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Using the TPACK framework to unite disciplines in online learning

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This paper builds on a previous case study in which a group of lecturers from various disciplines were interviewed about their practice as facilitators of online learning. The lecturers' comments about their teaching practices revealed their awareness of specific types of teacher knowledge about online teaching. This was an unintended outcome of the previous study. Subsequently, as reported in this paper, the data were interrogated further using a new lens to investigate the extent to which these elements of teacher knowledge were evident throughout their practices. The technological, pedagogical and content knowledge (TPACK) theoretical framework enabled the researchers to identify the lecturers' views about the content taught in online and blended environments, the pedagogy which guided teaching and course design, and the technology selected to facilitate students' learning. This paper also considers practical issues about using the TPACK framework as a research tool as a lens through which to view online teachers' knowledge about pedagogy, technology and content.

Introduction

The teaching practices of academic staff in online learning contexts reflect their beliefs about teaching and, specifically, their conceptions about how students learn (Levin & Wadmany, 2006; Lucas, 2005; Norton, Richardson, Hartley, Newstead, & Mayes, 2005). Findings from a previous study (Anderson & Barham, 2010) about the professional practice of a group of online teachers found that online teaching practices across disciplines were more generic and less discipline-specific than expected. Analysis of the data from this previous study also revealed specific types of teacher knowledge about online teaching and online learning. In the second phase of the study, reported in this paper, interview data from the study (Anderson & Barham, 2010) were interrogated further to determine the extent to which elements of various types of teacher knowledge were evident throughout the practices of the academic staff who participated in the study.

Mishra and Koehler's (2006) technological, pedagogical and content knowledge (TPACK) framework was selected to guide this interrogation of the original data through a multi-faceted focus on the various domains of teacher knowledge– including technological knowledge, pedagogical knowledge and content knowledge. Used as an analysis tool, the TPACK framework also provided a lens through which to acknowledge and document the areas of overlap between these three domains of knowledge. The TPACK theoretical framework (Mishra & Koehler, 2006) enabled us to identify the lecturers' views about the content taught in online environments, the pedagogy which guided teaching and course design, and the technology selected to facilitate students' learning. As well as reporting on the investigation into the types of teacher knowledge held by this group of academic staff, this paper also considers practical issues about using the TPACK framework as a lens through which to view online teachers' knowledge and pedagogy, technology and content.

Since the second phase of the study trialled the TPACK framework to analyse the academic teachers' views and practices about online teaching, the questions which drove this second phase of the study were:

1. To what extent were elements of teacher knowledge evident in the reported online teaching practices of the academic staff in this study?
2. What were the affordances and limitations of using Mishra and Koehler's (2006) TPACK framework to qualitatively analyse interview data?

By adopting these two research questions to direct the analysis of data in the second phase of the study, the combined intention of the research was to document practice and to consider the interrelationships between the TPACK components.

Literature review: Effective online teaching practice and teacher knowledge

Effective online teaching practices promote conditions in which online learning occurs. Such practices are strengthened by effective course design principles, structures and practices. The identification and description of the skills required by lecturers to create and facilitate an effective online course is an area that has been under investigation for some years (Herrington & Oliver, 2000; Kerns et al., 2005; Northcote, Seddon, & Brown, 2011; Salmon, 2011; Van Duzer, 2002). The degree of "onlineness" has also been identified as a factor which impacts on the quality of online courses and online teaching (Northcote, 2008; Salmon, 2011).

Consensus about some of the best online teaching practices can be summed up by De Gagne and Walters's (2009, p. 578) suggestion that "a solid learner-centered environment and instructor visibility will lead to greater participation, teamwork, respect, and commitment from teachers and students". Although much effort and the findings of many studies have contributed to our understanding of effective online course design and effective online teaching practices, discussion continues regarding the impact of context and discipline on online teaching practices (Anderson & Elloumi, 2004; Benson & Samarawickrema, 2009). Whether or not particular teaching practices are generic or discipline-centred in online learning contexts was a question that beset the authors of this paper in both the early stage of this research (Anderson & Barham, 2010) and the secondary stage of the research, as reported in this paper.

Each lecturer's content knowledge could be considered unique to their disciplinary context. However, other forms of lecturer knowledge are more universal in their application. For example, a lecturer's pedagogical knowledge about their specific teaching methods and their knowledge about students' learning processes also impact on their practical approaches to online teaching. Furthermore, a lecturer's knowledge about how to select and use appropriate technology to facilitate learning and teaching influences the quality of the learner's experience in an online course.

However, before effective online teaching strategies can be put into practice in generic or discipline-specific ways, lecturers must first develop a set of online teaching skills and online course design skills through time, effort and professional learning. Such skills are typically developed by accessing a range of professional development resources, workshops and strategies (Bell & Morris, 2009; Bright, 2007). In addition to these approaches, lecturers often learn in context by using and analysing teaching and learning technologies in a "just in time" rather than a "just in case" manner (Fuscoa, Haavindb, Remolda, & Schanka, 2011). In this way, lecturers develop specific skills at the time when they are required, rather than learning a set of skills for possible future application. As well as engaging in the process of learning while teaching, as practical requirements dictate, the introduction of teaching and learning tools and environments which are technologically based can often provide the catalyst (Matzen & Edmunds, 2007) in the form of a positively framed disruption (Meyer, 2010). The introduction of such tools can mark the moment for lecturers to revise, refocus and develop their online teaching and course design skills. Consequently, the development of lecturers' knowledge about how to teach in online learning environments occurs in multiple settings and in many ways; for example by interacting with varied colleagues and by using a collection of technological tools. Their use of technology is informed by their pedagogical approaches and their mastery of content. Conversely, lecturers' pedagogical approaches and content knowledge impact on their use of learning and teaching technologies.

