

Implementation of a hybrid mobile web learning environment in the health professions: A design based research approach



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Teaching has always been at the core of what it means to practice in the health professions. Health professionals generally accept that as part of their role they will be involved in educating subsequent generations of health professionals. However, whilst health educators typically have extensive knowledge and skills in the area of their professional discipline, the art and science of passing knowledge from one generation to the next (pedagogy) in the clinical setting, is often overlooked in the context of demanding clinical, teaching, and/or research responsibilities. Furthermore, many health professionals have had no formal training in educational theory and best practice methods, and busy schedules leave little time for improving their own educational knowledge and skills by attending scheduled courses or workshops. This paper discusses how design-based research influenced a hybrid mobile-web learning solution for providing educational professional development to health professionals who are also teachers. It is argued that design-based research provides a rigorous framework in which to ground educational design and development processes, particularly when dealing with embryonic and unproven learning technologies.

Introduction

One of the strategic goals of the University of Notre Dame Australia (UNDA) is to provide educational professional development (EPD) and further learning opportunities for academic staff to enable them to enhance their teaching skills. As such, UNDA, like many universities, offers a Graduate Certificate in University Teaching (GCUT). This course is well attended by staff across multiple disciplines, although most participants tend to be those who teach on campus as opposed to those who teach in workplace-based settings. Whilst staff from the medical school, and other health professional courses, have participated in the GCUT, no hospital-based medical teachers have enrolled to-date.

Research conducted by Bate and Steketee (2010) into the EPD needs of medical teachers at UNDA established that the traditional delivery mode of the GCUT, and other scheduled EPD workshops, were inadequate in that they did not take into account the complex and busy nature of working in clinical settings. It was also found that medical doctors were open to enrolling in higher degree programs in order to attain qualifications in medical education, particularly if the objectives of the course were aligned with their specific needs of teaching in a clinical setting. An environmental scan of other health professional educators' needs across the university revealed similar sentiments.

These findings were the impetus behind the development of two new post-graduate courses in health professional education. The Graduate Diploma of Health Professional Education and the Master of Health Professional Education were conceived to build upon the generic educational objectives of the GCUT and to focus educational theory more specifically on the needs of teaching and learning in a clinical context. An important specification of the courses was that they could be accessed flexibly at a place and pace suited to the individual requirements of the participants but also be firmly underpinned by sound educational design theory.

This paper describes the methodology used to guide the design process for these courses. It begins with a review of the literature on the challenges associated with providing EPD to medical educators. The emphasis on a 'medical context' is a direct result of the course designers' roles as educational

support staff in a medical school. However, it is evident in the literature that EPD challenges faced by medical educators can, and do, transcend to other health professional contexts. An in-depth insight into how a design-based research approach enabled the developers to retain a clear focus on the important attributes of learning design whilst at the same time balancing a variety of technical, administrative and logistical issues is also presented.

EPD for medical teachers

It is widely accepted that medical doctors (and other health professionals) have a professional duty to teach (Foster & Laurent, 2009; MacDougall & Drummond, 2005; Travabie & Baker, 2011). In fact, as Shapiro (2001) points out, the word ‘doctor’ is derived from the Latin word ‘docco’ which means ‘to teach’. Although doctors receive extensive and ongoing training for their roles as clinicians, very few are trained and prepared for their roles as teachers (Steinert, 2005). This is problematic given that from a very early point in their careers, they are placed in situations where they are required to contribute in some way to the training of medical students and trainee doctors. And because pedagogical know-how is generally not innate, medical teachers tend to revert to how they were taught and adopt teaching strategies and styles that they themselves experienced as trainees. In a study into the formation of doctors as teachers, MacDougall and Drummond (2005) reported that many of these teaching experiences were suboptimal and resulted in passive and sometimes stressful learning.

