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IMPLICATIONS OF UPDATING DIGITAL LITERACY – A CASE STUDY IN AN OPTOMETRIC CURRICULUM

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ABSTRACT

Aim/Purpose	The aim of this project was to explore a method to enable an updated understanding of digital literacy to be implemented in curricula in an environment of an existing, but outdated, understanding of digital literacy.
Background	The changing healthcare environment increasingly emphasizes the importance of digital literacy skills; therefore academics in the optometry discipline at Deakin University sought to better understand where digital literacy skills were taught in their program, and whether delivery was implicit or explicit.
Methodology	This case study describes a systematic review of the optometric curriculum to first identify where and what digital literacy skills are currently being addressed in the curriculum, identify the gaps, and develop a strategy to address the gaps.
Contribution	The main outcome of this work is the development of a spiraling curriculum to support the development of digital literacy skills required in later units of the program and for clinical practice post-graduation.
Findings	Although the definition of digital literacy may be outdated, the digital literacy capabilities being addressed in the curriculum had grown as digital technology use by staff and students had expanded. This, together with the realization that students were not as digitally capable as expected, indicated that teaching digital literacy skills needed to be made overt throughout the curriculum.

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Recommendations for Practitioners	The process developed through this case study provides a strong foundation for course teams, curriculum developers and educational designers to efficiently analyze digital literacy expectations in existing, accredited health-related curricula and improve the curricula by more overtly embedding digital literacy teaching into it.
Impact on Society	Graduates of the amended program of study are expected to be better prepared to undertake their future careers in a digitally enhanced and disrupted environment.
Future Research	The framework will be used to explore digital literacy teaching practices in other disciplines. A systematic evaluation will be undertaken to identify the benefits and short comings of using the framework. The elements that make up the new definition of digital literacy need to be better articulated to allow curriculum developers to be better informed as to how to interpret the framework in their context.

Keywords optometry, digital literacy, graduate learning outcomes, health professional education

INTRODUCTION

It has long been appreciated that training programs for health care professionals must equip students with a range of knowledge and skills beyond the discipline specific. In a number of degrees that lead to professional accreditation, graduate competencies are mandated by registration bodies, therefore the curriculum must include training and assessment in diverse professional competencies, for example including reflective- and evidence-based practice, communication, teamwork and problem solving. Whilst many competencies within the discipline-specific domain (for example pathophysiology or disease management in optometry) are well scaffolded throughout training programs, the curriculum for learning opportunities and assessment of complementary competencies are also of vital importance in the development of professional identity across the spectrum of health practitioners

A need to revisit digital literacy in the optometric curriculum at Deakin University was identified, as there was growing recognition that:

- demands being placed on students' digital skills was changing;
- students' digital skills were not as advanced as many academics were expecting; and,
- the skills needed in the workplace are increasingly focusing on digital literacy capabilities in areas that are broader than the University's current understanding of digital literacy.

This paper reports on the first stages of a case study that explored the development of digital literacy as a complementary competency in an optometry degree at Deakin University. We first provide the context of the degree, which emphasizes discipline and professional skills development, followed by an explanation of why digital literacy was the focus of the case study. We then discuss the process that was adopted to identify where digital literacy skills development occurred in the curriculum and the framework that was developed to facilitate digital literacy development in an integrated learning environment. The paper concludes with some overall comments on the efficacy of conducting such a review, as well as highlighting some limitations of the process. Further work is identified, particularly relating to evaluating the outcomes of the review and curriculum redevelopment in light of the review. Although our focus is upon a single course, the outcomes of this review are relevant to a range of health-related disciplines given the increasing focus on reflective- and evidence- based practice, lifelong learning and a rapidly changing technological environment.

BACKGROUND

The practice of optometry in Australia is limited to individuals who are registered by the Optometry Board of Australia, who publish the registration standard and entry level competencies. The Optometry Council of Australia and New Zealand (OCANZ) is responsible for assessing optometry programs against these standards including the entry-level competencies. The range of competencies go beyond the discipline specific, including a number of professional competencies that are heavily dependent on students developing strong digital literacy skills during the course of their optometric degree. These competencies include such elements as the ability to develop and self-audit optometric skills (which requires competencies in reflective practice and the skills to independently research to maintain lifelong learning), adopt an evidence-based approach to practice, and use resources from optometric and other organizations to enhance patient management. Other competencies revolve around trainee optometrists developing communication, critical thinking and teamwork skills. Whilst these skills have, in the past, been considered "soft skills" that can be developed informally during the course of training, there is now a focus from universities, registration bodies and industry groups across the spectrum of health-care professions to develop a professional identity at the same time as developing professional knowledge. (Kiely & Slater, 2015)

Overlaying professional requirements, Deakin University has articulated eight Graduate Learning Outcomes (GLOs) which are operationalized as Course Learning Outcomes. These are developed through every degree. The GLOs are:

1. GLO1 Discipline specific knowledge (in this case vision science and the practice of optometry);
2. GLO2 Communication;
3. GLO3 Digital Literacy;
4. GLO4 Critical Thinking;
5. GLO5 Problem Solving;
6. GLO6 Self-Management;
7. GLO7 Teamwork;
8. GLO8 Global Citizenship.