The specific forms of knowledge that teachers require to effectively teach with technology have been identified by Mishra and Koehler (2006, p. 1020) "as a complex interaction among three bodies of knowledge: content, pedagogy, and technology". They suggest that teachers should have a theoretical and practical grasp of these bodies of knowledge in order to effectively and purposefully integrate technology into their teaching. Mishra and Koehler's (2006) Technological, Pedagogical and Content Knowledge (TPACK) framework of teacher knowledge offers a lens by which these areas of teacher knowledge can be analysed and compared. Mishra and Koehler have identified seven types of teacher knowledge:

1. Content knowledge (CK);
2. Pedagogical knowledge (PK);
3. Technology knowledge (TK);
4. Pedagogical content knowledge (PCK);
5. Technological content knowledge (TCK);
6. Technological pedagogical knowledge (TPK); and
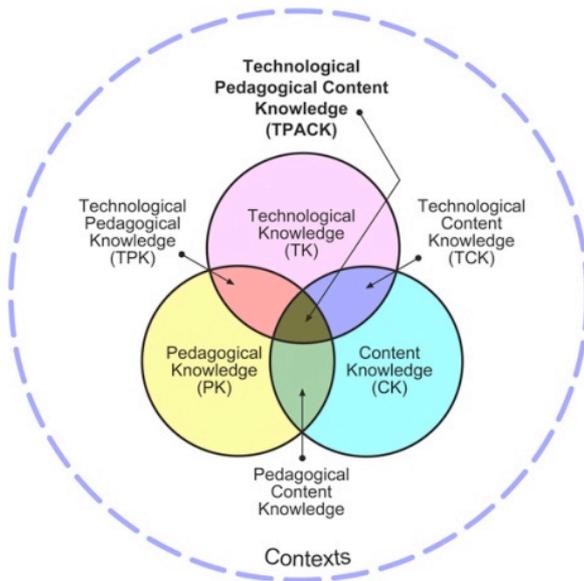7. Technological pedagogical content knowledge (TPCK).

Figure 1. TPACK framework. Graphic used with permission from: http://tpack.org/

Instead of focusing on the transfer of content as the main aim of an online course, Mishra and Koehler's TPACK framework acknowledges the significant interplay between a teacher's pedagogical stance, their use of technology and their knowledge of the content of the discipline in which they are teaching. In this way, content is seen as only one element of the overall context of learning and teaching.

Mishra and Koehler's (2006) TPACK framework has also been used across a variety of educational contexts to date, especially in the realm of pre-service and in-service teacher education (Finger, Jamieson-Proctor, & Albion, 2010; Graham et al., 2009; Jang & Chen, 2010). However, it has not been extensively tested in relation to higher education online learning and teaching environments. Nor has it been widely applied as a research tool. Even so, the TPACK framework, through its use across diverse settings for a variety of purposes, represents a method by which themes, consistencies and discrepancies can be identified in a set of data to determine evidence of the teacher knowledge held and used by academic staff in online learning contexts. Because the previous study (Anderson & Barham, 2010) found that "generic rather than discipline-specific challenges were most prominent" among the comments of lecturers who were facilitating online learning environments, the TPACK framework was selected as a lens through which to further analyse the place of discipline-specific content in relation to the more generic issues of pedagogy and technology in online education contexts.

Methodological approach

The two phases of the study

This study was conducted in two phases. The initial study (Anderson & Barham, 2010) adopted a qualitative case study approach (Merriman, 1998) in order to reach a deep understanding of the views and practices of the fifteen lecturers who participated in the study. Qualitative data gathering and data analysis processes were used. An interpretive case study approach ensured that the lecturers' views were gathered in a way that acknowledged each individual lecturer's unique situation; incorporating disciplinary contexts such as Music, Indigenous Studies, Marine Biology and Communication Studies. This method

enabled the investigation to take place with a dual purpose - to explore both *how* the lecturers taught online as well as *why* they used various technologies and teaching strategies.

Nevertheless, findings from analyses of the data in the initial stage of the study revealed the need for a secondary level of analysis. After the first stage of analysis, questions remained regarding the reasons that drove the lecturers' decisions about their teaching practices, especially in relation to pedagogical, technological and content decisions. Subsequently, the next stage of the study aimed to specifically determine the research participants' teacher knowledge and to answer the first of the two research questions which drove the second stage of the study:

- Research question 1: To what extent were elements of teacher knowledge evident in the reported online teaching practices of the academic staff in this study?

This question was largely focused on the how and why of online teaching, especially in relation to how teacher knowledge about pedagogy, technology and content informs the use of online teaching practices. Nevertheless, we were wary of overlooking the more traditional, and currently less fashionable focus on the *what* of teaching (the content), especially in terms of how content relates to pedagogy. The technology choices in the varied disciplines that were represented by the lecturers who participated in the study were also studied. The pursuit of answers to research question 1 required additional analyses using a research tool that enabled an investigation of the various types of teacher knowledge held by the academic staff who participated in the study.

