In health sciences, case-based learning is a type of learning environment that supports intrinsic feedback and has an authentic approach involving accounts of real clinical experiences aimed at giving students the opportunity to explore and apply skills and theories that they have learnt in their field of study. This paper reports on an innovative online learning platform called ‘integrating Science And Practice’ (iSAP), developed to integrate interactive case studies based on realistic clinical scenarios in radiography, radiation therapy and medical ultrasound and supported by a range of multimedia resources. iSAP allows students to be immersed in authentic clinical experiences where they apply critical and reflective thinking to challenging practice scenarios which address, amongst others, relationships between diagnostic modalities, disease and clinical presentations, behavioural/fitness to practice and radiation dose issues. The innovative online learning platform for each iSAP case involves a case description/scenario, professional issues and resources, Clinical Action Plan (CAP), Expert Response (ER) or Practitioner Response (PR), and a Comparative Report (CR) or Reflective Analysis (RA).

iSAP provides educators with insights into the student’s clinical reasoning abilities, reflective skills and their capacity to integrate various knowledge domains. iSAP provides students with a cost effective way of accessing practitioner expertise, whilst learning how to make informed clinical judgements within an evidence-based practice paradigm.

**Keywords:** case based learning, multimedia, problem solving, reflective practice, feedback
Traditional teacher-centred approaches are limited in their ability to enable students to make vital connections between theory taught and clinical decision-making. Environments that support learning through practice include those where situated actions elicit intrinsic feedback. In such an environment, the student experiences and acts within a situation that emulates the real world. The student is exposed to consequences in response to their action, which, similar to the real world, they will in turn respond to by way of modulating their actions, and responses. The types of learning environments that support intrinsic feedback include activities and knowledge situated in practice and emulating the real world, and may be supported by digital technologies. Case-based learning involves a situation or an account of real experience that provides deep authentic student learning. The aim of case-based learning is to give students the opportunity to explore and apply skills and theories that they have learnt in their field of study.

In 2001, the Department of Medical Imaging and Radiation Sciences developed and implemented a case-based learning program for the radiography degree program at Monash University called “Student Oriented Learning About Radiography (SOLAR)” (Baird and Wells, 2001). A number of iterations followed and in 2014 the name was changed to ‘integrating Science and Practice’ (iSAP) to open the program and platform for use in radiation therapy and medical ultrasound as well as other health science disciplines within the faculty. The iSAP case-based learning platform uses a range of multimedia to provide innovative interactive case studies in the online environment. The program provides educators insights into the student’s clinical reasoning abilities, reflective skills and their capacity to integrate various knowledge domains. iSAP provides students with a cost effective way of accessing practitioner expertise, whilst learning how to justify clinical actions within an evidence-based practice paradigm. It empowers students to cultivate the capacity to make informed clinical judgements to ensure the best patient care. Additionally, the immersion into authentic clinical experiences compels students to apply critical and reflective thinking to challenging practice scenarios that address amongst others, relationships between diagnostic modalities, disease and clinical presentations, psychosocial aspects, fitness to practice, and radiation dose issues. The essence of professional practice involves a creative, sensitive and enthusiastic practitioner amongst others (MacLure & Norris 1991). These are attributes that are difficult to be taught within an academic setting. However, through observation and a conscious reflective process the student could conceptualize the tacit and intuitive knowledge developed as a consequence of experience by the expert practitioner.

The iSAP conceptual framework involves the following components (Figure 1):

- The case/scenario
- Professional issues and resources
- Clinical Action Plan (CAP) – The student’s response to the presented scenario and professional issues
- Expert Response CAP (ER) or Practitioner Response (PR)
- Comparative Report (CR) or Reflective Analysis (RA)

Figure 1: iSAP welcome page showing the five requirements of the conceptual framework
The case/scenario

The scenarios of iSAP cases contain exemplars of, amongst others, various disease and clinical presentations relating to professional practice. It is essential that the educator creates a practice situation for students that models or simulates the clinical environment. The educator’s design task is to set an authentic learning goal that aligns with the complexity of the task. Learning outcomes should identify the purpose of the skills development.

Professional issues and resources

Technically based scenarios from clinical practice are enriched with psychosocial issues. These are brought to live in a media-rich environment to engage and challenge the student to make sense of the complexities and develop their conceptual organisation to respond to the professional issues. Suggested activities can assist the student to prepare for the case-based learning and how to address professional issues. The student is provided with a diversity of rich resources which includes multimedia to assist in their evidence-based interpretation of the underlying concepts.

