Chapter 11
Implementing PebblePad into Forensic Chemistry—A Whole of Program Approach

Sarah L. Cresswell and Alexander S. Forrest

Abstract Forensic chemistry at Griffith is undertaken as part of a 3- or 4-year program and students study both mainstream chemistry courses and specialised forensic science courses. We have introduced reflective learning tasks, using PebblePad, into two first-year courses and again into a final-year capstone course with a view to encouraging students to engage more actively in learning reflection. The ultimate aim is for students to accrue a range of assets/resources that can be used to generate a portfolio to showcase their skills and which could be ultimately used to address job selection criteria. This chapter will discuss the preliminary results of this implementation and will identify where and how reflective learning tasks can be best used in particular courses within the forensic chemistry program to achieve these outcomes.

Keywords PebblePad · Portfolios · Undergraduate program · Reflective writing

11.1 Introduction

Over the past decade or so, we have seen an increase in student enrollments in forensic chemistry at Griffith University, and there has been much debate about the relevance of these programs and the opportunities subsequently available to graduates from them (Horton et al., 2012; Welsh & Hannis, 2011). When prospective forensic science employers are asked about the skills they look for in a new graduate, along with their fundamental knowledge of sciences, higher cognitive skills like problem solving and critical thinking are high on their "wish list" (Fraser & Williams, 2009). It is, therefore, vital that we encourage students to engage in activities that allow development of these skills through practical work, moot courts and reflection on their learning (Overton, 2001) with the habit of reflection and questioning central to

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education (Grayling, 2003; Kirkup, 2013). However, until recently, the key missing element in our approach has been the absence of a framework to stimulate, develop and link student reflection to their learning experiences in a coherent and consistent manner throughout their degree program. In this context, we consider "reflection" to have the meaning suggested by Boud, Keogh, and Walker (1985): reflection is "a generic term for those intellectual and effective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciation" (p. 19).

Reflective practice has long been considered an important part of tertiary education but is something often implied rather than directly taught. Using ePortfolio tools such as PebblePad has been shown to be effective in providing the scaffolding required to enhance reflective thinking (Roberts, Maor, & Herrington, 2016). The authors have sought to provide students with the opportunities to develop reflections of their activities during their forensic chemistry program to enable to them to create portfolios of evidence for job applications and/or for addressing selection criteria for jobs after graduating.

Our plan was to introduce a scaffolded reflective learning environment in the forensic chemistry major, spanning all three or four undergraduate years with a consistent approach across all the courses in which it was integrated. We anticipate that this will lead to more reflective and self-analytical graduates; ones who can self-assess their results in the context of the laboratory or teaching and learning activities. These graduates will, therefore, be better equipped to think critically and develop the problem-solving skills that employers seek.

11.1.1 Forensic Chemistry Programs at Griffith University

Griffith University is a large Australian university. It is government-funded and comprises five campuses from the Brisbane City Centre to the Gold Coast. The programs described in this chapter have been running since 2004 with the first graduates completing in 2006, although reflective workbooks/portfolios were not introduced until 2017. Griffith University offers two Bachelor degree programs in Forensic Science; one a standalone program of 3 years duration and the second a double degree program combined with the Bachelor of Criminology and Criminal Justice of 4 years' duration. Both programs offer majors in forensic chemistry, forensic molecular biology or in both forensic molecular biology and forensic chemistry. The students studying the two forensic science programs are primarily domestic students from the greater Brisbane area, but members of the cohort come domestically from as far afield as Mount Isa in central Queensland and Katherine in the Northern Territory and internationally from New Zealand, Singapore and Europe. Within Queensland, Griffith University is the only university to offer full degree programs in forensic science so our cohort tends to be from a larger geographical area than students studying other science disciplines.

The authors aimed to identify ways to integrate reflective writing portfolio activities into the forensic chemistry curriculum as a means of developing students' capacity for critical thinking and reflection on learning. They utilised the PebblePad virtual learning environment and describe that process herein. Forensic science is an ideal vehicle for problem-based learning and a number of publications cover innovations in this area within chemistry (Glazer, 2015; Sommerfield, Overton, & Belt, 2003) and forensic science (Cresswell & Loughlin, 2017; O'Connor et al., 2008), but there are fewer references made to either reflective practice in forensic science or to the use of technology to facilitate such reflection despite its increasing use in other areas of science education and practice (Embo, Driessen, Valcke, & Van Der Vleuten, 2014). In the forensic chemistry curriculum, two courses were identified in which to trial the use of PebblePad for reflective practice; one course towards the beginning of the students' degree program and one at the very end. These were chosen as the results from guided-inquiry laboratories in the former course are used as the basis of the statement of evidence assessed in the latter course.

The aim of these courses is to allow students to develop towards becoming professional forensic scientists. As such, the necessity to reflect on their results within the context of a fictitious case scenario is important. The guided-inquiry laboratories (Cresswell & Loughlin, 2015) are developing independent investigation and the subsequent inclusion of reflective practice places the student as an expert professional forensic scientist. This development of professional identity is then revisited in their capstone course when they are again required to engage in the preparation and presentation of expert testimony.

11.1.2 Students' Journey Through the Forensic Science (Chemistry Major) Programs

The first-time students are introduced to the use of this reflective writing tool is in Chemistry 1A. This course is taught in the first trimester of the first year and is common across several degree program disciplines, including the forensic science programs, and in 2016, it was identified as a pilot course to introduce students to PebblePad. Initial development of the blended learning approach to reflective writing for Chemistry 1A was carried out towards the end of 2016 for implementation in trimester one, March 2017. It served as a pilot for the later implementation of reflective learning using PebblePad into core courses of the forensic chemistry programs as described in this chapter. The blended learning approach to development of courses is described in earlier chapters.