Due to its overlapping structural focus on multiple types of teacher knowledge, the TPACK framework was used to conduct the secondary stage of data analysis in this study. The use of the TPACK framework in the context of the research study reported in this paper provides additional evidence of how the framework can be used to analyse online teaching practices within professional learning contexts, a process already instigated with social studies teachers by Doering, Veletsianos, Scharber, and Miller (2009). This paper reports on how the framework has been used specifically within a higher education context in which online teaching practices were the focus. Because the TPACK framework was used to conduct the secondary level of analysis, the study also aimed to evaluate the use of the TPACK framework as a research tool. The following question was investigated throughout this second phase of analysis in the study:

- Research question 2: What were the affordances and limitations of using the Mishra and Koehler's (2006) TPACK framework to qualitatively analyse interview data?

The findings from the study's secondary level of analysis are reported in this paper.

Participants

Because this research study primarily adopted a case study approach, the research participants for this study were selected according to a purposive sampling technique, "to select information-rich cases whose study will illuminate the question under study" (Patton, 2002, p. 46). A group of lecturers in one university, across a variety of disciplines, were invited to participate in this study. Selection of the participants was guided by the researchers' knowledge about individuals within the university who displayed the attributes that matched the purpose of the study (Berg, 1989; Neuman, 1997) – namely to investigate online teaching practices. As such, participants were selected on the basis of their experience as online facilitators and their history of involvement with the university's academic development staff and professional development activities. Fifteen participants were selected for inclusion in this study. These participants represented the following discipline areas: Music; Information Communications Technology; Marine Biology; Cultural Studies (Media); Physiotherapy; Nursing; Architecture; Pharmacy; and Indigenous Studies.

Data gathering

To align the data gathering methods with the investigative nature of this study, the data gathered during this study were qualitative in nature (Freebody, 2003). Data were gathered across an eighteen-month period through semi-structured interviews that ranged from thirty to fifty minutes. Each interview was

video recorded, which, with the participants' permission, enabled the later use of sections of these video recordings in an online resource which instructed other lecturers about how to teach effectively in online learning environments.

The interview schedule for the semi-structured interviews was informed by findings from a literature review about effective online learning practices and views, including studies and guidelines by scholars such as De Gagne and Walters (2009), Herrington, Oliver and Herrington (2007), Kerns et al. (2005), and Stacey and Gerbic (2008). The best practice principles advocated by Kerns et al. (2005), and Stacey and Gerbic (2008) provided particular direction for constructing questions that were related to online teaching and learning. Interview questions were used in conjunction with prompts, which provided further direction for follow-up interview questions based on the nature and direction of the participants' responses to previous interview questions. The informal integration of these prompts throughout the interviews ensured that the tone of the interviews was more conversational than interrogative.

The main questions and prompts used to guide semi-structured interviews with the lecturers were as follows:

1. How are your courses delivered (e.g., solely internal face-to-face, external, online, blended)?
   Prompts: paper and post material (study guides, A/V, readings)
2. How do you facilitate learning in the online environment?
   Prompts: communication tools and strategies, context variables - number of students, intended learning outcomes, activities and assessment, traditional approaches within the discipline
3. Have you ever used multimedia in your online courses?
   Prompt: justification, effectiveness
4. Do you have any advice to offer on making online learning more accessible?
   Prompt: World Wide Web Consortium's accessibility guidelines
5. How do you gain a sense of how effective your courses are?
   Prompt: Evaluation (formal, informal)

Data analysis

The initial stage of analysing the interview transcript data involved the process of constantly comparing the data gathered in this study to findings from previous literature about effective online learning. The constant comparison process was conducted to establish categories of focus in order to "identify similarities and differences in approaches to teaching online among a small group of lecturers from various disciplines" (Anderson & Barham, 2010, p. 3).

The themes identified through these transcript analysis processes were compared with best practice principles identified in the literature (Anderson & Elloumi, 2004; Dole & Bloom, 2009; Herrington, et al., 2007; Kerns, et al., 2005; Van Duzer, 2002). Although the initial stage of data analysis provided answers to the research questions upon which this study was originally based, other questions remained. These additional questions were specifically focused on the lecturers' choices of online teaching practices, especially in relation to their choice of pedagogy, technology and content. The extent of the knowledge each lecturer held about the use of content and technology, as well as their pedagogical knowledge, required further investigation. Mishra and Koehler's (2006) TPACK framework was selected as a lens through which the second stage of data analysis was conducted so that the teacher knowledge of each lecturer could be identified, analysed and reported.

Subsequently, the lecturers' comments about their online teaching practices were further analysed in relation to the seven different areas of teacher knowledge which constitute the TPACK framework:

1. Content knowledge (CK);
2. Pedagogical knowledge (PK);
3. Technology knowledge (TK);
4. Pedagogical content knowledge (PCK);
5. Technological content knowledge (TCK);
6. Technological pedagogical knowledge (TPK); and
7. Technological pedagogical content knowledge (TPCK).