When the Bachelor of Vision Science/Master of Optometry combined degree was designed, there was an emphasis on using integrated, active learning methodologies to co-develop both professional skills (GLO1) and professional identity (GLOs 2-7). To this end, a reverse-design process was adopted to develop the curriculum which has undergone constant refinement since 2012. The current curriculum is shown in Table 1 below. The program is designed across ten trimesters and can be completed in 3.5 years (3 trimesters per year). The first 3 trimesters (Year 1) focus on providing learning experiences and opportunities that enable students to develop foundational skills in biology, optics, ocular anatomy and ocular physiology (GLO1). Significant resources and time are allocated to enable students to develop their professional identity (GLOs 2-7), with a focus on digital literacy and academic and scientific literacy skills that equip students with the ability to locate, evaluate and curate the information that they need to guide independent and active learning. The following 5 trimesters combine vertically and horizontally integrated curricula to simultaneously teach the vision science and clinical optometric skills required for independent practice. This is followed by two capstone units where students experience industry-based learning (IBL) within optometric practices (shown in Table 1 as Community Optometry I and II). In this final 6 months of the Master of Optometry degree, students work in community practice, providing clinical care and communicating with their professional colleagues.

As seen in Table 1, 25% of the foundation studies are categorized as being almost entirely discipline specific (green fill) and the learning outcomes are concentrated around GLO1, 33% are heavily focused on developing professional identity (yellow fill) and the remainder teach a mix of professional knowledge and professional identity (no color). Following the foundation studies, the curriculum uses a problem-based learning (PBL) pedagogy and team-based learning (TBL) assessment strategy which are vertically integrated with clinical skills development. TBL is also used to provide students an additional opportunity to learn material in a process that encourages reflective practice and demands digital literacy skills. The active, independent learning promoted in this part of the course is highly dependent on students being able to analyze problems, reflect on their current state of knowledge, access relevant information and integrate this new information in a collaborative environment to develop their knowledge and solve clinical problems. Digital literacy, communication and many of the other GLOs must be developed during this phase of the learning journey. In the capstone units, the foundational and vertically and horizontally integrated teaching are combined where, again, the learning is considered to be discipline specific, but now is a conflation of the professional identity and professional skill set that students have developed in the earlier parts of the course (blue fill in table 1).

Table 1: Deakin's Optometry curriculum map

Bachelor of Vision Science	T1	Cell Biology	Optics I	Understanding Health	Health Info and Data	Foundation Studies
	T2	Chemistry	Optics II	Vision Science I	Ocular Anatomy	
	T3	Accounting	Optometry Business	Vision Science II	Ocular Physiology	
	T4	Health and Vision Science I		Principles and Practice of Optometry I		PBL/TBL/Clinical Optometric Skill Development
	T5	Health and Vision Science II		Principles and Practice of Optometry II		
	T6	Health and Vision Science III		Principles and Practice of Optometry III		
Master of Optometry	T7	Advanced Optometric Studies I				
	T8	Advanced Optometric Studies II				
	T9	Community Optometry I				IBL (Clinical Placement)
	T10	Community Optometry II				

Such integrated learning within health professional programs is not new, being well established in medical education courses since the latter part of the 20th century, particularly through the integrated approaches to teaching of the biomedical sciences that underpin medical, nursing and a range of health practices and the integration of sciences with medical practice (Prideaux & Ash, 2013). The rationale for integrated learning can be located within the literature of cognitive psychology. Regehr and Norman (1996) have summarized the literature and examined its implications for professional education, concluding that 'information in isolation is inert and unhelpful'. The storage and retrieval of information in memory is aided when the information is combined into meaningful schemata as are found in integrated learning programs. One of the key factors is the concept of 'context specificity'. It has been demonstrated that the ability to retrieve an item from memory depends on the similarity between the context in which it was originally learned and the context in which it is retrieved. Therefore, authentic scenario-based training that encourages learners to access, analyze and retrieve information is likely to translate to an improved ability to manage complex patient scenarios in real-life practice. As such, a number of skills that fall within the digital literacy domain are required. Students must develop the ability to define learning goals based on a rapid and efficient reflective practice exercise, efficiently access quality information, curate this information and then apply the knowledge back to the patient care plan.