The two-specific core forensic courses, Principles of Forensic Investigation and Forensic Evidence and the Expert Witness, were suggested by the authors as second-wave courses for implementation in the forensic chemistry programs and development work occurred during the first half of 2017 for implementation in trimester two, July 2017 (Fig. 11.1).

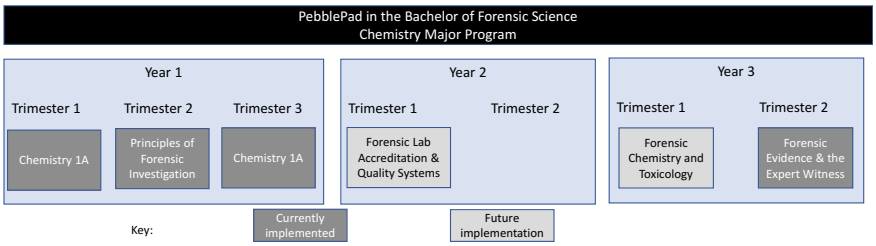


Fig. 11.1 Current and future PebblePad usage in the Bachelor of Forensic Science (Chemistry major) program

The Principles of Forensic Investigation course runs in trimester two of the first year and incorporates guided-inquiry laboratory activities (Cresswell & Loughlin, 2015) and Forensic Evidence and the Expert Witness is undertaken in trimester two of the students' final year as their capstone course. Guided inquiry uses a problem scenario placed in a real-world context and challenges students to develop problem solving and group work skills and allows them to apply their theoretical knowledge to new scenarios (Domin, 2007; Lee, 2012). This was taken one step further in Principles of Forensic Investigation by subsequently asking students to reflect on the results of their laboratory analyses and place them into the context of the fictitious case they were involved in investigating. To do this, they not only had to successfully complete the laboratory experiments but also to determine the significance of their results, which they recorded in a reflective workbook. These additional reflection steps were included to give students the opportunity to determine if their results had meaning in the context of the case or if they comprised extraneous information or were insignificant. The guided-inquiry laboratories are developing independent investigations, so reflection is a way of making students more aware of the process of investigation. The subsequent application of the findings of investigations places the student as an expert professional—another development of identity captured by reflection on the significance of their work.

In Forensic Evidence and the Expert Witness, which is the capstone course running in the final trimester of the program, the first cohort of students to be introduced to PebblePad had not previously been exposed to the tool in their first year. Nonetheless, it was possible to introduce guided inquiry by working in reverse; students were asked to observe real court practice before attending their moot courts and to reflect on how their experience might help them develop their own practice when they presented their own "expert evidence" before genuine barristers in the moot court setting.

11.2 Development of Reflective Tools

The reflective tools described herein were developed in conjunction with the Griffith Sciences Blended Leaning Support Team (Allan & Green, 2018). Initial discussions with the Blended Learning Support Team (BLST) resulted in the creation of learning

design templates (Fig. 11.2), and subsequently, the BLST and authors discussed the requirements for the workbooks in each course. The BLST used their expertise to create the workbooks in PebblePad and without their assistance, the development of the tools would have taken considerably longer and would almost certainly not have been as effective. One consequence of the implementation of reflective tasks as student assessment that should be considered, is the increase in marking time required to grade these tasks, especially in large classes such as the core Chemistry 1A first-year course with more than 450 students. To this end, the authors were also successful in obtaining additional sessional staff budget to cover the additional hours of marking which flowed from these initiatives but would have been unable to fully implement the activities described without this financial support.

As previously described, the tools developed in PebblePad were designed to give students the opportunity to reflect on what they had seen, heard and learnt during each class. Workbooks were created with "prompt" questions to guide students in what they might want to consider in their reflection and to give a framework for subsequent assessment by the academic staff. Students were also encouraged to put their learning in context with prior learning and with future career aspirations as appropriate. Ultimately, the students could use their workbooks as the basis for creating a professional portfolio about themselves; their strengths, attributes, career goals, etc., which could be used in place of, or alongside, a formal resume for future job applications. This specific activity was not undertaken as part of their forensic science degree program but has been developed in the pre-capstone course in the Bachelor of Science at Griffith University and could, in future, be integrated into the Bachelor of Forensic Science.

These academic tasks are presented below in the order in which they occur in the program and in which they will be encountered by students.

11.2.1 Chemistry 1A (Not Specific to Forensic Chemistry Programs)

In Chemistry 1A, students are introduced to the fundamental concepts of theoretical and physical chemistry, and as well as lectures they also undertake five laboratory classes each lasting 3 hours. The aim of using PebblePad workbooks in this course was to introduce students to reflective practice by asking them a series of leading questions relating to:

- what skills they have learned in the laboratory class;
- why these skills are important;
- how the skills may benefit them in future careers (whatever they might be) and;
- self-assess their confidence in undertaking the tasks again.

Due to laboratory health and safety rules, electronic devices are not allowed in the laboratory environment unless they are going to stay there, meaning students cannot bring their own devices into and out of the laboratory. Students are, therefore,