All of these knowledge areas were considered in the specific contextual framework of online teaching in the higher education sector, in which this study was conducted. The TPACK framework suggests that it is the interplay of both the theoretical and practical aspects of these bodies of teacher knowledge that provide a platform for the successful integration of technology which, in effect, supports effective learning and teaching processes. For this reason, the components of the TPACK framework have been used in this study not only as a viewing lens through which the data gathered in this study have been analysed at a secondary level, but they have also been adopted as a method of structuring the findings and recommendations that emerged from the data analysis processes conducted during the study.

TPACK under scrutiny as a research tool

In addition to determining the extent that elements of teacher knowledge were evident in the reported online teaching practices of the academic staff in this study, the researchers aimed to evaluate Mishra and Koehler's (2006) TPACK framework as a research tool. Specifically, the use of the TPACK framework as a tool to analyse qualitative data was considered by the researchers, especially in terms of the affordances and limitations offered by the framework to qualitatively analyse interview data.

Overall, the second phase of the study enabled the researchers to document the research participants' teaching practices and to consider the interrelationships between the components of the TPACK framework.

Findings and discussion

The data analysis processes that were conducted throughout this study produced a set of findings and a set of recommendations that could be considered for application by other university lecturers and professional development programs. In the presentation of findings, as set out below, codes (L1, L2, L3, etc.) representing each participant in this study are used to indicate the source of quotes from the interview transcripts. Comments by the participants reflected elements of the three main components of Mishra and Koehler's (2006) TPACK framework: Technological teacher knowledge, pedagogical teacher knowledge and content teacher knowledge. Each component and overlapping subcomponent (seven types of teacher knowledge in total) of the TPACK framework have been used as structural organisers to present the analyses of the participants' comments.

Pedagogical knowledge (PK)

Koehler and Mishra describe Pedagogical knowledge (PK) as "teachers' deep knowledge about the processes and practices or methods of teaching and learning" (2009). Despite the present study's focus on teaching in online learning environments, it was possible to identify distinct evidence of pedagogical knowledge in all participants' responses to interview questions. For example, lecturers demonstrated their awareness of established pedagogical principles such as the need to plan and develop scaffolded learning activities that align with intended learning outcomes.

> I like to take a scaffolding approach where I start off – particularly with the first year students. It is important to … design the course carefully and have multiple pathways to content. (L1)

Indicative of a student-centred approach, some lecturers' comments also reflected a degree of empathy and responsibility for building students' confidence as learners through scaffolding.

> I think if you start small, start specific and build confidence because that's the main stumbling block. There is just this aura of panic … when they come in: Is this going to be hard? And you need to show them that, no it's not! (L1)

Lecturer, L4, reflected on the nature of teaching in a university context whereby remaining fluent in the delivery of complex material can be challenging if there are significant breaks between teaching periods.

> The problem with lecturing is you've got thirteen weeks and then it all goes quiet, you don't see that material for a while again and you tend to forget how to do it. … [Fortunately] because I'm doing first semester and second semester and similar course across it keeps me familiar with what I'm doing (L4).

Discussing class size in relation to opportunities for interaction, several lecturers commented on how they vary their approach accordingly.

> Postgraduate courses tend to be smaller … whereas the [larger] undergraduate courses, I tend to split them into tutorial groups etc. which defines a different approach (L2).

Interestingly, in spite of a pedagogically-sound learning activity designed to encourage student-driven dialogue and deep thinking about content, students in one lecturer's class found it "hard to get out of the didactic mode."

> They were always looking for a right answer and some of the content was related to very grey areas that could be discussed and purposely so because students were at a level where they needed to get to that deep thinking and they were a little uncomfortable that the content wasn't being policed more by myself as a course coordinator, or even the mentors. It was hard for students to get out of the ... traditional didactic mode that we would know in uni. (L4)

In sum, the comments made by these lecturers revealed their knowledge of a wide range of recognised "processes and practices or methods of teaching and learning" described by Koehler and Mishra (2009, p. 5) as pedagogical knowledge (PK). Consequently, the TPACK definition for pedagogical knowledge proved broad enough to account for the wide range of comments that these lecturers made about their approach to teaching in general as well as online.

Technological knowledge (TK)

Technological knowledge (TK) as defined in the TPACK framework relates to a teacher's ability to apply information and communication technology (ICT) skills and knowledge "productively at work and in everyday life … and to continually adapt to changes in information technology." Such TK enables a person to accomplish a variety of different tasks using information technology and to develop different ways of accomplishing a given task (Koehler & Mishra, 2009, p. 5).

Dialogue indicative of teachers' TK was not prominent except in answers that focused almost exclusively on the technical strengths or constraints of a given technology or tool. For example, in response to the question: Have your online students ever reported any technical problems accessing resources or participating in online activities? An indicative response was:

> Yes, uneven access to bandwidth speeds and connections, which has created problems for quizzes (L3).

Similarly, lecturer L2 explained that in the early days of computer-assisted learning students were sent CDs by post, and that "there was no guarantee that students would have a computer let alone the Internet".

Reflecting on strategies developed through first-hand experience of the technology and its constraints, Lecturer L2 commented:

> Yes students still do have problems primarily with things that haven't been thought through well enough. … I used to have the problem much more. I'd put up a video that was in one block that was 10 MB, now I don't do that anymore. I'd very rarely would I put up something that is that big but if I need to put up something that was long I'd break it into three or four different files so that they could download it. I'd put it on a remote server that I knew was always going to be there. (L2)

Similarly, lecturer L5 who integrates audio recordings, music and video into lecturers, reflected on the initial learning curve associated with technology-assisted delivery, and the need to access technical support and training.