Clinical Action Plan (CAP)

The student is directed to apply critical thinking and rigorous assessment in light of their scientific knowledge and practical experience to the scenario provided in the specific case. The student is then required to generate a ‘Clinical Action Plan’ (CAP) which is submitted to the online iSAP platform, using a text box or by uploading a file in various formats. Once submitted, the report is lodged for
assessment.

**Expert Response CAP (ER) or Practitioner Response (PR)**

Once the student submits their individual CAP to the online iSAP platform, feedback is immediately released to the student in the form of a model CAP by an expert practitioner. Expert practitioners are distinguished by their ability to shape their profession by seeking imaginative solutions to real clinical problems whilst anticipating and demonstrating an understanding of the wider psychosocial and professional implications. Each expert CAP is peer-reviewed before inclusion in the scenario. These expert responses are energized by video and audio interviews, appropriate to 21st century learning.

**Comparative Report (CR) or Reflective Analysis (RA)**

The educator assesses the student’s submitted CAP and provides summative extrinsic feedback which is guided by marking rubrics. In this process the student is provided with the second task of developing a comparative report (CR) or reflective analysis (RA). The student will receive instructions for this task after receiving the Expert CAP. Contrasting the expert response with their own, allows for the student to critically reflect on their own decision-making processes in comparison to the expert’s. Students should be able to justify their choice of action and provide a revised action plan.

Peer discussion is a powerful class activity that can be used during the case-based learning program and is often included as a group tutorial session. Peer discussion can stimulate the sharing of ideas and provide a learning opportunity where different viewpoints are discussed and reflection upon the student’s own perspectives can be encouraged. It assists in developing critical thinking and the deepening of understanding of complex clinical situations. This process can be an effective tool to prepare students for writing their comparative (reflective) reports.

**Discussion**

Technology-enhanced learning is a complex activity that requires justification about the goals to be met through such an intervention (Kirkwood & Price 2013). Digital technology can be set to respond conditionally to input by users and therefore is ideal for case-based learning with a cyclical nature. However, pedagogic requirements still need to be maintained. External forces such as technological advances, work-integrated learning and assessment influence the nature of learning and teaching (Rae, 2010). The iSAP interactive program emulates a real-world clinical experience and is capable of providing intrinsic feedback in response to a student’s input. Inherent to the iSAP properties are challenges being set which require the student to problem-solve through critical thinking and reflection (Kalaš, 2010). The educator therefore needs to design a clinical modelling environment that would support the student’s conceptual development within the pedagogy of learning through practice. The main objective is for the modelling environment to enable the student to use high-level cognitive skills such as interpretation and critical problem-solving amidst the backdrop of scientific inquiry. In transforming the clinical cases using technology enhancement, students are provided with a pseudo-direct engagement with professionals and experts of some standing. Providing realistic psychosocial scenarios have further professional development merits for students and provide for subject matter to interact and engage within academic and professional communities.

The four-step learning model for the iSAP case-based program reflects elements of learning through practice, collaboration and discussion and is modified from the learning through practice model by Laurillard (2012).

1. Modelling
Learning through practice is fundamental in preparing students for the complex health care environment. The central challenge is in creating a learning context that links the theory to experiential practice. Modelling should be constructive and embed goal-oriented action as this motivates the student to modulate their clinical practice (Laurillard, 2012). The modelling cycle requires engagement from both the educator and the student. Figure 2 demonstrates the modelling cycle for iSAP.

Figure 2: Modelling Cycle - Educator facilitates student metacognition and prepares student for case based learning activity

In the iSAP cases, the scenarios are draw from real cases and reflect this as short, succinct statements that create the sense of urgency and necessity to act. The educator has formulated the learning outcomes relevant to the student learning stage and supporting the case. Figure 2a illustrates the learning outcomes and the respective case scenario, which is in the form of a letter highlighting the consequences of a human error in image acquisition.

Figure 2a: Learning Outcomes and Case Scenario
The educator then sets the task for the student in the form of outlining several professional issues that must be addressed (Figure 2b). Supporting multimedia is used to provide the student with relevant illustrations that are otherwise difficult to explain in text. In this case, the image acquisition and human error are re-enacted in a short video.