Elaboration of learning in 'richer' and 'wider' contexts provides multiple opportunities for information to be stored in one context and then retrieved in another. Horizontally integrated programs where various disciplines are integrated in a single case provide students with multiple opportunities for information storage and retrieval. Repeated opportunities to use information in different systems or case contexts also assist in overcoming the effects of case specificity. In vertically integrated programs knowledge in different contexts and combinations of disciplines is revisited over the duration of the course. Practicing health professionals integrate discipline knowledge and experience, applying this to clinical practice, providing a strong rationale for students to learn through integrated clinical practice. If students gain knowledge in integrated learning environments they will be better able to retrieve this in the integrated clinical environments. Janssen-Nordman, Merrinboer, van der Vleuten, and Scherpbier (2006) have reviewed empirical studies in the design of integrated learning programs and concluded that "when students learn complex tasks in an integrated manner it will be easier for them to transfer what they have learned to the reality of day-to-day work settings".

As is standard for many medical and allied health training programs, the Deakin Optometry course incorporates several of the principles of integrated design. The case- and problem-based learning tutorials integrate learning from across the disciplines which students apply to a single case drawn from practice. This is followed by team-based learning sessions which allow for multiple examples of cases in multiple contexts expanding students' capacity for information retrieval and assisting students to combine information into meaningful schemata. The cases have been carefully underpinned by concept maps which promote the revisiting and elaboration of key concepts from across the disciplines in the various stages of the course.

Integrated learning is a key part of the preparation and practice of contemporary health professionals. It is built on sound evidence that aids both the storage of information in memory and its retrieval and application in practice. Again, a key requirement is the ability to reflect, formulate a plan to locate information, curate this information and re-apply new knowledge to a problem. Many of these skills are core to a collection of competencies that may be categorized within a digital literacy framework.

WHY IS DIGITAL LITERACY IMPORTANT?

Paul Gilster is acknowledged to have coined the term digital literacy in 1997 and conceptualized it as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers" (Gilster, 1997, p.1). Gilster's understanding of digital literacy is now over 20 years old. It has evolved to incorporate elements derived from other terms such as information literacy, computer literacy and media literacy (Gallardo-Echenique, de Olibeira, Marqués-Molias, & Esteve-Mon, 2015) and is now used to describe almost anything related to technology or computers. It is interchanged with behaviors, understanding how technology works and, more broadly, the role of technology in daily operations (Lankshear and Knobel, 2008). It is for this reason that digital literacy is hard to define. The complexity of the term creates challenges for educators who are responsible for equipping students for employment in the digital age, regardless of discipline. It also poses challenges for students who are expected to acquire, at worst an unknown and at best a fuzzy, set of capabilities. Often staff and students' expectations are not aligned, causing significant issues for both parties (Coldwell-Neilson, 2013, 2018).

Digital technologies have advanced considerably since the last century and moved from "closed shop" situations to being ubiquitous. You do not have to be a computer expert to have more computing power in your pocket, in the guise of a mobile phone for example, than that of an IBM mainframe computer of the last century. Now, the activities of daily living are regularly facilitated through mobile devices such as mobile phones and tablets. Technological advances are dramatically changing the nature of employment which will, inevitably, lead to disruption of current work practices and the need for skill sets which can support employment in the digitally enhanced environment (Committee for Economic Development of Australia (CEDA), 2015; Foundation for Young Australians (FYA), 2015). Our workplaces have changed accordingly, over a relatively short period, with almost all desks housing a digital device, a desktop PC or a laptop, and other smart devices. Employees are expected to use these devices to facilitate their work efficiently. Similarly, students are expected to use such devices to facilitate their learning and to develop appropriate skills to be able to be effective in a digitally disrupted workplace.

A report recently published by the Commonwealth Scientific and Industrial Research Organisation (Hajkowicz et al., 2016) suggests that digital literacy will be a threshold capability of the future and, as Coldwell-Neilson (2017) states:

Digital literacy is increasingly being recognized as an essential skill, on a par with literacy and numeracy, to support job readiness.

The term digital literacy is used assuming that others have a shared discourse. Further, there is an assumption that because digital natives (those born or brought up during the digital technology age, nominally since 1980, a concept developed by Prensky in 2001) use technology extensively, they are digitally literate. This is not the case (Ng, 2012). There is growing recognition that technology use does not necessarily equate to technology understanding and may not contribute to transferable digital literacy skills (Burton, Summers, Lawrence, Noble & Gibbings, 2015; McLachlan, Craig & Coldwell-Neilson, 2016). Further, it has been demonstrated that, as a concept, the phrase digital natives is unhelpful when making assumptions around digital capabilities particularly of students (White & Le Cornu, 2017). However, that said, it is not uncommon for students to believe they are digitally literate as they use social media and other information sharing applications extensively. But the skills they develop through using such technologies seem to be locked into the technology itself; they often do not recognize that the skills are transferrable to other situations, applications or technologies.