> It was a fair bit of trial and error … and getting some more specific expertise [assistance from technical support staff] at using audio editing software …. (L5)

As was the case in relation to teachers' pedagogical knowledge, most of these teachers mentioned the student perspective in their responses. If the somewhat teacher-focused TK criteria were applied too literally, the potential to elicit important detail regarding the student perspective could be missed.

Technological content knowledge (TCK)

Technological content knowledge (TCK) is defined by Koehler and Mishra (2009, p. 5) as "an understanding of the manner in which technology and content influence and constrain one another." Teachers, they assert, "need to understand which specific technologies are best suited for addressing subject-matter learning in their domains and how the content dictates or perhaps even changes the technology—or vice versa" (Koehler & Mishra, 2009).

Most lecturers' comments were focused on technology-assisted learning in general, however, several (L2; L3) gave discipline-specific examples of how they use multimedia, including video, to enhance the learning of subjects such as marine biology, physiotherapy technique and others.

> Yes it's good to show examples of diversity of marine life and habitats. Through media such as video the natural beauty can be demonstrated. This can have an engaging effect on students. It can have an emotional benefit as well as being used for factual purposes. (L3)

Other lecturers who were not currently using video in their online course environments were nonetheless giving thought to how multimedia content could be integrated to support student learning about topical issues.

> Integrating a video of Kevin Rudd's apology and what the community thought about it would be a very powerful learning resource. Short interviews with Aboriginal people dealing could also be integrated into courses. (L5)

Another discipline-focused comment about content delivery came from a lecturer teaching advanced mathematics:

> I think that mathematics really is an activity … you need to actually do it and demonstrate it when teaching – and so that's what I tried to do using the Smart whiteboard. One of the advantages … is that you can save everything as a PDF, and so I saved everything I could and circulated that to the students as well after the classes." … So there may actually be some advantages to teaching this way. (L6)

Lecturer, L4 demonstrated an "understanding of the specific technologies best suited for addressing subject-matter learning within the domain" as per Koehler and Mishra's (2009, p. 5) definition of TCK. For example, in regard to what is or is not feasible to teach online in the context of physiotherapy, lecturer, L4, commented:

> In physio we have theoretical principles that we have to teach and we have very practical hands-on skills that we need to teach and different modes are appropriate. We certainly wouldn't teach the practical hands-on skills of assessing a patient using the online environment - that would need to be face–to–face - but the decision making process was what we were using that online environment for. The students had already learned the practical skills and they were able to apply that to a patient in a decision-making discussion forum. We certainly use video for the review of techniques and that's something we've been doing even much before I developed the wiki for the clinical reasoning. Some of our

> instructors have videos of the different assessment [of patient] techniques that they would do.

Clearly, these videos of real world practitioners (including some clinical mentors) demonstrating correct technique acted as an important point of reference for these students to review as often as required.

> The students learn the techniques in the face-to-face session, then they practice them on each other and develop their own way of doing things that sometimes start to go off the track. So by having the video there for review they are able to re-watch the instructor doing it the way that that person would like to see it done. It really provided much better review for them for those sessions. And we've been doing that on Blackboard with basic windows media player videos.

Lecturer L4 went on to make a useful point that highlights the need to make expectations clear when encouraging student-generated content.

> The other issue for students is that online content can be a bit infinite … particularly when you've got student-generated content that is part of their learning and they're wanting to show how much they've worked and everything, and it became almost overwhelming for all the different groups to go through everything that all the students had put up – because students tried to put up everything instead of focusing on what they felt was important about their case. So I'm trying to get them to focus on what they really need to be doing instead of just putting everything up that they can think of (L4).

Similarly, lecturer L9 highlighted the importance of reminding students to focus their research and use of resources appropriately where student generated content is expected.

> When they [students] were all doing their presentations, with them really going out and doing quality research to bring back for the class to see. … where they are using the correct terminology, where they're being culturally specific in their resources and not just grabbing anything [from the web], where they take on board everything that I have told them and they have been learning from each other. (L9)

The afore-mentioned quotes were indicative of the range of comments provided by most participants. Significantly, all reflected an "understanding of the specific technologies best suited for addressing subject-matter learning within the domain" as per Koehler and Mishra's (2009, p. 5) definition of TCK. The power of audio-visual resources such as online video of marine life is one such example. The use of a wiki to host student-generated content and encourage peer assisted learning is another.

Content knowledge (CK)

In simple terms, Content knowledge (CK) refers to "teachers' knowledge about the subject matter to be learned or taught" (Koehler & Mishra, 2009, p. 5).

Examples of lecturers explicitly demonstrating their knowledge about the subject matter, such as harmonic movement in music or scientific method in the physical sciences, were rare in most of the interview transcripts. Most comments of this nature were integrated into their explanation of how technology selection and content influence and constrain one another, as discussed under the previous heading Technological content knowledge. As a consequence, this short section of the paper reflects that CK was not a significant focus emerging from the analysis.

Technological pedagogical knowledge (TPK)

Citing the work of Duncker (1945), Koehler and Mishra (2009, p. 5) argue that teachers need to "look beyond most common uses for technologies, reconfiguring them for customized pedagogical purposes." Hence, an understanding of "the affordances of technology and how they can be leveraged differently according to changes in context and purposes is an important part of understanding TPK" (Koehler & Mishra, 2009).

