Planning to teach with ICT: Some insights into university teachers' knowledge

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In this study we explored the nature and types of knowledge that university teachers draw upon when they are making decisions related to the use of Information and Communication Technology (ICT) in their courses. The data were obtained using a 'think aloud' protocol. Shulman's (1987) and Mishra & Koehler's (2006) frameworks were used as an initial basis to classify teachers' knowledge. The mental resource perspective was adopted as a general lens to obtain an insight into the nature of teachers' knowledge. The results showed that teachers' decisions were based on different types of knowledge. When teachers planned to use ICT in their courses, they combined different knowledge types with context-specific experiences and projected situated actions. In this paper we illustrate three qualities of teachers' knowledge that underpinned core teachers' planning decisions: a) the linking role of pedagogical knowledge; b) relational nature of teachers' design thinking; and c) the experiential basis of teachers' anticipations.

Keywords: course planning, ICT integration, university teaching, teachers' knowledge.

Introduction

Planning a university course, especially one that will incorporate Information and Communication Technology (ICT), requires the integration of different types of knowledge. This knowledge, which teachers use during planning, is both wide ranging and diverse (Kreber & Cranton, 2000; Shulman, 1986). In order to make informed decisions about appropriate pedagogical deigns for teaching in a specific context, teachers should be able to fluently switch between, and combine, various types of knowledge and ways of knowing (Goodyear & Markauskaite, 2009). Researchers have attempted to identify the kinds of knowledge that underpins teachers' expertise (Calderhead, 1996; Carter, 1990; Shulman, 1987). For example, Shulman (1987) identified seven types of knowledge which include knowledge about curriculum, general pedagogy, disciplinary content, discipline specific pedagogy, students, and institutional arrangements. He emphasised one specific type of teachers' knowledge - Pedagogical Content Knowledge (PCK) - that teachers should use when considering how specific content could be taught effectively. He noted that PCK could not be dissected into content knowledge and pedagogical knowledge as separate entities, suggesting that some kinds of teachers' knowledge are closely coupled and form distinct areas of expertise.

Teachers are increasingly, and frequently, facing the challenge of integrating technologies into their disciplines and pedagogical repertoire. Mishra and Koehler (2006), extending PCK, suggested that teachers need a specific type of knowledge that they called 'Technological, Pedagogical And Content Knowledge' (TPACK). They emphasised that isolated skills associated with ICT are not sufficient for successful ICT use in teaching. Rather, teachers should be able to consider content, pedagogy and technologies together. Studies on TPACK have investigated broad types of knowledge that emerge at the intersections of content, pedagogy, and technology, as well as additional kinds of knowledge such as those that are associated with learner characteristics and context (Archambault & Barnett, 2010; Yardakul, Odabasi, Kilicer, Coklar, Birinci, & Kurt, 2012). Findings from these studies generally suggested that ICT integration requires teachers to have a strong knowledge base in a variety of areas, such as subject, themes and sub-themes of content, organisation of subject matter, relationships among concepts, pedagogical approaches, techniques and principles, and knowledge of the learners' needs and abilities. The TPACK theoretical framework acknowledges a context dependent nature of teachers' ICT-related knowledge, however, in many empirical studies, TPACK is often regarded as a generic and well-articulated construct; one that could be measured using general self-reported questionnaires with multiple-choice scales.

Further, many studies of TPACK have focused on the kinds of teachers' knowledge that are required for integrating ICT into classroom practice, and relatively few have explored those kinds of knowledge that teachers need for ICT-related planning and design (Angeli & Valanides, 2009; Kadijevich, 2012). Calderhead (1984) emphasised that course design and planning, while often invisible, is an important part of teachers' work and needs to be explored and understood much better. This study is concerned with the nature and types of knowledge associated with this 'hidden' part of teachers' practice. We specifically focused on investigating the knowledge that university teachers draw upon when planning and revising courses before the start of a semester, concentrating on the core decisions made concerning the use of ICT in teaching.