Digitally enhanced environments demand ongoing digital literacy skills development and the healthcare industry is not immune from these changes. Some examples of digital disruption specifically within the healthcare sector are provided as motivation for the need to review digital literacy within healthcare curricula. Sullivan and Staib (2017) describe digital disruption as:

The changes facilitated by digital technologies that occur at a pace and magnitude that disrupt established ways of value creation, social interactions, doing business and more generally our thinking;

In the context of digital transformation of hospitals in Australia. The example they provide is of the roll-out of an integrated electronic medical records system in a large tertiary university hospital. Vernig (2016) discusses telemental health, were digital technologies have facilitated clinicians to connect remotely to patients via teleconferencing. Vernig points out that telemedicine is not a new concept, but has been within our horizon since NASA utilized technology to monitor the health of astronauts while in space. Ford, Compton, Millett and Tzortzis (2017) examine the role of digital disruption more broadly in the context of healthcare service innovation. They propose that healthcare systems are:

Experiencing significant challenges posed by population increases, ageing populations, increasing rates of chronic disease, the need to improve access to services for patients in remote areas, and ever-higher consumer expectations;

But technology has the potential to 'contribute to solutions that transform the traditional structure of the healthcare industry and its operating model' enabling more efficient and effective delivery of care and prevention programs, which could lead to improved health outcomes. Ford et al. (2017) further suggest that there are three types of disruptive technology in the healthcare industry, specifically genomics, nanotechnology and digitization (the combination of hardware and software).

Recent Developments to Support Digital Literacy Education

The European Commission has been a leader in identifying the need for building capacity in the digital space since it identified digital competence as one of eight key competencies for lifelong learning in 2006. These have had a significant impact on subsequent developments, guiding the development of digital literacy, competency frameworks and programs to ensure that citizens do not feel 'left behind and marginalized by globalization and the digital revolution' (European Commission, 2008 p.1). The European Commission (2006) defined digital competence as:

… The confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet. (p.6).

The Joint Information Systems Committee (JISC) has been leading digital literacy developments in higher education in the UK for some time. Aligned with the European Union's definition, JISC defines digital literacies as 'the capabilities which fit an individual for living, learning and working in a digital society' (JISC, 2014). JISC goes on to suggest that digital literacy goes:

Beyond functional IT skills to describe a richer set of digital behaviors, practices and identities. What it means to be digitally literate changes over time and across contexts … (JISC, 2014).

JISC has developed a six-element model of the literacies underpinning their definition, which is described in Figure 1 (from https://www.jisc.ac.uk/guides/developing-students-digital-literacy).

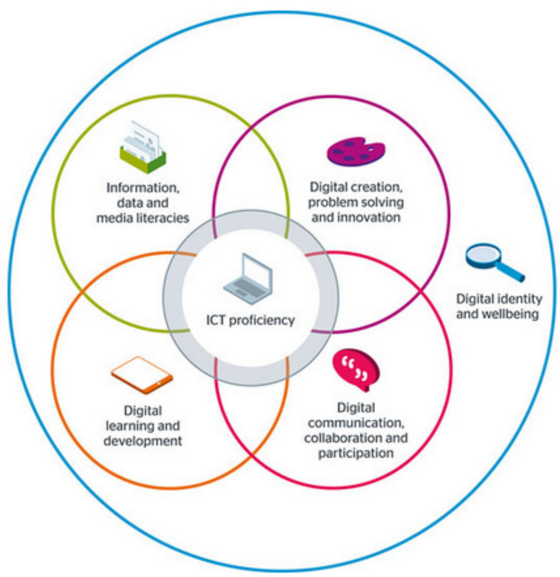

Figure 1: JISC six element model of digital literacy (used with permission)

In conjunction with the JISC model, Sharpe & Beetham (2010) developed a pyramid model to describe the digital literacy developmental process. The process starts with access to and awareness of digital technologies, followed by functional skills development to higher level capabilities and identity (see Figure 2). This model is particularly helpful in facilitating and understanding how students can be motivated to explore new technologies and gain new skills by presenting them with challenges at the higher levels of the pyramid. The four levels of the pyramid can be interpreted as tools (I have), skills (I can), practices (I do) and attributes (I am).

Figure 2: Digital literacy development pyramid (used with permission)

A review of existing digital literacy frameworks and models by All Aboard Ireland points out that the overlapping, multi-literacy nature of the existing digital literacy definitions is still required when defining digital literacy but:

All of these domains are engaged with the digital sphere; meaning that today 'digital skills' extends in meaning well beyond the original narrower, IT skills based definition (All Aboard 2015, p.12).

