the top of the cliff, left it out of gear with the handbreak off or whether the car was further back from the edge of the cliff and was driven off the cliff. They learn that where the car lands (the range) depends on the initial velocity of the car. The online component also includes automated quizzes and sample test questions and answers.

Face-to-face component

During the face-to-face residential workshop, students are given the opportunity to apply their knowledge and practice using equipment involving light, dynamics, velocity, momentum etc. In addition, they take part in problem solving activities. For example, a ‘body’, similar to the one in Figure 1, is dropped from a balcony. Working in teams, the
students set up a crime scene and take measurements to determine the cause e.g., Was she pushed? Did she fall?

1.33 Example at Undergraduate level

The ‘flipped blended’ model is recommended at undergraduate level. The following example is a compilation of lessons adapted from different sources; the first being a virtual microscopy lesson (Bird, 2010; Muehlethaler, 2014) and the second is a lesson (lesson four below) that I took part in as a master’s student at University of Western Australia in 2001. I have since used this lesson (lesson 4) in some of my classes. I once asked my student graduates what was the best thing they experienced in the course. Two students referred to this lesson and expressed their feeling of elation when they found a microscopic sponge spicule amongst the beach sand that was unique to a particular area. This series of lessons on soil analysis is an example of a ‘flipped blended’ approach that uses the strengths of online learning i.e., interactive virtual resources and during the face-to-face component, maximises the teachers time and extends the students to use their problem solving skills on forensic problems.

Soil analysis

Lesson 1 (Online): This is a theory and practice-based lesson. Students are provided with the theory of microscopes through online resources. In addition, the online component includes the use of ‘virtual microscopes’ so they become familiar with the different parts of the microscope and how to focus.

Lesson 2 (Face-to-face): This is a practice-based lesson. Students are given access to different types of microscopes; light field, dark field, polarising, comparison and are given soil samples to examine.

Lesson three (Online): This is a theory-based lesson designed to prepare them for the next lesson; an excursion. Students are provided with online resources on different soil types and associated vegetation. Resources include short 10 minute videos, instructional screencasts, interactive quizzes.
Lesson four (Face-to-face): This is a problem-based lesson. This lesson takes place both off-site and on-site. Students are first taken on an excursion to three different locations e.g., coastal, hills etc. The teacher provides students with maps of soil topography and shows them how to take soil samples before asking students to do so.

On their return to class, without being forewarned, students are required to brush down, vacuum their clothes and shoes and collect the soil. Students then examine the soil that has been collected from their clothes and compare it to reference samples collected during the excursion. Students are given a week to write a report on the providence of the evidence that was collected and defend their findings.

Lesson five (Online): Students take part in a discussion forum and compare their findings with each other. Students are provided with written feedback on their reports.

1.34 Conclusion

The proposed best practice model presented in this chapter was designed to address the challenges of online learning, either as a ‘stand-alone’ course or a component of blended delivery, identified by tertiary forensic science students, teachers and industry personnel participants in this study.
REFERENCES (Appendices for R and S)