However, with the professionalization of medical education and greater accountability to graduate safe and competent practitioners, medical education providers today are expected to deliver high quality teaching experiences that are underpinned by contemporary learning theory. Furthermore, medical education has changed and continues to evolve. The traditional apprenticeship model where the trainee learned the craft of medicine by working closely with a more skilled clinician is becoming increasingly rare due to the growing numbers of medical students and the changing landscape of the health care environment. Foster & Laurent write,

“... twenty-first century clinical teachers must not only be able to teach at several levels simultaneously but also to provide adequate and appropriate supervision and feedback to juniors as they progress towards autonomy as practitioners. Increased student numbers also means that doctors must also be skilled in effective lecturing and group teaching. It is therefore essential that current and prospective clinical teachers receive adequate assistance in developing their teaching skills and learning about the theories underpinning the principles of adult education” (2009, p. 25)

Whilst not a theory as such, Knowles’ (1990) principles of andragogy have influenced educational practices in contemporary medical education. Andragogy is based on certain assumptions about how adults learn:

1. Adults are independent and self-directing; they recognise that they are responsible for their own decisions and lives, even when it comes to learning.
2. Adults have accumulated many experiences; experiences are resources for further learning.
3. Adults value learning that integrates with everyday life; they need to see the purpose of learning something.
4. Adults are more interested in problem-centred approaches to learning rather than subject-centred ones. These problems should be life-centred and contextualised as adults learn best in the context of real life application.
5. Adults are more motivated to learn by internal drives rather than by external ones, although some external motivators (e.g., promotion) are valued.
6. Adults learn best in communities of practice where they have opportunities to collaborate with others and share perspectives.

In applying these principles to the training of doctors as teachers, it is evident that approaches that role model contemporary adult learning theory should be adopted. For example, medical teachers should learn the theory underpinning good teaching practice by applying it in the context of real life situations

and problems. They should be encouraged to draw upon their previous experiences as a learner, as well as a teacher, in evaluating this theory, and they should be given ample opportunities to discuss their experiences with fellow medical teachers. Importantly, medical teachers should be supported in the process of grappling with what makes a good educator by robust resources and prompts that scaffold their thinking and progress along the way.

Despite this change in medical education and, consequently, the change in the role of the medical teacher, the professional development of doctors as teachers is not seen as something that is mandatory in their professional training (MacDougall & Drummond, 2005). In the Australian context, there is no formal pathway for doctors to gain teaching competence and teaching excellence often goes unrewarded and unsupported. Culturally, and certainly historically, education as a discipline is undervalued in the realm of clinical practice and the perception that “teachers are born, not made” (MacDougall & Drummond, 2005) lives on in health care settings to this day.

However, professional development in the area of educational practices can assist in addressing these issues. It can serve to strengthen attitudes towards teaching and learning and can also provide a conceptual framework for practices that are often performed intuitively and serendipitously by doctors with no training in education (Steinert, 2005). Importantly, it can improve learning experiences and ultimately, learning outcomes for students. Students value learning experiences where there are clear objectives and expectations; where constructive feedback is provided in a timely fashion; where a range of instructional methods are used and where positive, safe learning environments are established (Copeland & Hewson, cited in Steinert, 2005).

In summary, the characteristics of well designed EPD programs are those that are designed on the same principles of adult learning theory that the programs themselves aim to instil within doctors as teachers. As adult learners, medical teachers will want their EPD courses to have clear goals and expectations and to have relevance and purpose to their specific teaching needs. Whilst they will want to know theoretical underpinnings, they will also want to learn strategies and skills that have practical applications. Furthermore, given the busy nature of their roles as clinicians, there is also a need for EPD courses to be flexible and to acknowledge that traditional face-to-face delivery methods are often impractical.

Aim of this study

In the light of the issues identified above, the aim of this project was to develop a set of postgraduate courses that took into consideration the cultural and historical nuances of teaching within the medical and health professional contexts. Using design-based research methodology, a hybrid mobile-web learning environment was adopted. This approach addressed the requirement that delivery should be flexible but also ensured that the design was robust and aligned with principles of adult learning theory. For example, it was important that the courses exposed participants to authentic, contextualised experiences that drew on their prior experiences and that employed a variety of media to cater for a range of learning styles. Finally, it aimed to provide flexible, accessible courses that recognised the inability of many clinicians to attend traditional face-to-face courses.