The literature around these technology-based definitions of digital literacy is starting to become outdated, as current higher education graduates are not displaying the basic, functional digital literacy skills required by employers. Therefore, it is essential that, regardless of the understanding of digital literacy that is adopted within a learning environment, the capabilities are developed within specific contexts, in the case of this study, optometry, for students to be adequately prepared for the jobs of the future in that context. Further, Australia is approximately 10 years behind Europe and the UK as far as addressing digital literacy in educational contexts is concerned. It was not until 2015 that the Australian Government and others (CEDA, 2015; FYA, 2015) highlighted the need for higher education to respond to the fast-changing future employment environment. The Government's National Innovation and Science Agenda "emphasizes the government's priority of helping students embrace the digital age and prepare for the jobs of the future. Graduates need skills related to using digital technologies creatively, effectively and independently in a digital world". (Coldwell-Neilson, 2016)

Within the optometric, and broader health care disciplines, there is strong recognition of the impact that technology is having. Goodfellow and Maino point out that information technology is vying with 'Reading, wRiting and aRithmetic' as an additional leg to this three-legged stool and 'of all the things changing in optometric education, technology is leading the pack' (2011). Although talking about information literacy, Denial (2016) points out that although 'the millennial generation are savvy in the use of technology' this does not necessarily translate to technology literacy skills and discusses the importance of integrating relevant, sustainable teaching to support the skills that students 'think they have'. The initial reverse-designed optometry curriculum was strongly focused on discipline specific knowledge (GLO1) and there was concern that the demands of advancing technology use in the discipline may not be being accommodated. It was recognized that many of the expected professional skills relied on strong digital literacy skills, so a key driver for undertaking this case study was to improve students' graduate outcomes in general and digital literacy skills in particular. To do this we:

1. Identified current learning activities and assessment that implicitly or explicitly taught or assessed digital literacy, with the aim of;
2. Addressing shortcomings and ensuring inclusion of opportunities to develop a broader set of digital literacy skills beyond the understanding implied by Gilster's definition.

PROCESS

In order to better understand the representation of digital literacy throughout the Bachelor of Vision Science/Master of Optometry, it was decided to map the existing course against an accepted definition of digital literacy. Mapping the course in this way revealed where, and how, digital literacy was assessed across the span of the course. It also allowed for the creation of a framework to understand the stages of development of a digitally literate optometry student. It must be noted that digital literacy within the Deakin context is driven by the relevant graduate learning outcome which defines it 'as using technologies to find, use and disseminate information' (http://www.deakin.edu.au/about-deakin/teaching-and-learning/deakin-graduate-learning-outcomes), but it also falls within the professional development domains that Kiely and Slater (2015) discuss. This understanding of digital literacy was key in establishing and informing the development of digital literacy capabilities within the optometry degree initially, as well as all other degree programs within Deakin. To meet the expectations of a modern, digitally disrupted, working environment we felt it important to verify that explicit and implicit learning opportunities be mapped for constructive alignment. To operationalize the mapping process, we initially defined the scope of digital literacies that a graduate optometrist required and then engaged in a reverse-designed curriculum mapping process to identify where skills were assessed.

The mapping afforded an opportunity for the course team to reflect on the digital literacy skills they assumed students already possessed (i.e. had developed outside of the curriculum), what level of skills and capabilities were expected and whether this expectation was reasonable. It also enabled identification of any gaps in the intended constructive alignment of the degree. Mapping was also used as the basis for understanding which assessments required students to improve on their existing digital literacy skills and identifying where support was needed to facilitate improvement. By scaffolding the learning opportunities and assessment across the early part of the course, we aimed to provide a foundation in digital literacy skills which contribute to professional identity development in an analogous fashion to the foundational discipline specific programme designed to provide the base upon which to build professional (clinical) skills

The course team determined that the JISC model of digital literacy (shown in Figure 1) most closely resembled the digital capabilities that they expected of graduating students, hence the mapping process relied on the six JISC digital literacy elements which are:

- ICT proficiency
- Information, data and media literacies
- Digital creation, problem solving and innovation
- Digital communication, collaboration and participation
- Digital learning and development
- Digital identity and wellbeing

Although ICT proficiency is displayed in the centre of Figure 1 with the other elements emanating as petals from this central element, it is seen as the foundation for the other five elements to be built on and grow.

Unit guides for each individual unit within the Bachelor of Vision Science/Master of Optometry (as shown in Table 1) were used to commence the mapping process. These guides provided details on the unit and course learning outcomes, the assessments for the unit, and the corresponding unit learning outcomes associated with each assessment.

Information about each assessment was then examined by two reviewers (independent to the optometry curriculum team), and a decision was made on whether the task assessed any of the six JISC digital literacy elements. If an assessment assessed digital literacy explicitly (by reference to a digital literacy-associated unit learning outcome) or, in the judgement of the two reviewers through their inherent knowledge of the course, implicitly (without a digital literacy-associated learning outcome but where the description of an assessment clearly relies on digital literacy), the details of the assessment were recorded including unit name, where the unit fell in the course curriculum (i.e. year and trimester), task details, type of task, and which element(s) of digital literacy were being called on by the assessment. In the absence of any explicit or implicit connection to digital literacy, these same assessment details were recorded but an indication made that none of the six JISC elements were applicable to that assessment. Academic staff from the Bachelor of Vision Science/ Master of Optometry course reviewed the results of the mapping process to confirm its accuracy.