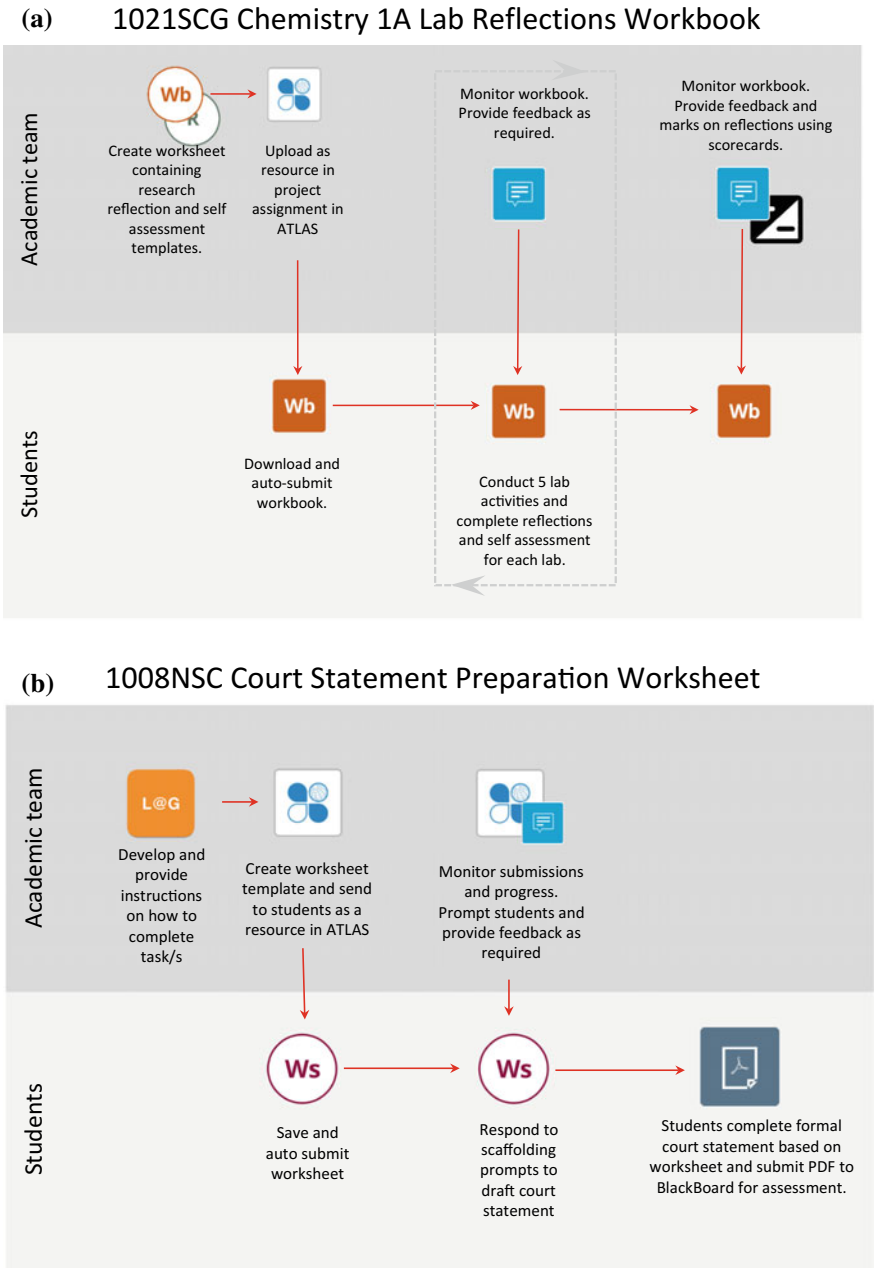


Fig. 11.2 Learning design templates; *WS* Worksheet; *WB* Workbook

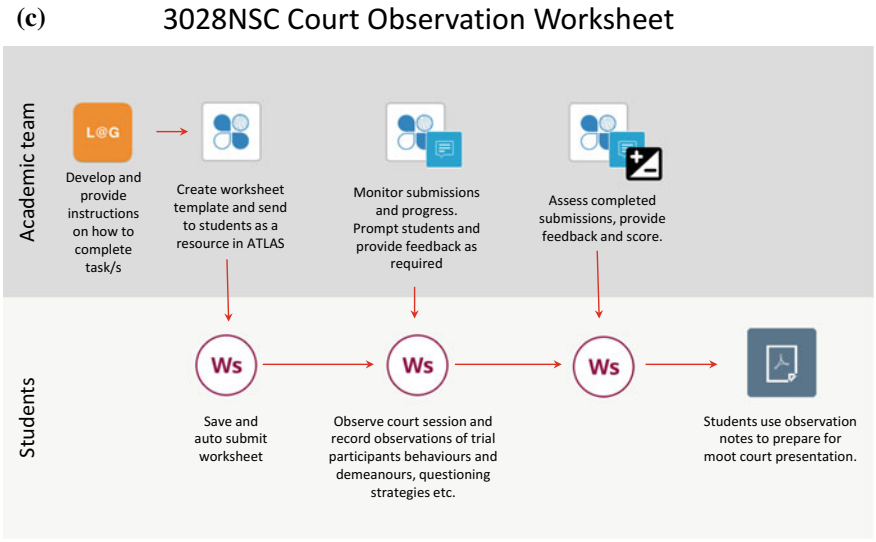


Fig. 11.2 (continued)

required to complete the PebblePad task at a later time, and in another place, which makes it less than ideal in terms of pedagogy—creating an artificial break between the laboratory exercise and the reflection upon it. Having said that, the time delay does have the positive consequence that students must genuinely remember, and therefore reflect on their laboratory activity, rather than simply narrating what they did during the class.

There are five laboratory classes each student undertakes and each had a separate reflective workbook associated with it. Over three iterations of the course some modifications to the submission procedures were required to facilitate students' successful completion:

- First iteration: separate workbooks were created for each of the five laboratory classes and students were required to assemble them into an individual portfolio for submission.
  - A minority of students failed to complete all five reflections, but a larger number completed all five workbooks and submitted them for assessment, but then failed to compile a portfolio of their work. This made assessment of the submissions more complicated than was initially envisaged for the sessional staff who undertook the assessment.
- Second iteration: students were "forced" to submit a full portfolio of workbooks for assessment, not individual reflection workbooks.