Design based research

In recognition of the fact that the effectiveness of any new curricula should be measured according to what it sets out to achieve, design-based research methodology has been used to guide the course development as well as the iterative review cycle. Three central questions have focussed this process in terms of the courses’ design, flexibility and impact:

1. To what extent does the hybrid mobile-web learning design offer a viable flexible learning solution in health professional education?
2. What aspects of the hybrid mobile-web learning design are most and least effective for the target audiences?

3. What level of impact has the hybrid mobile-web learning design had for health professionals taking part?

Barab and Squire (2004, p. 2) note the advantages of design-base research as tool to both guide and impact upon teaching and learning:

Design-based research is not so much *an* approach as it is a series of approaches, with the intent of producing new theories, artifacts, and practices that account for and potentially impact learning and teaching in naturalistic settings.

Reeves (2006) suggest four stages in the conduct of design-based research:

1. Analysis of practical problems.
2. Development of solutions informed by existing design principles and technological innovations.
3. Iterative cycles of testing and refinement.
4. Reflection to produce new design principles and enhance future implementation.

This paper focuses on the first two stages in the design-based research process. Specifically, it discusses conceptualisation of the problem, the technological affordances available, and the design principles that framed the proposed solutions.

Conceptualisation of the problem

The problem, as described thus far, is one of providing flexible EPD to busy health professionals in a way in which knowledge can be readily applied to real world teaching and learning contexts. Participants should be able to gain credit for engaging with EPD if they so wish. Qualifications should acknowledge the diversity of health professions, and at the same time provide a meaningful context for each participant.

Technological affordances

Mobile devices, such as tablets and phones, lend themselves for use by clinicians who themselves need to (a) be contactable and (b) have access to large amounts of complex information. Mobile devices also present significant opportunities to facilitate learning in a way which previously has not been possible. In this project, the use of e-books as a mechanism to mediate learning tasks was seen an attractive option for a number of reasons. Firstly, the EPUB version 3.0 standard supports media formats such as video, audio, interactive elements (e.g. instantaneous feedback) and avatars. EPUBs can then be opened using an e-reader on Android and Apple devices thus providing access to a rich multimedia environment. Another advantage of developing for an e-reader is that design products (e.g. Apple *i-Author*) do not require a high level of technical competence alleviating the need for expensive development. Finally, EPUBs can also be read on non-mobile devices meaning that tasks can be mediated in a truly flexible way.

In this project, the affordances offered through the EPUB 3.0 format can help to consolidate prior knowledge, promote learning through engagement with avatars that are introduced in simulated learning environments, and help to guide research through links to web-based resources and templates. In summary, using the EPUB standard provided a student-centred mobile learning environment that potentially could mediate *tasks* to busy clinicians in an authentic manner. The task driven mobile learning environment is supported by two web-based tools: *RefWorks* and *BlackBoard*.

RefWorks provides an interface for all supporting *resources* whether these are located in refereed journals, newspaper articles or *YouTube* video clips. This one point of reference provides a consistent interface for all guided research that is embedded in the mobile learning environment. It is acknowledged that mobile devices may have limitations for the creation and production of knowledge.

Therefore, formative and summative assessment opportunities such as e-portfolio activities, journal reflections and blogging are provided through the *BlackBoard* learning management system.

The use of mobile and web-based technological affordances is represented diagrammatically in Figure 1.