Mapping of assessments to digital literacy elements resulted in the creation of a picture of digital literacy across the course, from which conclusions were drawn about the frequency the elements of digital literacy were assessed, where in the course curriculum they were assessed, and the types of assessment tasks that were used to assess these skills. This stage highlighted where there was a mismatch between expected learning and assessment expectations. Of particular concern were components that were explicitly assessed without explicit teaching, or implicit assessment which could result in non-achievement of associated explicit assessment.

The mapping process facilitated the creation of a framework of the Bachelor of Vision Science/Master of Optometry's view of the stages of the digitally literate optometry graduate. The framework was adapted from Sharpe and Beetham's (2010) developmental model (shown in Figure 2) and sought to identify the tools, skills, practices and attributes of an optometry graduate. The mapping is shown in Table 2. The reviewers relied on this mapping, in conjunction with details from assessment, unit or course information, to describe the components of each developmental stage in the context of the course. Components in each stage were recorded as affirmative statements that the digitally literate Optometry student might make at a particular stage, e.g. 'I am a proactive, lifelong learner who keeps up to date with emerging research and technology.' Academic staff from the Bachelor of Vision Science/Master of Optometry were then consulted to confirm that interpretation and contextualisation of the components was appropriate and to validate the developmental stages framework. This triangulation process confirmed that interpretation and contextualisation of the components was appropriate.

Table 2: Stages of the digitally literate Optometry graduate

	Component	Year levels (1, 2, 3, 4)	Explicit (E) Implicit (I) Taught (T) Assessed (A)
Attributes	I effectively develop evidence-based communications for patients and colleagues.	All	ET - EA
	I am a proactive, lifelong-learner who keeps up to date with emerging research and technology.	All	IT - IA
	I interpret key resources and defend evidence-based decisions for a wide range of clinical and ethical challenges in optometric practice.	All	ET - EA
	I generate, collect, organise, analyse and manage data appropriately.	1- 3	ET - EA
	I work effectively with colleagues in teams, including online.	All	IT - EA
	I approach my business dealings with acumen and integrity.	All	IT - IA
	I manage my online persona and personal information strategically in order to maintain a positive and professional image.	All	IT
Practices	I critically appraise the quality of scientific information.	All	ET - EA
	I communicate research effectively using multimedia	All	IT - EA
	I effectively consult research literature to fill gaps in my knowledge, and put it into practice.	All	ET - EA
	I reflect on how to collect and communicate data.	1	ET - EA
	I evaluate and communicate data regarding the structure and function of the visual system, giving due respect to cultural and social issues.	2-4	ET - EA

	Component	Year levels (1, 2, 3, 4)	Explicit (E) Implicit (I) Taught (T) Assessed (A)
	I compare and contrast the clinical data collected with findings reported in the clinical and scientific literature.	1	ET - EA
	I work within a research team to design research questions, design experimental protocols to test these questions, then beginning to collect data using this protocol.	2-3	ET - EA
	I demonstrate efficiency and effectiveness in my use of digital clinical technology during patient examinations, in order to achieve appropriate diagnostic outcomes.	2-4	ET - EA
	I argue for a perspective using appropriate claims backed by evidence.	All	IT - IA
	I adapt clinically presented information into a written case report in a clear, concise and insightful form.	2-4	ET - EA
	I use technologies to identify and synthesise discipline knowledge, evidence, data and statistics and use this to problem solve, and inform decision-making and professional best practice.	All	ET - EA
	I conduct myself professionally.	2-4	IT - EA
Skills	I can source, consult and synthesise literature relating to vision science.	All	ET - EA
	I can prepare scientific and educational posters.	1, 3	ET - EA
	I can prepare online videos.	1, 2	IT - EA
	I can develop an effective business plan.	1	ET - EA
	I can apply research literature to practical exercises and case studies.	All	ET - EA
	I can identify gaps in my knowledge.	All	ET - EA
	I can collect and communicate research data.	All	ET - EA
	I can compare patient's cases to evidence in the literature.	All	ET - EA
	I can demonstrate and apply proficiency in operating clinical tools that are used to collect data to assess the structure and function of the eye and visual system.	2 -4	ET - EA
	I make use of technology in order to attend case conference sessions.	4	IT - IA
	I collaborate in a professional manner, using collaborative technologies as appropriate.	3 - 4	ET - EA
	I can understand multiple perspectives on a topic.	All	ET - EA
	I interpret statistical information correctly.	All	ET - EA
	I gather data from, and ask specific questions relating to, experiments.	All	ET - EA
	I am able to use Optometric equipment for professional purposes.	2 - 4	ET - EA
Tools	I have access to, and can use, bibliographic referencing tools (e.g. EndNote)	All	ET - EA
	I am aware of library-purchased and freely available information resources	All	IT
	I can use university LMS and other learning tools	All	IT
	I am aware of and have access to connectivity/data transference and management tools	All	IT
	I am aware of and use social and professional networks	All	IT
	I can use clinical diagnostic tools	All	IT - IA

Thus, the mapping process enabled the state of digital literacy in the Bachelor of Vision Science/Master of Optometry to be examined from a different perspective to that used in the original course design. Deakin's digital literacy graduate learning outcome was the basis of digital literacy understanding in the original program whereas the JISC model, together with Sharpe & Beetham's

(2010) pyramid was used for the current mapping. A framework was created to describe the stages of the digitally literate optometry student as currently envisioned by the course team.