Figure 2b: Professional Issues / CAP Instructions
1. Feedback and Revision

The expert CAP provides an opportunity to demystify any misunderstandings and enhances the metacognitive abilities and critical management skills of the student (Baird, 1996). Intrinsic feedback comes into effect when the student receives the expert response to the professional issues depicted in the case. In the case example, such intrinsic feedback comprises the experience of a practicing dentist and forensic odontologist in interpretation and application of OPG images (Figure 3a). Chang and Rieple (2013) link complex skills involving interactions with stakeholders, or as in iSAP’s expert practitioners, to the heightening of emotional involvement of the student. The feedback and revision cycle for iSAP is shown in Figure 3.

Figure 3: Feedback Revision Cycle - Student is provided with intrinsic and extrinsic feedback
The educator provides the student with a summative assessment and extrinsic feedback following the evaluation of the student CAP report along developed assessment criteria. Together with the expert response, the student is able to revise their understanding of concepts in the context of use.

Figure 3a: Expert Response
In a variation to traditional teacher-led feedback, Kolb and Kolb (2005) assert that when other students are included in the experiential learning cycle, the whole learning process becomes more effective. iSAP allows for the application of what has been learned via the Feedback-Revision-Cycle through its scaffolding approach. Students can offer and exchange ideas, comment and provide alternative outputs, amongst other thus facilitating the iteration between concepts and practice. Laurillard (2012) summarises this as the ‘iterative nature of the discussion process provides a powerful process for conceptual development’.

1. Modulate and Generate

The student needs to modulate their assessment of the case incorporating their intrinsic feedback (expert CAP) and the extrinsic feedback (Educator report and/or peer feedback). This approach via the task of a reflective analysis or comparative report promotes a deeper, much richer learning experience as the student is prompted for another iteration within the learning cycle (Figure 4).

Figure 4: Modulate and Generate Cycle – student conducts internal conversation and reflects on own response using feedback
Quality reflection can further support the student’s intrinsic motivation of continued engagement with the case and build the competence to achieve the intended learning goal. The iSAP case program directs the student to develop quality reflection that is based on comparing and contrasting their report with the response by the expert and on what the case has taught them should be their approach in a particular situation described within the case. This task instructions are purposefully structured and guided by criteria-based marking rubrics with a focus on learning outcomes, impact on learning, future application and evaluation of the evidence used.

Figure 4a: Comparative report / reflective analysis instructions
1. Revised Action Feedback

One of the objectives is for the student to be able to reflect on what they have learnt through the case and how they would approach a similar situation when in the clinical environment. The educator provides support for moderation and feedback through clinical mentoring and guidelines for clinical placement. Enacting evidence-informed case-based practice provides the student with a degree of familiarity of observed behaviour and preparedness for actual experiences. The learning cycle is closed by providing the student with the opportunity to compare their professional practice output and interpret differences using this intrinsic feedback and modulating an improved response (Laurillard, 2012). Figure 5 illustrates this revised action feedback cycle.

Figure 5: Revised Action Feedback Cycle – closes the loop by providing the student with the opportunity to engage and compare their professional practice output and interpret differences
Notably, the role of the educator is extended to include the clinical placement supervisor, who will also assume mentoring and guiding roles and provide practical learning experiences. Other professionals and peers in the clinical environment will continue to enrich the learning cycle of the student and further work skill development.

Through the Figures 2 to 5, the iSAP case-based learning program is modelled as an active learning process, illustrating the four learning cycles of: modelling, feedback and revision, modulate and generate, and revised action feedback. Each cycle is accompanied by a range of suggested activities that can provide further contextualisation for learning in the classroom, online or in the clinical placement and these are summarised in Table 1.