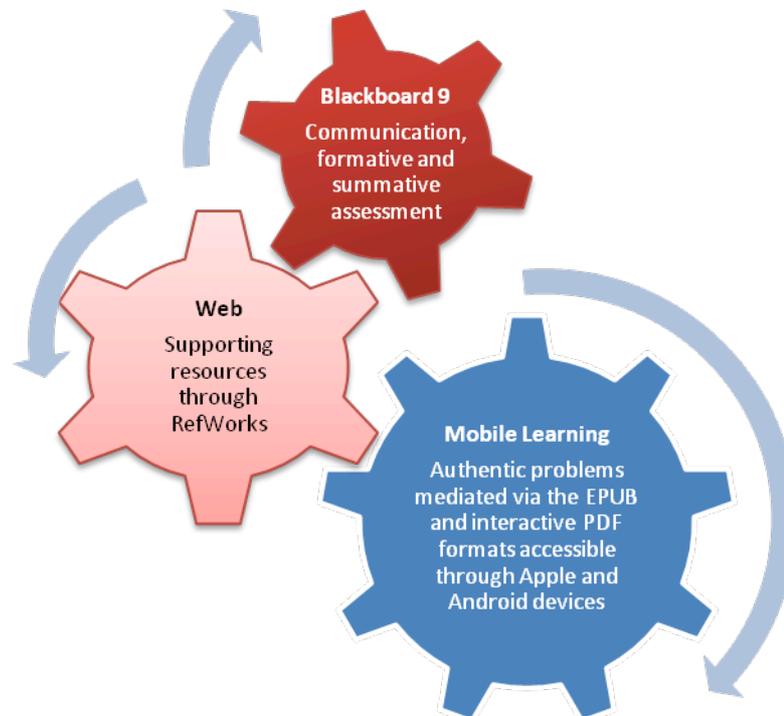


Figure 1: Conceptual design of the hybrid mobile-web learning environment

In a recent study of nursing students' use of mobile devices (Jamieson-Proctor, Albion, Redmond, Harris, Yuginovich, Maxwell, Fasso, Sander & Larkin, 2012), it was found that the lack of a defined role for the use of the device (in this case an *iPod Touch*) was a major impediment to the success of the initiative. For participants to gain optimum advantage from the technological affordances offered in the conceptual design of the hybrid mobile-web environment, each component needs to have an identified function and work seamlessly with other components. Each is an important cog in the overall educational design. These functions are underpinned by a set of design considerations that are grounded in contemporary theories of learning.

Design principles

From the outset, the designers agreed that a set of design principles should be developed to inform and drive any technical solutions rather than the other way around. The designers met and agreed upon nine principles that should underpin the educational design process. These design principles, detailed in Table 1, required a range of technical and logistical solutions.

Storyboarding is the central educational design procedure which maps out in detail the problems, activities, resources and assessments that participants will encounter. Design-based research is used to guide and review the educational design process, and the products that emanate from this process. Design and review of the hybrid mobile-web learning environment is an ongoing and iterative process. Whilst there will be 'formal' evaluation reviews conducted after each phase of the design-based research approach, 'informal' reviews have been frequent and focused on multiple elements of the problem (e.g., technical, pedagogical, logistical etc). After each unit is designed, course developers have reviewed it against the nine design principles outlined in Table 1 to determine whether content

and design has adhered to them or not, and, if not, what modifications or compromises should be made. The following section reports on the key features of the review process undertaken so far.

Table 1: Principles underpinning the design of the hybrid mobile-web learning environment and the proposed technical solution

Design principle	Description	Technical/logistical solution
Flexible access	Courses will be developed to enable participants to access activities anytime, anywhere.	Activities provided through web and mobile interfaces.
Flexible design	With the exception of the dissertation unit, all learning activities can be accessed at a module (i.e. learning outcome) level. These modules can be consumed in any order, and participants may choose whether or not to be assessed.	Activities to be discrete and modularised.
Prior knowledge	Participants are encouraged to share their prior knowledge with their peers and/or the unit facilitator through the process of engaging with learning activities and contributing to the learning community. The application of existing knowledge and expertise to learning activities (e.g. by participants using artefacts such as lesson plans, marking guides etc.) is equally encouraged.	Blog and e-portfolio functions activated in <i>BlackBoard</i> .
Authentic activities	The central theme for each module is that learning will be contextualised and relevant to participants. Learning activities will have explicit meaning in at least one of the health professions, but will have application to other health professions. Learning activities will mirror real world practices, problems and dilemmas in health professional education.	Where possible activities to be context-free. Where this is not possible, activities to be developed in such a way as to optimise generalisability.
Community	Participants will be encouraged to share their perspectives through a learning community. They will also be encouraged to 'collaborate' such that participants come to view each other as integral resources for pushing their thinking and learning to higher levels. Where numbers permit, participants will be offered opportunities to work on learning activities in small groups.	Blog function activated in <i>BlackBoard</i> .
Facilitation	Educational expertise will be provided at the unit level to support, and provide feedback to participants as they work through activities that comprise each module. The unit facilitator will also be responsible for assessment.	Email, telephone and face-to-face support.
Scaffolding	Participants will be provided with resources and tools that will help them to complete designated tasks. Where possible, these will be functional resources and tools used in health professional education.	Electronic resources provided through <i>RefWorks</i> .
Purposeful assessment	Assessments emanate from learning activities. Each assessment will be designed so that the product of the assessment will be of use to the participant in her/his teaching role.	E-portfolio function activated in <i>BlackBoard</i> .
Reflection	Participants will be encouraged to consider what and how they learnt and also share the products of their learning with others, being open to feedback and opportunities to improve their practice.	E-portfolio function activated in <i>BlackBoard</i> .