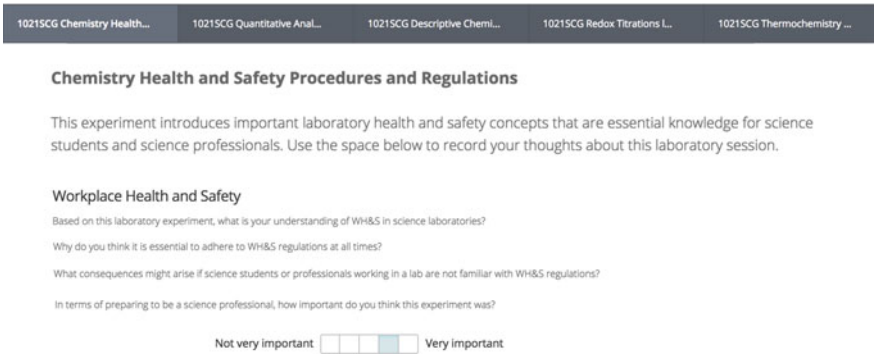


Fig. 11.3 Chemistry 1A PebblePad template

  - This had the benefit that it made it easier for the convenor to assess the students' work, but it did mean that not all students participated in the activity, possibly because they considered it too onerous.

- Third iteration: development of a combined workbook containing pages, one for each of the five experiments (running at the time of writing).
  - This increased student participation by simplifying the creation of the PebblePad submission since all five experiments were now in a single workbook, allowing students more time for reflection. The basic template for the new laboratories reflections workbook is shown in Fig. 11.3.

Students were assessed for attending and completing the laboratory classes (four marks) and they were awarded an additional mark for each PebblePad reflection they completed fully. Whilst some students (less than 10% of the initial cohort) chose not to engage with the PebblePad reflections at all in 2017, the vast majority of students completed one or more of the reflections and submitted them for assessment. A total of 393 responses were obtained for the first PebblePad reflection which represented 96% of the cohort. Over 85% of the cohort of students completed at least three reflections and 77% completed all five. The final step of collating all the PebblePad reflections into a portfolio was undertaken by 61% of the cohort but students were allocated full marks if they completed all five reflections even if they were not collated into a portfolio. The reflections were designed not to be onerous but to give students the opportunity to identify the skills they had practised in the laboratory, why each particular experiment was important in their course and to determine how confident they might be should they be asked to repeat it at a later time. This encouraged students to be self-aware and start to be able to identify their strengths and weaknesses within this laboratory environment.

11.2.2 Principles of Forensic Investigation

In Principles of Forensic Investigation, a course that sets the foundation for future forensic study in both majors in the Bachelor of Forensic Science programs, students are required to undertake forensic tests of a number of residues purportedly sampled from a fictitious crime scene. These test results remain with students throughout their studies and eventually form the basis for statements of evidence submitted for court examination in their final trimester at university in the capstone course, Forensic Evidence and the Expert Witness (see below).

The students recorded contemporaneous laboratory notes in a laboratory notebook and were then required to use PebblePad to reflect on their laboratory results to relate them to the case they were involved in investigating. This two-stage process was necessary because, as with Chemistry 1A, electronic devices cannot be taken into the laboratories. In professional forensic science laboratories, each laboratory staff member has a workstation area with a dedicated computer allowing results to be recorded electronically at the time of the analysis. In a teaching environment, this is not possible due to large class sizes, so the two-step process of result recording is necessary although as over 90% of students completed the PebblePad reflection workbook to record their results, it would appear the two-step process does not deter student participation in this task.

Students in this foundation course previously saw their laboratory sessions, which were undertaken in groups of three, as exercises to be completed for marks and little else, even although they were informed that the results would be important to them in their later studies. The question arose as to how to connect these laboratory exercises with their overall forensic studies, so they could place them into a meaningful context. PebblePad seemed a suitable tool for our blended learning approach to make this work based on its successful implementation into the preceding Chemistry 1A course.

Students undertook their group laboratory exercises and the writing task, a formal laboratory report that followed was divided up and writing was shared between the students in the group. During the course of the trimester, each student rotated through the various report sections (introduction, experimental details, results, discussion and conclusions) from experiment to experiment so that they all completed the entire suite, whilst the group submission reduced the overall marking load for the academic in charge. Once all experiments have been completed, students were required to use these as a basis for writing a single assessable court statement covering all the experiments.

The PebblePad templates were set up so that a number of questions framed each of the writing activities to help students complete their individual and collective writing tasks. They also covered the elements of the various experiments in such a way that they guided students to think about various aspects of their different tests in a holistic fashion covering the entire “crime”. This reflective practice was designed to follow-on from the activities they had undertaken in Chemistry 1A and was an attempt to foster further reflective practice principles in students. The basic template is shown in Fig. 11.4.

This worksheet will assist you to prepare your Statement for Court. Complete each section after the relevant laboratory class, tutorial or lecture so you have rich detail to include in your formal legal statement. You will receive one mark for each section you complete.

Nature of the samples

Consider the way samples collected from the crime scene have been packaged and labelled. Who has handled them and why? What has the chain of custody been? What might the impact be if an error were to occur?

Presumptive Tests

What was tested? What were the decisions to be made about testing? What tests have been conducted? Why? What were the outcomes of the tests? What records are kept about the tests? Who has access to these records? What other tests will be conducted?

Nature of the illicit drug

What is the nature of the illicit drugs found at the crime scene? How has the identity of the drug been confirmed? How will this be reported to the court?

Determination of Blood Stain

What tests were conducted? Why? What are the limitations of testing DNA? What can DNA testing reveal? What were the outcome of the tests? What will be reported to the court?

Conclusion

What conclusions can you make based on the tests you have conducted? How will you present this to the court?