Mathematics lecturer, L7, demonstrated such knowledge while talking about using electronic interactive white boards (IWBs) in teaching by videoconference. Rather than use these technologies for a primarily one-way didactic style of presentation, L7 endeavoured to exploit the opportunities for real-time interactivity to actively engage students in problem solving, asking them to fill in the blanks where applicable.

> The combination of the Smart Board and the video camera facility … were just perfect! … I can talk it through and … it's the ability to even interact with the students and ask them questions, you know: "Well how would you do that?" … So the ability to have them actually participate in the process … while still having prepared materials … that I can put up on Blackboard afterwards … (L7)

Although the technology that lecturer L7 refers to has existed for some years, it is significant to note the evidence of TPK in this explanation of the methods used to foster engaged student learning.

The relevance of this lecturer's reflection is further apparent in light of Koehler and Mishra's (2009, p. 5) observation that many ICT tools including, for example, software such as MS PowerPoint, were designed originally for the business sector. As a result, educators are still in the process of adapting their pedagogy to the affordances and constraints of these tools. Other studies (Mitchell, Hunter, & Mockler, 2011; Sunderberg, Spante, & Stenlund, 2012) note "a distinction between technical interactivity and pedagogical interactivity," suggesting that "pedagogical interactivity" is the more challenging to perfect. Mitchell, Hunter, and Mockler (2011, p.9) note that teachers using IWBs in a senior secondary teaching context found "the content driven focus of senior school studies limited their flexibility with the technological tools and degree of interactivity." It follows, therefore, that university lecturers are likely to face similar challenges, especially when teaching a large volume of complex content that has traditionally been taught in a didactic style using chalk on a blackboard.

A lecturer in pre-service teacher education teacher reflected on the practice of pre-recording lectures and teaching in a "mixed mode" context as a response to what Koehler and Mishra (2009, p. 5) might describe as adapting ICT-pedagogy to a "change in context and purposes."

> Mixed mode is the term that comes to mind and the pragmatism was in an attempt to engage the students in a course that they were finding difficulty basically attending. I had to compromise my pedagogy a bit. I'd call teaching as theatre and you don't do much theatre on a recording looking at a digital [recording device] in your lounge room when you're recording. So I missed that side of it and a lot of the students like that type of engagement. Having said that the balance is pragmatically students have got much better access to a course but it does require a bit of a shift in the pedagogy, … using antidotes, for example, to liven up a somewhat dead panned delivery is one example of which I might not have done. (L5)

In respect to ICT technical skill acquisition, L5's advice to those adapting to online teaching was:

> Start simply and modify one element at a time or consider modifying one element whether it's taking onboard Blackboard in more sophisticated ways than just delivering information, whether it's recording the odd lecture and making it available on tape, or whether it's using Lectopia [lecture capture] successfully and just taking advantage of it, just taking small steps and using to get a familiarity with it. (L5)

Ever since students have been given around the clock access to university email and learning management systems (LMSs), lecturers have in theory become more accessible. On this issue, a lecturer in marine biology commented on the need to be strategic in respect to the timing and approach to communication with students when teaching online.

> The next thing is about managing your own time once that course is up and running and available, and we've had to learn about time management in dealing with student requests in online courses where students may be overseas or here and feel free to contact us at any

time to ask questions and it's a bit of a trap to reply immediately – that tends to train students to contact you [at whatever] times they like. … So we've tried to focus on particular days of the week and remind students that that's the day for consultation. Please send us an email then try and wait until that day to get an answer from us, or if you really need a quick answer try posting it on the discussion forum and maybe another student might be able to help you with that" (L3).

A lecturer in media and cultural studies (L1) offered similar advice about online communication with students. That is, that

> ... any questions asked in emails regarding the course are posted on Blackboard and are left for 24 hours. This enables time for other students to respond or comment. (L1)

L1 responds after the 24 hour period if other students have not been able to solve the particular issue in question.

The implication in both cases described above was that aside from any time-management benefit for lecturers, students benefit by being encouraged to communicate with each other, solve problems together and formulate their questions and responses thoughtfully. In addition, they may learn to be patient when using asynchronous communication, much as they would have to do in the workplace.

In sum, just as the lecturers' comments about the use of technology were informed by their pedagogical decisions, so too were their choices regarding the degree of onlineness they decided to implement. They recognised the affordances of online technologies to provide flexibility and high quality learning experiences for their students, as did the meta-analysis on online learning by Means, Toyama, Murphy, Bakia and Jones (2010).

The consideration of which online communication tools to use was a recurrent theme in the lecturers' comments. However, their comments were usually set within references to pedagogical issues. For example, lecturer L6 and lecturer L8 favoured the use of Chat for discussions about weekly readings in preference to online forums and discussion boards. L5 made extensive use of mp3 audio recordings of lectures that he pre-recorded at his desktop. Lecturer L4 used a wiki as the main tool to support online teaching of clinical reasoning skills in a physiotherapy degree program.

Pedagogical content knowledge (PCK)

Pedagogical content knowledge (PCK) is described by Koehler and Mishra (2009, p. 5) as consistent with Shulman's (1986) conceptualisation of PCK whereby "transformation occurs as the teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and students' prior knowledge."