Flexible access

The key feature of the Flexible Access principle is the ability of participants to engage with activities anytime, anywhere. Designing for an eReader supports this principle by giving participants the opportunity to use a mobile device to render either an EPUB or interactive PDF file formats. Mobile learning is augmented by web-based systems for accessing resources and responding to assessment requirements. The *BlackBoard* mobile App facilitates smooth integration between the mobile environment and assessment components. Therefore, the entire learning system is available 24 x 7 on a mobile device, a computer or both. The only downside to providing a mobile learning option is that

initial access to the EPUB or interactive PDF file requires a wireless network as file sizes are over 25 MB.

Flexible design

The original Flexible Design principle is based upon the idea that discrete modules can be accessed concurrently and/or in any order. Modules are then assembled into units, and units in turn into courses. Remaining faithful to this idea has proven to be antagonistic with the notion that deeper learning involves using prior knowledge as a basis for constructing understanding (Jonassen, 2002). Each module, which is centred on one or more learning objectives, acts as a platform for the creation of scenarios and problems which ultimately become the guiding experience for participants. The design offers participants an opportunity to embark upon a journey where solving one problem provides a foundational knowledge to engage in another. For example, in the Teaching Methods unit, participants are asked to construct a teaching philosophy, determine key features of twenty first century learning, develop a lesson plan, deliver a teaching episode, and reflect upon whether their teaching philosophy was enacted through this teaching episode. There is a connection between all of these activities and offering them as discrete stand-alone modules would diminish the overall learning experience. Therefore, the Flexible Design principle has been re-drafted to reflect the true intent of the overall educational design:

Learning activities are accessed at a module level. These modules provide a pathway designed to help participants engage with the theoretical constructs of health professional education at a deeper level.

The Flexible Design principle now complements more fully the Prior Knowledge and Scaffolding principles by providing participants with opportunities to (a) increase their awareness of how their own knowledge is developing and (b) use their own resources and tools as scaffolds.

Prior knowledge

Learning is a transformative process of integrating new information and experiences into existing understandings, revising and reinterpreting existing knowledge in order to reconcile it with something new (Billet, 1996). Participants in the hybrid mobile-web learning environment can come from a variety of health contexts, and the educational design encourages the sharing of experience and understandings. Prior knowledge is valued, and a number of web-based tools are used in the design to activate prior knowledge. For example, sometimes participants “don’t know what they don’t know” and short quizzes supplemented by resources help participants to gauge their understanding of key underpinning knowledge. An online mind mapping tool (www.spiderscribe.net) enables participants to create, store and share their current thoughts and explore the links between concepts. Finally, blogs are used to encourage participants to present their point of view and receive feedback from peers.