Fig. 11.4 Principles of forensic investigation PebblePad template

The reflective aspects of this task were predicated on a desire to encourage students to think about the implications of each task in relation to the overall crime and to link each of them into a coherent schema for presenting their "evidence" as a legal statement. Students were given a mark (5% of total assessment in the course) for submitting their completed PebblePad as encouragement, but not all students completed the task despite the course marks allocated to it. Unfortunately, a small percentage of students (<10%) chose to forfeit the marks and end-of-course feedback suggested this was because they considered the task too onerous and/or did not see the purpose of completing it.

11.2.3 Forensic Evidence and the Expert Witness

In Forensic Evidence and the Expert Witness, students prepare statements of evidence based on forensic tests they perform in Principles of Forensic Investigation or elsewhere in their program. A substantial portion of the course is given over to examination, cross-examination and (where appropriate) re-examination of each student in a real courtroom on their "evidence" by Queensland Bar Association Barristers. The purpose is to ensure they get to undertake the role of an Expert Witness and also get to see numerous other students in the same role. Over several weeks, this provides an opportunity to see many of the different strategies used by barristers in the examination of Expert Witnesses and permits students to observe and become familiar with the interplay between prosecution and defence counsel in the course of an expert appearance.

Prior to their exposure to the court, each student was asked to visit the Supreme Court of Queensland in Brisbane and to sit in on at least one criminal trial. The purpose was to ask students to record their impressions of the questioning techniques used by barristers when examining or cross-examining witnesses and to report on the types of responses they observed. They were also asked to report on their impression of the role of the judge and any other court personnel they observed and the interplay between them during the course of the trial. They encapsulated their observations into contemporaneous notes which they used later as a basis for reflection.

Out of these observations, they were asked to reflect on what they had seen and heard and write a short reflective report on how they felt that this would illuminate their own performances in the role of Expert Witnesses later in the course.

They undertook the entire exercise using PebblePad, which provided a means for editing the notes they made in court and writing the reflective document, which they then submitted for grading. In previous iterations of this course, students were placed in the moot courtroom with only voluntary prior exposure to real, functioning courts. We soon realised that this robbed the exercise of context for students who had not attended real trials. This implementation of reflective learning created an opportunity to build court visits into the course at an early stage, and certainly before students were required to appear in the role of an expert witness themselves.

PebblePad was used here to develop a reflective experience for students, and the resulting submission attracted a 10% weighting in the course assessment. A grading scheme was provided so that students could see the criteria against which their reflective submission would be marked. Students generally reported that they had found the exercise helpful and were keen to see it retained for future years. In addition, all students submitted their reflective document, and all but three (out of 41 students) scored full marks for their work. A surprising number of students visited the courts more often than the minimum attendance specified, which indicated that they found the experience interesting and potentially useful. Some had the opportunity to observe forensic scientists known to them from prior courses giving expert evidence in real trials.

Throughout the subsequent court sessions in which students themselves appeared as witnesses, reference was made back to the actual trials they had attended and opportunities for reflection and comparison between their own experiences and those that they had observed were explicitly provided. The PebblePad template provided to the students is shown in Fig. 11.5.