Consistent with this conceptualisation, lecturer L9 applied PCK to exploring new ways to represent subject matter online using a web 2.0 blog-enhanced LMS, while guiding a group of students on their first 'journey' as online learners.

> The very first two weeks they [students] were very anxious, very nervous, none of them had done online learning before. So I more or less kept saying to them I'm new to this as well, we're taking the journey together, let's learn together. I tried to do a lot of modelling where possible. So the very first presentation I did, I posted on Blackboard and showed them exactly what I wanted. I critiqued myself, I did very basic perhaps slightly poor one so the students could suggest what could have been improved, what did not work etc. and then they could see it visually and make sense of it (L9).

Scaffolding and modelling were fundamental to lecturer L1's approach in which students are given increasing leeway to do things in their own way after building confidence with smaller set tasks during the initial phase.

> I like to take a scaffolding approach where I start off – particularly with the first year students, giving them quite small tasks to do online and specific instructions on how to accomplish that, and then giving them more complex things to do and giving them more freedom, more leeway to do in their own way.

After giving much consideration to determining the best way to deliver various practical and theoretical aspects of a course in a physiotherapy program, lecturer L4 used a combination of instructional video resources, an open source wiki moderated in part by external clinical mentors, and a proprietary LMS to teach students in a blended mode course.

> We certainly wouldn't teach the practical hands-on skills of assessing a patient using the online environment, that would need to be face-to-face, but the decision making process was what we were using that online environment for. The students had already learned the practical skills and they were able to apply that to a patient in a decision-making discussion forum.

Consistent with PCK, L4 used multiple ways to represent content and to encourage students to explore alternative conceptions about the theory and practice of assessing a patient.

These findings indicate that the way in which lecturers choose to present and, in some cases, gradually reveal content to their students, is interdependent on the lecturer's pedagogical knowledge about how students learn.

Technology, pedagogy, and content knowledge

Koehler and Mishra (2009, p. 5) describe TPACK as an emergent form of knowledge that goes beyond all three "core" components (content, pedagogy, and technology). Further that, among other things, TPACK requires an understanding of … what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face." They argue that "by simultaneously integrating knowledge of technology, pedagogy and content, expert teachers bring TPACK into play any time they teach."

Consistent with Koehler and Mishra's (2009, p. 5) assertion, the lecturers interviewed in this case study research incidentally mentioned learning and teaching technologies entwined with pedagogically related issues, rather than technology, pedagogy and content in isolation. Note that in the following excerpts, the TPACK acronyms displayed in square brackets show examples of overlapping teacher knowledge.

> So, for example, I got them to join Flickr and post photos online [TPCK], not because that was an essential component of the course content but just as a way of helping them build confidence [PK] in uploading files and working with files, whereas with the 300-level courses I do a lot more group work where it's the online communication [TPK] and carrying out of … more complex tasks online. (L1)

> We have examples of patient videos that … we discuss good and bad points about … [PK]. We don't generally put the [video-recorded] interviews online because they are generally a bit longer than watching just one technique, and it's a little bit hard for students to then watch and download them easily [TK]. I had a wiki tips page and anything that I had a problem with … they tended to look for their own solutions [TPK] (Lecturer L4).

Summary of findings and discussion

The three main components of Mishra and Koehler's (2006) TPACK framework were represented in comments by participants across all discipline areas. Lecturers' pedagogical, content and technological knowledge emerged as themes in this study.
Issues related to each lecturer's pedagogical stance in the online learning environment emerged as dominant themes from the data analysis processes conducted in this study. Lecturers' comments about their online teaching views and practices reflected their concerns about student engagement, alignment of learning activities with course learning outcomes, and teacher presence.

The lecturers' technological knowledge appeared as a strong theme in this study, being represented by lecturers' comments about the selection of appropriate technological teaching and learning tools and how to achieve an appropriate degree of onlineness. They were concerned about how to transfer their on-campus teaching pedagogies into online learning environments. Interestingly, the ideas advocated by Mishra and Koehler (2006), about the inappropriateness of separating technological issues from pedagogical issues, the lecturer-participants in this study also represented examples of how these two issues were inseparable in online learning environments.

Though less prominent than the themes that were linked to pedagogical and technological lecturer knowledge, content-related lecturer knowledge was also recognised as a theme in the lecturers' interview comments.

Irrespective of whether disciplines significantly influence the adoption of particular online teaching practices, online learning appears to be gaining popularity not just through student demand, but as a result of the growing body of evidence that supports the quality of learning achieved through online learning contexts: "Students who took all or part of their class online performed better, on average, than those taking the same course through traditional face-to-face instruction" (Means, et al., 2010, p. ix).

Although the purpose of this study was to gain a deep understanding (Berg, 1989) of the types of teacher knowledge held by the lecturer-participants in the study through analysis of their online practices and views of a group of lecturers across a range of disciplines, the readers of this paper are invited to consider the lessons learned from this study in conjunction with their own contexts.