Authentic activities

As mentioned previously, adult learning is primarily problem-based, rather than subject-based. In essence, problems provide a stimulus for learning. In trying to better understand, or solve the problem, participants learn relevant and related concepts in a contextualised meaningful way. The problem within the unit Teaching Methods in Health Professional Education is centred on a staff meeting where the Dean has informed faculty that their school will be undergoing an external curriculum review and each staff member will be asked to contribute to the process in some way. Using a range of multimedia, participants are asked to complete a series of tasks in their effort to support the curriculum review process. These tasks are authentic in that they represent real-life challenges faced by health professional educators in their efforts to ‘perform’ in an academic context. In keeping with Herrington, Oliver & Reeves’ (2003) assertion that “Authentic activities comprise complex tasks to be investigated by students over a sustained period of time”, the tasks within this unit are completed over the course of the semester and often require participants to trial concepts and ideas to their teaching and learning

context, reflect on it and share their experiences with the rest of the group. This is also in keeping with Herrington et al's (2003) definition of an authentic activity in that "collaboration is integral to the task, both within the course and the real world, rather than achievable by the individual learner".

One educational design challenge that has emerged has been in striking an appropriate balance between authenticity and generalisability. For example, developing a scenario and supporting resources that will equally serve the needs of a lecturer in nursing administration, a problem-based learning tutor, and a medical clinician who uses bedside teaching as her/his primary teaching approach.

Community

The traditional view of learning is one which emphasises the individual who is engaged in a process that is separated from other activities. This learning process is orchestrated by the teacher who manages the flow of knowledge from expert to novice. More recent conceptions (e.g. Wenger, 1999) view learning as part of our lived experience of participating in the world around us. The teacher is an important part of this, but so are others. The educational design underpinning the hybrid mobile-web learning environment is one that supports sharing, communication and collaboration. For example, in the Teaching Methods unit, participants are asked to conduct a self-appraisal of their teaching practice using a web-based tool and share, with their peers, their thoughts on both the quality of the tool and the process of self-appraising. This is conducted through a blog tool in *BlackBoard* where participants are encouraged to provide their own comments as well as responding to other participants' blog posts.

Facilitation

The hybrid mobile-web learning environment is not a self-paced e-learning resource. Facilitators will be allocated to each unit at the ratio of 1 facilitator for every 20 participants. The facilitator has four primary functions. Firstly, to support participants as they work through the activities that comprise each module. This is particularly important in the initial days after enrolment as participants acquaint themselves with what could be seen as a formidable and alien learning environment. The second function of the facilitator is to create a community of learners. Encouraging participants to make contact, and help each other, will help to create a vibrant and stimulating learning environment. The third function of the facilitator is to provide feedback to participants as they work through formative assessment tasks. Research (e.g. Butler & Winne, 1995) has shown that quality feedback greatly enhances knowledge construction and the propensity to apply knowledge to new situations. Finally, the facilitator will make judgements about the quality of work provided by participants through the various summative assessment items in each of the units. The facilitator, therefore, has a vital role to play in ensuring that the educational design works in the way it was intended including feeding back suggestions for improvement through the design-based research process.

Scaffolds

Problem-based authentic tasks are by nature more complex than pure academic ones. The ill-defined nature of the problem requires participants to engage in higher order thinking skills if they are to reason their way to a solution. For participants to successfully do this, they must be supported in their thinking by a range of mental strategies, resources and general prompts. These sorts of 'supports' are commonly known as 'scaffolds' in literature on learning strategies and learning theory. Scaffolds come in a range of forms (e.g., evocative questions from the teacher, texts, concept-mapping tools etc.) and bridge the gap between what the student currently knows and the knowledge needed to accomplish the task (Vygotsky, 1978). The types of scaffolds embedded in the hybrid mobile-web learning environment can be classified according to Steketee's (2002) symbolic, physical, social and individual resources. It is intended that participants will access social scaffolds through interactions with peers and the facilitator. Participants will be required to, on a regular basis, collaborate with the facilitator and peers to share thoughts and perspectives. These collaborations will encourage the participant to reflect on their developing ideas in the light of theory as well as multiple perspectives –

thus pushing their thinking to higher levels. Links to symbolic scaffolds such as concept maps will be embedded into the problem as tools that participants can access when necessary. Physical scaffolds such as electronic readings and links to other electronic sites will form the basis of the 'content' that participants' access in trying to gather relevant information to solve the set problem. Finally, individual scaffolds come in the form of metacognitive strategies that participants will be asked to engage in as they reflect on their prior knowledge, their progress and the extent to which their approach to learning has been successful or not.