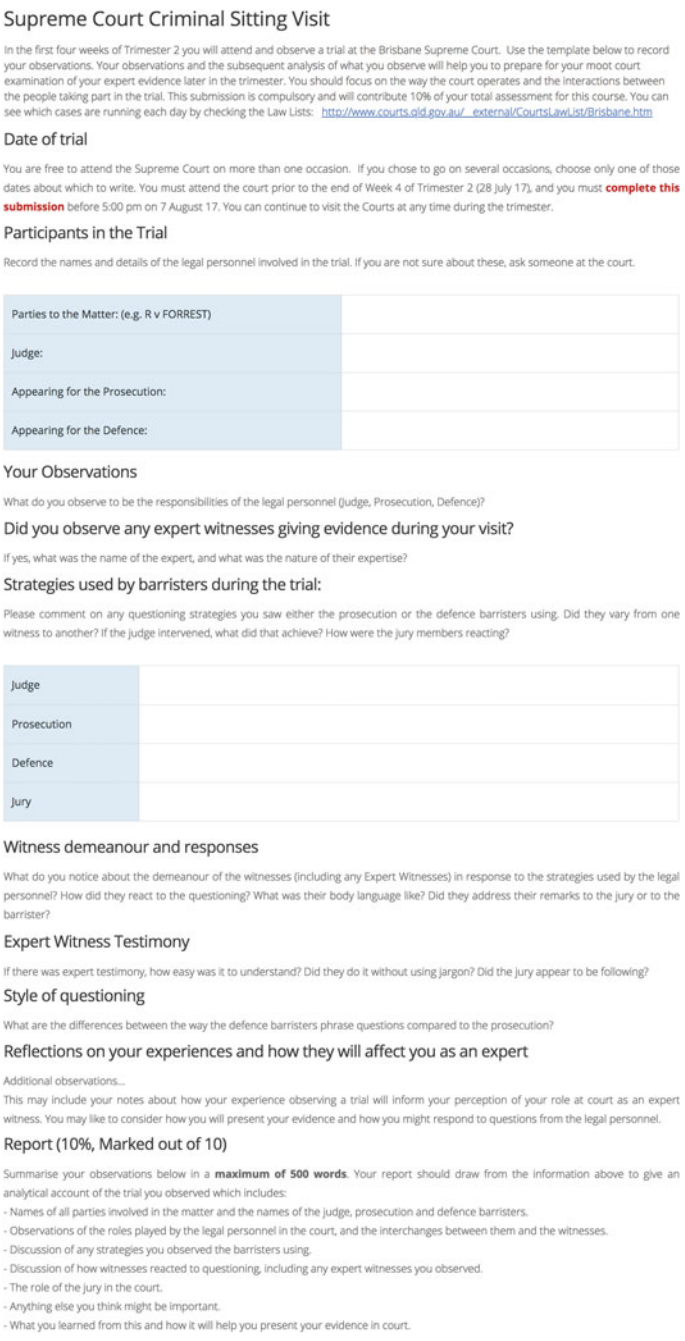
11.3 Results

Chemistry 1A was the first-time students in the forensic chemistry programs were exposed to PebblePad and/or the idea of reflecting on laboratory results, as opposed to simply writing their results in their laboratory book and checking the values were correct. Making students aware of the new virtual learning environment in PebblePad was not as straightforward as it might otherwise have been due to the fact that other disciplines were using the platform in different ways, and whilst some of our students were using it in multiple courses, others used it in only in one course, leading to some confusion amongst students. Table 11.1 shows the rates of PebblePad submissions for the courses, convened by the authors, that ran in 2017 and trimester one of 2018.

The rate of participation in reflective exercises varied between courses and appears to be related to the assessment structure and the degree of perceived relevance to future careers. Given that the transition from high school to university is already stressful, this could perhaps have been handled better by providing all students with a clear introduction to PebblePad, how it can be used, how students can access it and why the University had invested in it. Despite this, students were able to access PebblePad via their Blackboard e-learning system, the same system they use to access their emails and lecture notes/slides for each course and because students were already familiar with Blackboard, this process worked well.

In the first iteration of PebblePad in Chemistry 1A, 96% of the first-year cohort submitted one or more workbooks compared with only 61% who created the whole five experiment portfolio. Students were required to gain a mark of 50% over their five laboratory classes, including completing the corresponding PebblePad reflections but as the reflections only comprise 20% of the laboratory assessment, students can pass by simply completing the laboratory classes and laboratory book exercises in class. Therefore, whilst they were strongly encouraged to also complete the PebblePad reflection, not all chose to do so, and those who did not submit them, forfeited the marks for this component of the laboratory assessment. The second year this course was run, the rate of submissions of the portfolio of reflections rose to 83% of the cohort. Again, student feedback suggested some still were unable to discern a benefit to completing these reflections and therefore chose to forfeit the marks.

In the four reflections relating to wet chemistry experiments, students were asked to determine how confident they felt about each experiment on a scale of one to five; where one is not very confident and five is very confident. This activity was developed to encourage students to further self-assess their practical skills in undertaking the tasks. The results varied across the experiments but on average only 35% of students



Supreme Court Criminal Sitting Visit

In the first four weeks of Trimester 2 you will attend and observe a trial at the Brisbane Supreme Court. Use the template below to record your observations. Your observations and the subsequent analysis of what you observe will help you to prepare for your moot court examination of your expert evidence later in the trimester. You should focus on the way the court operates and the interactions between the people taking part in the trial. This submission is compulsory and will contribute 10% of your total assessment for this course. You can see which cases are running each day by checking the Law Lists: http://www.courts.qld.gov.au/__external/CourtsLawList/Brisbane.htm

Date of trial

You are free to attend the Supreme Court on more than one occasion. If you chose to go on several occasions, choose only one of those dates about which to write. You must attend the court prior to the end of Week 4 of Trimester 2 (28 July 17), and you must **complete this submission** before 5:00 pm on 7 August 17. You can continue to visit the Courts at any time during the trimester.

Participants in the Trial

Record the names and details of the legal personnel involved in the trial. If you are not sure about these, ask someone at the court.

Parties to the Matter: (e.g. R v FORREST)	
Judge:	
Appearing for the Prosecution:	
Appearing for the Defence:	

Your Observations

What do you observe to be the responsibilities of the legal personnel (Judge, Prosecution, Defence)?

Did you observe any expert witnesses giving evidence during your visit?

If yes, what was the name of the expert, and what was the nature of their expertise?

Strategies used by barristers during the trial:

Please comment on any questioning strategies you saw either the prosecution or the defence barristers using. Did they vary from one witness to another? If the judge intervened, what did that achieve? How were the jury members reacting?

Judge	
Prosecution	
Defence	
Jury	

Witness demeanour and responses

What do you notice about the demeanour of the witnesses (including any Expert Witnesses) in response to the strategies used by the legal personnel? How did they react to the questioning? What was their body language like? Did they address their remarks to the jury or to the barrister?

Expert Witness Testimony

If there was expert testimony, how easy was it to understand? Did they do it without using jargon? Did the jury appear to be following?

Style of questioning

What are the differences between the way the defence barristers phrase questions compared to the prosecution?

Reflections on your experiences and how they will affect you as an expert

Additional observations...
This may include your notes about how your experience observing a trial will inform your perception of your role at court as an expert witness. You may like to consider how you will present your evidence and how you might respond to questions from the legal personnel.

Report (10%, Marked out of 10)

Summarise your observations below in a **maximum of 500 words**. Your report should draw from the information above to give an analytical account of the trial you observed which includes:
- Names of all parties involved in the matter and the names of the judge, prosecution and defence barristers.
- Observations of the roles played by the legal personnel in the court, and the interchanges between them and the witnesses.
- Discussion of any strategies you observed the barristers using.
- Discussion of how witnesses reacted to questioning, including any expert witnesses you observed.
- The role of the jury in the court.
- Anything else you think might be important.
- What you learned from this and how it will help you present your evidence in court.