Implications of this study

The findings of this study have implications for teaching staff, course designers and providers of professional learning activities for academic staff in higher education institutions. In terms of how teacher knowledge impacts on practical online teaching strategies and course design structures, issues associated with pedagogy, technology and content (as outlined in the TPACK framework) were shown to be evident in the views and practices of the academic teaching staff interviewed during the study reported in this paper. Furthermore, the manner in which pedagogy, technology and content overlap in online classrooms provides a structure by which a teacher or course designer can reflect on their own practices and the practices of their colleagues. This awareness of the multiple aspects of the teaching process in online courses de-emphasises content as the driving force behind courses. Based on these findings, the online courses discussed by the academic staff in this study were no longer dominated by the traditional centrality of content; rather, the learner came more into focus along with the lecturers' pedagogical approaches and their use of meaningful technology

The findings of the second phase of this study, using the TPACK framework as an analysis tool demonstrated that some aspects of teacher knowledge were more dominant than others across the participants in this study. Although the content-related lecturer knowledge was recognised as a theme in this study, the lecturers' comments about pedagogical and technological knowledge were more obvious. This may have implications for future research in which the balance of the various types of teacher knowledge may be investigated in different contexts such as on-campus and in blended and online learning environments. Further research may also extend the use of the TPACK framework into the student realm; both lecturers and students could reflect on how the different types of teacher knowledge impact on their teaching and learning respectively.

As well as having implications for teachers, course designers and providers of professional development, the findings of this study provide some insight into the value of using the TPACK framework as a tool of analysis, specifically as a tool to analyse qualitative data such as transcripts from semi-structured interviews. The three main components of the TPACK framework were represented in the participants' comments. Although it was possible to separate particular types of knowledge into all three of the main categories, technological knowledge and pedagogical knowledge were more obvious and more frequently demonstrated than content knowledge. In the present study this may be due to the nature of the questions about online teaching and learning. In terms of the future use of this framework as an analysis tool, the

multiple components of the framework as well as the interrelatedness of these components enabled both discrete and relational data analysis processes.

There were definite benefits to adopting the TPACK framework as a research tool of analysis. The structure of varied types of teacher knowledge nested within the TPACK framework was a useful framework by which to separate the research participants' views and reported practices that were content related, as opposed to those which were pedagogy-related. The identification of teacher knowledge about technology, as set out in the TPACK framework, provided the researchers with a clear definition and set of analysis boundaries by which to identify and subsequently analyse the participants' understanding of how technology was related to their own teaching and their students' learning. The multi-layered structure of the TPACK framework, which consisted of overlapped areas of teacher knowledge, ensured that the analysis of the data in this study was not one-dimensional but afforded recognition of the complexity and multiple layers that were evident in the interview data which were gathered from a group of academic teaching staff. Using the TPACK framework enabled such intricacies to be identified and linked to other areas of teacher knowledge. In the future, the TPACK framework may not only provide a way to analyse self-reported teacher practices and perceptions, it may also prove to be a useful tool in analysing actual teaching practices as evidenced through the analysis of online courses and videos of on-campus, face-to-face teaching sessions (for example, lectures and tutorials).

In terms of professional development opportunities for groups of staff within universities, the TPACK model may prove to be a useful structure by which various aspects of online teaching could be identified, examined, taught, evaluated and improved. Consideration of all types of teacher knowledge would encourage lecturers to consider student learning needs, learning design issues and the affordances of online learning tools, as well as the content within their courses. The TPACK framework may provide a useful starting point for online or on-campus professional learning activities in which lecturers identify their own knowledge about teaching, for the purposes of career development and improvement.

Although this study demonstrates how the TPACK framework can be useful to analyse varied types of teacher knowledge across a group of lecturers, individual lecturers' *TPACK signatures* were less clear. Studies of this type in the future may well be advised to consider analysing individual lecturers' knowledge using the TPACK framework as a lens, rather than using the framework as a lens through which a group of lecturers' ideas were analysed. Furthermore, the developmental progress of an individual lecturer as a teacher and a course designer could be tracked using the structures and definitions offered by the TPACK framework. Such use of the TPACK framework by individual lecturers to track and document their own development as online teachers may have implications for using the framework as a self-reflection tool. As a reflection tool, the TPACK framework may provide academic development staff a method by which to engage lecturers in an in-depth analysis of their own teaching and the teaching of others in varied contexts, including online, blended and face-to-face learning environments.

The expansion of the TPACK framework to be used in more varied and creative ways, such as the example documented in this paper, aligns with the views of the originators of the framework. Their intentions were for the TPACK framework to contribute to the advancement of research in the education of teachers, professional development of teachers, and teachers' use of technology. The intention was that by providing options for investigating technology integration in ways that are now "amenable to analysis and development" TPACK would allow teachers, researchers, and teacher educators to go beyond treating technology as supplementary, "instead to focus again, and in a more ecological way, upon the connections among technology, content, and pedagogy as they play out in classroom contexts" (Koehler & Mishra, 2009, p. 5).

Conclusion

This case study research has confirmed the value of research that undertakes deep analysis of the practices and views of university educators who operate within online learning environments that are characterised by the availability of multiple technological tools and varied pedagogical approaches. The content-related issues and the specific discipline focus appear to be lesser concerns in the arena of quality online learning than issues of pedagogical intent and the selection of appropriate teaching and learning technologies.

Since the TPACK framework has been trialled and developed across a range of educational contexts, it is considered to be a robust tool to analyse and reflect on learning and teaching contexts and processes. This tool provides a useful and practical way by which to analyse the presence of various types of teacher knowledge reflected in the views and practices of tertiary teachers in online learning contexts.

Acknowledgements

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