THE SKILLS DEVELOPMENT FRAMEWORK

The Deakin Optometry course, as previously stated, was reverse designed from the competencies and standards prescribed by the Profession's accrediting body, OCANZ (Kiely & Slater, 2015). In this respect, the outcomes that we describe here are relevant to the majority of health care training courses; the majority of which are reverse designed from a set of competencies that define the entry level graduate. Most of these competencies are focused on knowledge and skills acquisition specific for the profession. However, implicit in these competencies are skills such as digital literacy. The act of reverse designing the curriculum from these standards provided a unique experience in determining discrete steps in knowledge acquisition. This robust infrastructure of the curriculum allows for objective analysis of the alignment between assessments and the explicit curriculum. Undertaking the analysis revealed how much of the curriculum is implicit, much of which may have been driven by the knowledge and specific skills described within the OCANZ competencies. It was clear that both the level of assessment, and taught curriculum included many assumptions about the initial skill level of the student, and the amount of skill development required (without formal teaching) in order to complete assignments and thus demonstrate skills.

The framework we have developed from this process, shown in Figure 3, stays true to the reverse design of the course. The initial step was to develop a clear list of attributes, skills and capabilities of a proficient, competent, and adaptable optometrist. Of particular importance to digital literacy were the elements of proficiency and adaptability. Due to the unknown nature of how the optometry profession will develop in the future, students must graduate with the ability to adapt to a changing digital future.

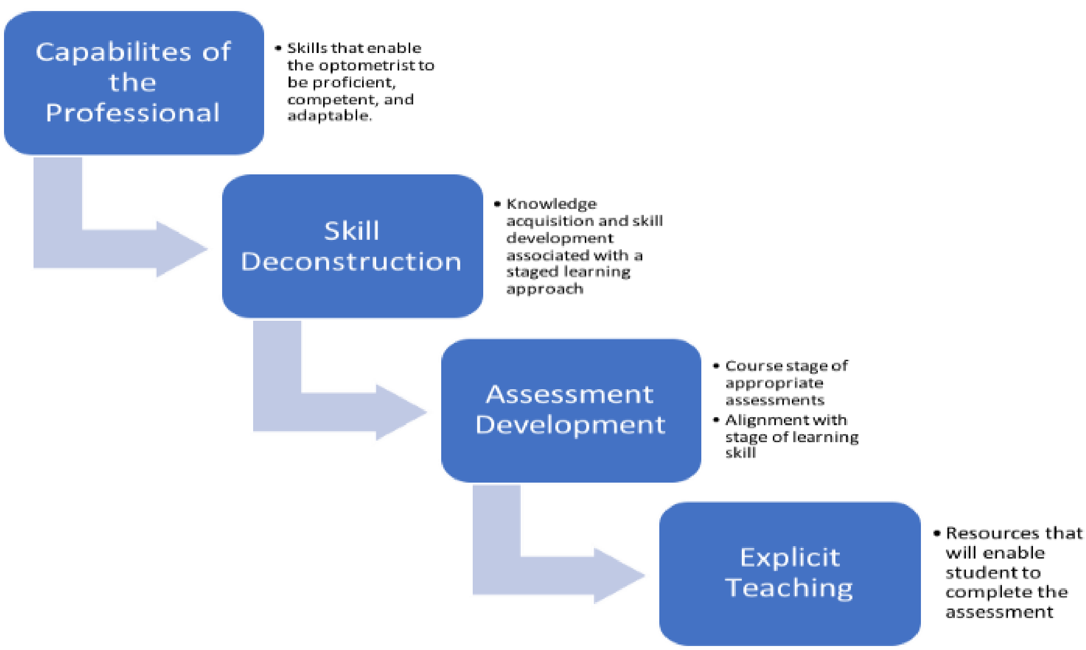

Figure 3: Framework for Skills Development

Once the skills are defined through the first stage of inspecting unit guides, the second stage of the framework is to deconstruct skills into stages of acquisition (i.e. year level). This stage is vital as it challenges assumptions around initial skill levels of students.

The third stage of the framework requires development of assessments based around stages of skill acquisition. This stage does not necessarily mean a *de novo* assessment task, but often an adjustment to current assessment practices. These adjustments may include explicit language around what is being assessed, or additions to the assessment that make the task more authentic to future practice.