Designing and planning for ICT integration: Teachers' knowledge bases

With the role of ICT and eLearning in higher education increasing, focus has shifted from "teaching-as-interaction" to "teaching-as-design" (Goodyear & Retalis, 2010). Teachers are increasingly engaged with planning and designing 'learning spaces' and tasks (Laurillard, 2012). However, the kinds of knowledge that underpin the teachers-as-designers' practice are still little understood. Shavelson (1976) argued that the decisions teachers make, in planning their instruction, parallel decisions made by instructional designers. Further studies suggested that expertise in teaching and design are both required during course planning and, while they are often integrated, they also remain distinct. For example, some university teachers work in teams with professional e-learning designers when they design e-learning sites (Ward, West, Atkinson & Peat, 2012). Markauskaite, Bachfischer, Goodyear, & Kali, (2011) explored the knowledge bases that such teams draw upon in their collaborative e-learning design process. They found that the teams' knowledge base included TPACK, but also extended it to include design-specific knowledge and teamwork-related skills. Further, other studies showed the nature of teachers' pedagogical knowledge and how teachers ground their ICT-related teaching decisions in experiences and specific contexts (Goodyear & Markauskaite, 2009; Markauskaite & Goodyear, 2009). This suggested that a much closer look at the situated, empirical grounding of teachers' knowledge is needed in order to obtain an insight into the teacher-as-designer expertise. In this study we distinctively focussed on the situated nature and types of knowledge that underpin teachers' planning for ICT integration.

Theoretical framework: Mental resource perspective

We broadly adopted the mental resource perspective (diSessa, 1988; Hammer & Elby, 2002) to investigate the knowledge that teachers draw upon when making ICT-related decisions. In contrast to the more traditional theoretical frameworks of human cognition that see expert conceptual knowledge as well integrated, generally coherent, and abstracted from contexts, the mental resource perspective considers knowledge as more fragmented, sensitive to contexts and comprising various knowledge constructs ranging from small intuitive mental "pieces" to explicit, integrated "coordination classes". These constructs include fine-grained context sensitive knowledge elements that are activated when the situation "feels right". This perspective, therefore, allows us to obtain a more nuanced insight into the nature of the knowledge involved in making specific teaching and planning decisions. In our study we aimed to obtain an insight into the various facets of knowledge that may form the foundations of teachers' TPACK when they design and plan courses. We adopted the TPACK framework to classify types of knowledge, but did not consider each TPACK domain as one generic construct. Rather, we aimed to explore the nature of teachers' knowledge elements at a fine-grained level.

Methodology

The study participants were four university teachers with responsibility to coordinate and teach different subjects to pre-service teachers. Their courses were specifically focused on the application of ICT in teaching and learning. The data were collected using a 'think aloud' method (van Someren, Barnard, & Sandberg, 1994) when teachers were planning and revising their units before the start of a semester. Rather than asking participants to consciously reflect on, and explain, their thoughts, the participants were asked to verbalise their thoughts in real time during their routine course planning. This technique provides the possibility to obtain a closer look at the nature of the knowledge that is called upon during a natural thought process. The planning sessions lasted from 45 minutes to 1 hour; each entire session was video recorded.

Chi's (1997) method for analysing verbal data was used to analyse the 'think aloud' recordings. Initially, the sessions were transcribed verbatim. Then, the transcripts were divided into the utterances, where each utterance formed a coherent unit of meaning. The transcripts were then re-read several times in order establish the meaning of each utterance. This was achieved by taking into account the meaning expressed directly in the statement and also in the surrounding context of the thought process. The utterances were then labelled to identify their content, meaning and relationship to the context. Shulman's (1987) knowledge bases and Mishra

& Koehler's (2006) TPACK categories were used as an initial basis to classify the knowledge elements into types. These were then further refined to take into account the nature of the knowledge, the blends of knowledge that were created, and the relationships between different knowledge types.

Results and Discussion

The initial analysis of the data indicated that the knowledge that teachers used during the planning of their courses is both wide-ranging and diverse. The teachers rarely drew upon individual kinds of knowledge when they made their decisions, but combined and linked different knowledge elements together. In this section we discuss three main qualities of teachers' knowledge that were characteristic of the teachers when they were thinking about their projected use of ICT.