Fig. 11.5 Forensic evidence and the expert witness PebblePad template

Table 11.1 Submission rates for PebblePad reflections from the first year of implementation

% submission	Chemistry 1A—Portfolio (%)	Chemistry 1A—1 or more workbooks (%)	Principles of forensic investigation (%)	Forensic evidence and the expert witness (%)
T1 2017	61	96		
T3 2017			91	100
T1 2018	83			100

gave a score of five for their confidence in being able to repeat a task and a further 40% gave a score of four. On the other hand, less than three per cent of students stated their confidence as a one. Over 85% of students who completed the reflections wrote considered responses, comprising several sentences of text, which illustrated their understanding of both the laboratory activity and the purpose of the reflective task. Student comments in end-of-course questionnaires stated that "*the PebblePad exercises were good at reviewing what was learnt in the lab*" but also "*I did not see how completing the PebblePad exercises helped me to learn in the lab*" [Student evaluation of course comments 2017]. Such dichotomy represents the overall student response to this initiative well.

In trimester two of the first year, the Principles of Forensic Investigation PebblePad exercise was undertaken by both forensic chemistry and forensic molecular biology students and it was not possible to distinguish between their submissions. We did, however, see an increase in the number of students who submitted the workbook compared to the data from those submitting a portfolio in Chemistry 1A the same academic year; over 90% of students submitted the workbook in the Principles of Forensic Investigation course. Student comments such as "*the course slowly developed our knowledge of how testing is done and reported in a way that doesn't overpower us*" in the end-of-trimester course evaluations suggested that we were making an impact.

When the PebblePad reflection was introduced to the final-year students in trimester two in Forensic Evidence and the Expert Witness, the reception was extremely positive and students saw it as a helpful prompt to writing a commentary on their court observation. Every student submitted the reflection and several students reported multiple visits to the courts. All believed that the exercise was helpful and informed their approach and demeanour whilst on the stand themselves. They also reported a greater understanding of court protocol and were more easily able to identify errors in their statements prior to submitting them for court examination. Comments on the student evaluation of course questionnaire, administered centrally by the university, stated that "*being exposed to real courtrooms and lawyers was an amazing experience*" and that the use of the PebblePad reflective piece was "*very practical and I feel has prepared me for a Forensic role in ways that were never taught in other courses*".

It is hard to draw any definite conclusions from the data in Table 11.1 in regards to whether there is a genuine reluctance in first-year students to engage with blended learning reflective tools or whether this is more indicative of the fact that we trialled all these courses for the first time in 2017, and both students and staff were, therefore, on a steep learning curve, especially during the first trimester of the year.

11.4 Implementation: Pros, Cons and Lessons Learned

Implementation of these reflective pieces as part of a blended learning approach in forensic chemistry relied heavily on the support of both academic staff and the university blended learning support team whose work has been described in earlier chapters.

The expansion of the use of blended learning approaches using PebblePad in the forensic chemistry program is planned but will again depend on access to, and help from, the blended learning support team. It also requires financial assistance from the school or faculty to cover the increased sessional staffing costs arising from marking of the additional assessment items. To date, the authors have been fortunate to have the support of both the school and the faculty, but without this support it will become impossible to maintain the level of assessment through PebblePad for cohort sizes which range from approximately 50 students in the final year of the forensic chemistry programs to almost 450 in Chemistry 1A in first year.

The integration of PebblePad with the Blackboard learning management system used at Griffith seems to have worked well from an academic's standpoint. Students have been able to access it both on- and off-campus and individual student submissions have been allocated to specific markers for assessment. This is especially important for Chemistry 1A where very large numbers of students are each completing five reflections collated into a workbook. The marking of these submissions is shared amongst a number of sessional markers with oversight by the course convenor. Whilst there is a significant cost associated with this marking, in the authors' opinion the pedagogic gains from students reflecting on their laboratory experiences compensates for this expense.

One of the advantages of the PebblePad platform is that students have control of their work and what is and is not submitted for assessment. This autonomy allows students to create portfolios of their own work for job applications, for example, as well as completing university assessment items. The major disadvantage we have found relates to how well students are introduced to the platform before they are first required to use it. Those students who hear about it from several people, where it is used in multiple courses in any trimester, seem better equipped to use it and to understand its purpose. In some cases where it is only used in a single course during a trimester, students may not fully understand its purpose or how to use it. Conversely where PebblePad is used in multiple courses in a single trimester, there is a risk that students will see it as a tool they are forced to use just because the university has bought it. Vachon et al. (Vachon, Foucault, Giguere, Rochette, & Morel, 2018) note

that "having a clear understanding of the ePortfolio goals and objectives positively influences its acceptability". If it is not implemented for a specific purpose or if it is implemented poorly, students may disengage before they have started to use it. It is, therefore, vital to ensure that academics and blended learning support teams communicate openly about the academics' plans and the feasibility of implementing PebblePad for that purpose. There will certainly be circumstances where this is not the right blended learning tool to use.

As discussed earlier, it is also important to ensure the completion of the reflective tasks and their compilation for assessment is straightforward and intuitive to students. When the first iteration of the reflective task was created in Chemistry 1A, a video and a flow diagram were prepared to help students to create the compilation of the five workbooks into a portfolio. Based on submissions though, many students in that cohort did not compile a portfolio and simply stopped after they had completed the workbooks. This may indicate a lack of capacity to follow instructions or may simply indicate that students did not read the instructions carefully to the end and therefore missed the final step. This course is now in its third iteration and the use of PebblePad has evolved to the point where students are now provided with a five-page workbook to complete which they automatically submit, but which they can alter, add to and amend as they continue during the trimester.

11.5 Future Directions

Based on the authors' experience to date with the implementation of PebblePad reflective activities, it is envisaged that they could be incorporated into other core forensic chemistry courses within the program such that a complete portfolio of reflections could be created and subsequently used to inform job applications and answer selection criteria. It is, however, vital that such activities are appropriately designed with a clear outcome in mind, rather than simply being added into every course regardless. For any blended learning approach to work well, there must be a clear purpose that can be effectively communicated to students. Students will not engage in what they see as frivolous activities, even if they are assessment items, and will make a conscious decision to skip over them.