Table 1: Supporting activities for the classroom and online
<table>
<thead>
<tr>
<th>Learning Cycle</th>
<th>Suggested Activities</th>
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<tbody>
<tr>
<td>Modelling</td>
<td>Suggested activities in the modelling cycle that can be used to prepare student for casebased learning and addressing professional issues:</td>
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<tr>
<td></td>
<td>• Existing case study from iSAP or any current, related content that is making news as preclass exercise to think of possible responses</td>
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<tr>
<td></td>
<td>• References and related readings on current topic</td>
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<td></td>
<td>• Role play for mini discussion and providing practice opportunities</td>
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<td></td>
<td>• Videos (e.g. positioning for radiography, dose calculations)</td>
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<td></td>
<td>• Psychosocial issues in cases for discussion (sociocultural, gender, workplace, colleagues, patients, carers etc.)</td>
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<tr>
<td></td>
<td>• Developing strategies for addressing professional issues</td>
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<tr>
<td>Feedback Revision</td>
<td>Suggested activities in the feedback revision cycle to prepare student for second assessment via:</td>
</tr>
<tr>
<td></td>
<td>• Existing case study expert CAP and (model) student CAP as in--class exercise to generate discussion</td>
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<td></td>
<td>• Contrasting selected content in references pertaining to professional issue</td>
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<td></td>
<td>• Role play or mini discussion and providing practice opportunities for addressing</td>
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<tr>
<td><strong>Modulate and Generate</strong></td>
<td><strong>Suggested activities to prepare student for comparative assessment:</strong></td>
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<td></td>
<td>• In class discussion contrasting expert CAP and student report and analysing student reflection and comparative report</td>
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<td></td>
<td>• Strategies and guidance for developing reflective comparative analysis practice (e.g. journal)</td>
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<td></td>
<td>• Group discussion and discussion forums for sharing on reflective practice – what works/what not</td>
</tr>
<tr>
<td></td>
<td>• Strategies for reflecting on psychosocial issues in cases for discussion (sociocultural, gender, workplace, colleagues, patients, carers, etc.)</td>
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<tr>
<th><strong>Revised Action Feedback</strong></th>
<th><strong>Suggested supports for moderation and post class learning through:</strong></th>
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<tbody>
<tr>
<td></td>
<td>• Mentorships in clinical placement</td>
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<td></td>
<td>• Peer groups</td>
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<td></td>
<td>• Opportunities for bringing practical experiences back to the classroom</td>
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</table>
The virtual space will have a clear role in future pedagogies and professional training. iSAP serves as a model for authentic learning which recreates the emotive clinical experience through the use of various media tools involving videos, stills and audio. Expert feedback responses are supported with audio or video interviews to instill the tensions and pressure of the clinical work environment. iSAP allows educators insights into the student’s clinical reasoning abilities, reflective skills and their capacity to integrate various knowledge domains. iSAP provides students with a cost effective way of accessing practitioner expertise, whilst learning how to justify clinical actions within an evidence-based practice paradigm. iSAP facilitates independent learning through intrinsic feedback within an experiential context. Its pedagogic value is recognized for its motivational value and ability to develop high-level cognitive skills of exploration, analysis, interpretation and reflection. The development and iterations of iSAP is a prime example of the complexity that is required to design an effective modelling environment that supports high level independent learning through intrinsic feedback.

Conclusion

The virtual space will have a clear role in future pedagogies and professional training. iSAP serves as a model for authentic learning which recreates the emotive clinical experience through the use of various media tools involving videos, stills and audio. Expert feedback responses are supported with audio or video interviews to instill the tensions and pressure of the clinical work environment. iSAP allows educators insights into the student’s clinical reasoning abilities, reflective skills and their capacity to integrate various knowledge domains. iSAP provides students with a cost effective way of accessing practitioner expertise, whilst learning how to justify clinical actions within an evidence-based practice paradigm. iSAP facilitates independent learning through intrinsic feedback within an experiential context. Its pedagogic value is recognized for its motivational value and ability to develop high-level cognitive skills of exploration, analysis, interpretation and reflection. The development and iterations of iSAP is a prime example of the complexity that is required to design an effective modelling environment that supports high level independent learning through intrinsic feedback.

Take Home Messages

- iSAP provides realistic clinical scenarios enriched with videography, imagery, audio and text and is an example of innovative online case-based learning platform;
- iSAP underpins and supports the different learning styles encountered by the diverse cohort we experience in the 21st century;
- Case-studies can be used in pre-class reading followed by in-class discussions that better prepare students for entry into the complex world of clinical practice;
- Excerpts of case studies can be selectively used for explaining difficult concepts;
- The digital case learning environment can be exploited for undertaking individual or group based assignments converting example case studies into an eBook for offline accessibility.

Notes On Contributors

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Appendices

Declaration of Interest

The author has declared that there are no conflicts of interest.