Linking role of pedagogical knowledge

Pedagogical knowledge was prevalent in most of the s' thought processes and decisions. In most situations pedagogical knowledge elements were activated together with other elements, such as knowledge of content, technology, management, and students' learning and assessment. Teachers sometimes combined their knowledge of pedagogy with their knowledge of technology. For example, one teacher described why she needed to allocate time for introducing a wiki by stating *"I really need to give them a better introduction that why to use wiki and what's expected"*. This illustrates that the teacher's focus was on using a wiki, however, she needed to provide students with an explanation of the rationale, which indicated an aspect of her pedagogy that related to her use of ICT in this course. Data also showed that, in some instances, teachers combined more than two knowledge types to take pedagogical decisions. For example, one teacher verbalised, *"I'm thinking to teach fractions in the next week 'cause students 've already developed their knowledge of mathematics, so using just simple learning objects for fractions 'd be a good way to go"*. In this episode, the teacher combined her pedagogical knowledge (when to teach) with knowledge of content (fractions), management (in which week to teach), students (what students already know), and TPACK (knowledge about available learning objects for teaching this particular topic). In this episode, as in many other observed situations, teachers appeared to combine various knowledge elements that were firmly linked to specific contexts and situations such as time and specific students.

Relational nature of teachers' design thinking

Data also revealed that each knowledge type consisted of a *variety of sub-types* which, when combined, formed complex, fine-gained relationships. Content knowledge involved further sub-types such as content knowledge of the teachers, relationships between the content and students' learning, the teachers' past experience of the content, and organising the content into different themes and sub-themes to make it accessible to the students. For example, *"In week one eh in week one, our content focus is fractions and I've access to several learning objects that talk about fractions. I'll use one of those in lecture and talk about multiple representations as part of that topic in lecture"*. In this episode, the teacher's focus was primarily on content knowledge - fractions. Simultaneously, she focussed on "multiple representations" that formed fine-grained relationships with each other. Further, she linked content knowledge with her knowledge of the organisation and management (when to teach, and what to demonstrate in lecture) and technological pedagogical content knowledge of the learning objects suitable for teaching the content.

Experiential basis of knowledge

Another finding from the data was that the teachers' made constant reference to their *past experience*. This was present in almost all types of their knowledge, and included past experiences with content, pedagogy, technology, management, and students' learning and assessment. For example, there were many references to content they taught last year, such as,*" Last year I taught them about evolution, using a reading which talks about Darwin but this year I've found another, which is about Darwin and Australia. This sounds really interesting and I want to use it this year 'cause its about Australia not just about Darwin."*. Overall, teachers' past experiences, related to the content, was one of the main inputs for decisions about course redesign. It was related to such aspects as which topic of the content they had taught in past, and whether that content was useful or needed to be changed in order to make it more useful.

Conclusion and Future Directions

The analysis throws light on the nature and types of the knowledge that teachers used during course planning. It

indicated how blended forms of knowledge were created through combination of different knowledge types. The findings point to three important qualities of teachers' knowledge upon which they draw making decisions about ICT: a) the dominant and linking role of pedagogical knowledge; b) relational nature of teachers' design thinking; and c) experiential basis of teachers' anticipations.

First, pedagogical knowledge appeared to serve a dominant role when teachers were involved in planning their teaching. Teachers' decisions were often based on small context-sensitive elements of pedagogical knowledge that were linked with other types of knowledge. Second, teachers' knowledge, related to different domains of TPACK (pedagogy, content and technology), did not appear as large units of abstract knowledge. Each knowledge type could be viewed by considering sub-types of knowledge, which were linked to other knowledge types and sub-types in fine-grained, complex and context sensitive ways. Third, in many situations, the teachers drew upon their past experience when making decisions regarding how ICT could be used in their teaching. Teachers' reflections on ICT integration decisions taken in the past, along with the outcomes experienced, were particularly influential; these formed a strong basis for planning future actions.

TPACK theoretical literature often pointed out the relational dynamic nature of teachers' technological knowledge(Mishra & Koehler, 2006). However, a range of empirical studies drew upon unitary conceptualisations teachers' knowledge, and often measured TPACK using inflexible, and little sensitive to the context, general instruments and scales. The findings of this study show that teachers, when they make course planning decisions, simultaneously draw upon, and combine, different kinds of knowledge. The knowledge elements upon which they draw are generally grounded in their experiences and specific contexts. This indicates that teachers' ICT-related knowledge is unlikely to form a generic well-articulated construct (such as TPACK) that can be understood outside specific contexts, experiences and situations. The mental resource perspective (diSessa, 1988; Hammer & Elby, 2002) offers a flexible theoretical and analytical framework for understanding the nature of such knowledge. In our future studies we intend to explore how knowledge elements of various types and sub-types interact and form more coordinated constructs that enable teachers to make decisions that are both fluent and sensitive to the situation.

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