Purposeful assessment

Closely linked to the concept of authentic activities are authentic and purposeful assessments. For activities to be genuinely authentic there must be some form of real life practical application of what has been learned. Purposeful assessment, where participants are assessed on their ability to demonstrate meaningful application of essential knowledge and skills that have been learned in the process of completing a task, is fundamental to sound educational design whether it is for an online or a more conventional learning environment. When there is seamless alignment between the learning task and the assessment task, participants are more motivated and engaged as they can see relevance to the theoretical constructs of a concept. They are able to apply theory to practice, generally in the context that is most relevant to their situation. In the hybrid mobile-web learning environment, assessment tasks are intended to match, as closely as possible, real world tasks required of the participants as health professional educators. For example, in completing an activity whereby participants are asked to audit their teaching practices over a two-week period in the light of contemporary learning theory, they are then asked to use the findings to devise a learning episode that they will implement, video and then send to the facilitator for feedback, and ultimately assessment.

Reflection

Reflection is an inherent and integral feature of metacognition. Metacognition involves two separate but interrelated phenomena, a) awareness about cognition, and b) regulation of cognitive behaviour (Brown, Bransford, Ferrara & Campione, 1983). Being able to regulate cognitive behaviour implies that participants think about and reflect on the process of learning before, during and post learning experiences. The current learning environment has a number of reflective opportunities embedded in it. For example, before tackling problems, participants are required to reflect on what they already know and use this information as the starting point for new learning. They are also required to reflect post learning in terms of writing reflections in their online journals and blogs about what they learned as a result of the experience. However, this review has revealed an inadequacy in terms of prompts for participants to reflect during learning, not only in terms of their understanding of the content, but in terms of opportunities to consider whether the learning strategies they are using are effective or not. Although quizzes are embedded throughout the units as opportunities to 'check your understanding' more deep reflective prompts are required that encourage consideration of the what and how of learning. This type of metacognition (i.e., being able to regulate one's own learning) is crucial for online learning environments such as this one given the cognitive demands of the set problems and the fact that participants are required to take a student-centred approach to solving them.

Conclusions

Educating medical doctors and other health professionals about best practices in teaching and learning is an important element in their overall development as professionals. Given that these individuals will be responsible for educating future generations of health professionals, it is necessary that they do so according to current thinking on how adults learn best. However, current approaches to educational professional development in the medical context has been less than adequate and it has been inherently accepted within clinical settings that doctors' experiences as learners are sufficient in making them adequate teachers. This is not the case and a review of the literature has revealed that untrained medical teachers can and often do provide substandard teaching experiences. Providing educational

professional development to doctors, however, is problematic given the complex and busy demands of their clinical commitments.

In trying to address this issue, two courses have been developed that take into consideration the cultural and historical nuances of training medical teachers. Using design-based research methodology, a hybrid mobile-web learning environment has been developed to ensure high flexibility and impact as well as sound principles of instructional design. In following stages of design-based research methodology, as proposed by Reeves (2011), cycles and products have been reviewed regularly. Design-based research has provided a systematic framework in which to conceptualise, re-think and re-engineer the design of the hybrid mobile-web learning environment. For example, the approach encouraged designers to develop an integrated system of learning, one which acknowledged the educational affordances of new learning technologies and articulated a clear role and purpose for each of the technologies adopted. The process helped designers to re-think the modular approach to one which better supports practices of building upon prior knowledge to construct new knowledge. Finally, designers have developed a more nuanced understanding of striking an appropriate balance between authenticity and generalisability in a complex health professional education environment. This paper thus provided insight into the extent to which the design principles were evident in aspects of the course content that has been developed to date. While there are areas for improvement, it is evident that the design-based research methodology has ensured the designers stay true to the objectives and specifications of the course.

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