In order to implement reflective tasks into a curriculum, it requires all staff involved in teaching the cohort to participate in developing the tasks, promoting them to students and being able to explain the purpose of each task. When multiple staff members are involved in a single curriculum, this can be problematic but the authors have encountered no resistance to this initiative in the forensic chemistry program. The blended learning support team have been an invaluable resource in helping the authors to prepare appropriate reflection tools and the professional forensic knowledge the authors bring has ensured the reflective tasks are authentic.

The authors believe that the use of reflective tasks in forensic chemistry courses allows students to gain a greater understanding of their own level of knowledge, their skills and potentially identify shortcomings which require further development. This capacity for self-assessment is an important skill for expert professional scientists and one to be encouraged throughout their program of study.

11.6 Conclusion

The implementation of reflective practice activities using the PebblePad platform has given the authors a tool to encourage forensic chemistry students to engage in structured reflective practice. Whilst the process has, at times, been challenging, the authors believe these are activities that should continue. Changes made to the submission process for the Chemistry 1A workbook have resulted in greater numbers of submissions although some students may still make a conscious decision not to engage in this process and lose the marks associated with this. Surface learners are most at risk of disengaging with this task and the authors' awareness of these students, and their subsequent intervention, will be key to encouraging a deeper learning approach from these students. Whilst the data presented here is only preliminary, it is also encouraging and suggests reflective practice in science is not only possible, but to be encouraged.

The production of ePortfolios by forensic chemistry students at the end of their programs of study is the final step in this reflective journey. Once this step has been taken, it is envisaged that all forensic chemistry graduates will be able to prepare such an ePortfolio for presentation to prospective employers.

References

Allan, C. N., & Green, D. M. (2018). *Griffith Sciences Blended Learning Model.* Griffith University ExLNT Explore Learning and Teaching. Retrieved November 22, 2018, from https://app.secure.griffith.edu.au/exlnt/entry/6405/view.

Boud, D., Keogh, R., & Walker, D. (1985). What is reflection in learning? In D. Boud, R. Keogh, & D. Walker (Eds.), *Reflection: Turning experience into learning*. London: Kogan Page Ltd.

Cresswell, S. L., & Loughlin, W. A. (2015). An interdisciplinary guided inquiry laboratory for first year undergraduate forensic science students. *Journal of Chemical Education, 92*(10), 1730–1735. https://doi.org/10.1021/acs.jchemed.5b00183.

Cresswell, S. L., & Loughlin, W. A. (2017). A case-based scenario with interdisciplinary guided-inquiry in chemistry and biology: Experiences of first year forensic science students. *Journal of Chemical Education, 94,* 1074–1082. https://doi.org/10.1021/acs.jchemed.6b00827.

Domin, D. S. (2007). Students' perceptions of when conceptual development occurs during laboratory instruction. *Chemistry Education Research and Practice, 8*(2), 140–154.

Embo, M. P., Driessen, E., Valcke, M., & Van Der Vleuten, C. P. (2014). Scaffolding reflective learning in clinical practice: A comparison of two types of reflective activities. *Medical Teacher, 36*(7), 602–607. https://doi.org/10.3109/0142159X.2014.899686.

Fraser, J., & Williams, R. (2009). *Handbook of forensic science*. Collumpton, UK: Willan Publishing.

Glazer, N. (2015). Student perceptions of learning data-creation and data-analysis skills in an introductory college-level chemistry course. *Chemistry Education Research and Practice, 16*(2), 338–345. https://doi.org/10.1039/C4RP00219A.

Grayling, A. (2003). *Meditations for the humanist: Ethics for a secular age*. New York: Oxford University Press.

Horton, R., Kelly, T., Lennard, C., Lewis, S., Lim, K., Roux, C., & Southam, D. (2012). Assessing students' attitudes toward forensic science: Collecting an expert consensus. *Forensic Sciene Policy and Management: An International Journal, 3*(4), 180–188. https://doi.org/10.1080/19409044.2013.849780.

Kirkup, L. (2013). *Inquiry-oriented learning in science: Transforming practice through forging new partnerships and persectives.* Retrieved November 22, 2018, from https://ltr.edu.au/resources/Kirkup_NTF_report_2013_2.pdf.

Lee, V. S. (2012). What is inquiry-guided learning? *New Directions for Teaching and Learning, 129*, 5–14. https://doi.org/10.1002/tl.20002.

O'Connor, C., Seery, M., McDonnell, C., O'Donnell, C., Fox, J., Cullen, J., & Cresswell, S. (2008). Development of context-based forensic chemistry labs for chemistry undergraduates. *Wavelength, 4*(1), 10–11.

Overton, T. (2001). Teaching chemists to think: From parrots to professionals. *University Chemistry Education, 5,* 62–68.

Roberts, P., Maor, D., & Herrington, J. (2016). ePortfolio-based learning environments: Recommendations for effective scaffolding of reflective thinking in higher education. *Educational Technology and Society, 19*(4), 22–33.

Sommerfield, S., Overton, T., & Belt, S. (2003). Problem-solving case studies. *Analytical Chemistry, 75*(7), 181A–182A.

Vachon, B., Foucault, M., Giguere, C., Rochette, A., & Morel, M. (2018). Factors influencing acceptability and perceived impacts of a mandatory eportfolio implemented by an occupational therapy regulation organization. *The Journal of Continuing Education in Health Professionals, 38*(1), 25–31. https://doi.org/10.1097/CEH.0000000000000182.

Welsh, C., & Hannis, M. (2011). Are UK undergraduate Forensic Science degrees fit for purpose? *Science & Justice, 51*(3), 139–142.

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