The fourth and final stage in the framework requires a decision on what needs to be taught in order for the student to be capable of completing the assessment, as well as perceiving its authenticity within the future profession. This is also the stage at which it is important to address any skills gap that may exist between where the student is, and where they need to be in order to achieve the learning that prepares them for the assessment. This is often quite individual, which is why it may not be part of the formal curriculum but be a student resource in order to address the skill deficiency.

The application of this framework to digital literacy, particularly the JISC definition, elucidated that the predominant optometric skill in which it would be fundamental in developing an adaptable skill was evidence-based practice (EBP). Evidence-based practice is presented to students as the bedrock of their profession. It is the foundation upon which they develop their clinical decision-making skills, communication skills, and reflective practice skills. Applying the framework highlighted assumptions that students would develop the skill of digital literacy in EBP while completing assessment tasks. In other words, digital literacy was very much part of the hidden curriculum, in this context referring to intentional learning without accompanying intentional teaching. The framework allowed this implicit curriculum to become explicit. Therefore, as digital literacy is a fundamental skill for EBP, it was important it be made more explicit in first year when students were encountering the theory of EBP and being assessed on the fundamentals of the EBP.

Conclusions and Future Work

Although there are now seven optometry programs in Australia and New Zealand, this is, to our knowledge, the first occasion on which digital literacy skills have been mapped in the context of a digital literacy specific framework. Our preliminary analysis of the outcomes suggests that there is strong coverage of digital literacy skills in the early years of the program, and that they are often taught and assessed explicitly. Thereafter, a number of skills are not taught or assessed and therefore it is assumed that the digital literacy skills have, at least, been maintained. Moreover, although we present a relatively dichotomous classification (explicit or implicit) we appreciate that this classification is better described as a continuous variable and our analysis has enabled us to identify areas where the curriculum can be taught in a more explicit way. To this end we have collaborated with Library staff at Deakin to develop a digital literacy toolkit which students will be able to access across their course of studies and provide explicit revision opportunities where students are required to use digital literacy skills taught in previous years of the course. This approach also addresses the often very different levels of digital literacy skills with which students enter the program. The toolkit has been developed with reference to specific tools, skills and practices rather than discipline specific situations, making it relevant in multiple disciplines.

The experience of optometry lecturers within the course is that students do not always appreciate the value of digital literacy skills in enabling effective clinical practice. Further work is currently focusing on providing teaching experiences that explicitly link digital literacy fundamentals with effective clinical practice. Evidence based practice and reflective practice are key domains to emphasize here. Given the emphasis within most medical and health related disciplined to move to patient-centered, evidence-based care plans, these are becoming fundamental skills across the health care continuum.

The process of mapping digital literacy skills in an otherwise well mapped curriculum indicates that there is a need to reframe learning opportunities to make them more explicit and to provide students with a clear appreciation of how the development of professional identity (e.g. digital literacy, communication, self-motivation) is as vital to becoming an optometric practitioner as is the development of discipline-specific professional skills. Our experience in this context suggests that mapping individual (or sets of) graduate learning outcomes beyond the discipline specific would be of benefit to all health professional training programs.

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BIOGRAPHIES

Jo Coldwell-Neilson has been an academic for 30 years. She has built a strong research and teaching profile engaging students in and with technology. She has been active in a variety of projects including implementing educational technologies in her teaching and in the teaching and learning activities at Faculty and University levels. Jo's research includes investigations into gender issues in IT, digital technology uptake in schools and higher education, and preparing students for careers in a digital environment. In 2016 Jo was awarded an Australian Learning and Teaching Fellowship. Jo is currently Associate Dean (Teaching and Learning) in the Faculty of Science Engineering and Built Environment.

James Armitage is the Optometry Course Director in the School of Medicine. He is a practicing optometrist and his research interests include developmental programming of cardiovascular, metabolic and autonomic dysfunction, and the interplay between ocular and vascular function. James' teaching practice includes the development and use of novel tools and learning resources to provide personalized, active learning opportunities for students. His scholarly teaching activities seek to review the way that communication, professional behaviour and digital literacy are taught and transform them from "hidden curriculum" to being explicitly taught and assessed which are central to the development of professional identity.

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Alex Gentle completed his clinical optometry training at City University and Moorfields Eye Hospital in London, received his PhD, in vision science, at the University of Wales, Cardiff and formal university teaching qualification from the University of Melbourne. He has been teaching, in clinical, classroom, online and research settings for over 20 years. He has designed full curricula for optometry programs and designed and delivered active and passive learning experiences for students and graduate clinicians. His commitment to educational innovation earned him a Deans Award for Teaching at the University of Melbourne. His research team, in myopia and refractive development, was honored with the American Academy of Optometry's Garland W. Clay Award.