Something's coming, something good: Identifying TPACK competence in pre-service teachers' analyses of learning objects

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There is a song at the beginning of the musical, West Side Story, where the character Tony sings that "something's coming, something good." The song is an anthem of optimism, brimming with promise. This paper is about the long-held promise of information and communication technology (ICT) to transform teaching and learning, to modernise the learning environment of the classroom, and to create a new digital pedagogy. But much of our experience to date in the schooling sector tells more of resistance and reaction than revolution, of more of the same but with a computer in the corner and of ICT activities as unwelcome time-fillers/time-wasters. Recently, a group of pre-service teachers in a postgraduate primary education degree in an Australian university were introduced to learning objects in an ICT immersion program. Their analyses and related responses, as recorded in online journals, have here been interpreted in terms of TPACK (Technological Pedagogical and Content Knowledge). Against contemporary observation, these pre-service teachers generally displayed high levels of competence and highly positive dispositions to the integration of ICT in their future classrooms. In short, they displayed the same optimism and confidence as the fictional "Tony" in believing that something good was coming.

Introduction

It has long been held that information and communication technology (ICT) would be the catalyst to transform education (DFEE, 1997; MCEETYA, 2006; UNESCO, 2008). But it appears evident that such transformation – or what has been called "previously unimaginable opportunities for conceptual understanding"(UNESCO, 2008, p. 1) – has been slow in coming and the source of ongoing negative critique (see, for example, Cuban, 1986, 2001; Oppenheimer, 2003).

A recent experience at a large Australian university has proven contrary to negative commentary and to findings of low ICT competence and confidence in similar studies of pre-service teachers (see, for example, Albion, 2003; Jamieson-Proctor, Finger & Albion, 2010). Pre-service teachers (*N*=43) at a large metropolitan university in Australia were asked to respond to simple questions relating to their understandings and experience of ICT in the classroom and to explicitly link ICT products, specifically learning objects, to curriculum goals. The findings in this study, albeit of

small-scale and localised to one institution, has given some cause for optimism that perhaps "something good" – as in the opening song from *West Side Story* – is coming.

The promise of ICT in teaching and learning

Something's coming. Along with many others, I have been waiting for something "great" to happen with the implementation of information and communication technologies (ICT) in classrooms, to start to see a broad diffusion of the potential currently and atomistically noted in individual classrooms. But, to my joy, as the well-known song lyrics from *West Side Story* (Bernstein & Sondheim, 1957) offer, "the air is humming: And something great is coming!" This paper will outline the positive perceptions and experiences of one group of pre-service teachers, particularly in their analyses of learning objects, which rekindled my optimism for the future. *Something's coming, something good*. The shift from the peripheral to the mainstream is in reach.

TPACK – Technological pedagogical and content knowledge

This shift can be conceptually framed within the influential concept of TPACK (Technological Pedagogical Content Knowledge) (Koehler & Mishra, 2008; Mishra & Koehler, 2006). TPACK attempts to move a long-held understanding of teacher practice, that is Pedagogical Content Knowledge (PCK), into the 21st Century context of the technology-rich classroom. Of particular interest in this paper is one of its components, Technological Pedagogical Knowledge (TPK). This, put simply, is where technology is integral to a learning outcome and where teachers make informed decisions about which technology to use in given situations. This is grounded in the notion, consonant with extant policy statements, that:

> … technologies afford us the ability to convey concepts in new ways that would otherwise not be possible, efficient, or effective, with other instructional methods. In other words, these technologies don't just help us teach the old stuff in new ways – they can also help us teach new stuff in new ways.
>
> (Klopfer, Pesterwell, Groff, & Haas, 2009, p. 4)

Mishra and Koehler (2006) described technological pedagogical knowledge as being:

> … [the] knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies. This might include an understanding that a range of tools exists for a particular task, the ability to choose a tool based on its fitness, strategies for using the tool's affordances, and knowledge of pedagogical strategies and the ability to apply those strategies for use of technologies. (p. 1028)

An example of fitting technologies to pedagogical strategies is in educational use of blogs. Richardson (2006) argued that, in this context, blogs:

- can promote critical and analytical thinking.

- can promote creative, intuitive and associational thinking (through brainstorming and commenting on interlinked ideas).
- can promote analogical thinking.
- can increase access and exposure to quality information.
- provides a combination of solitary and social interaction.

A call to change teaching practice to take advantage of the affordances of ICT in learning has been a familiar refrain in the literature over the past three decades. More recently, Hedburg (2006) declared that:

> We now need to choose pedagogical options that introduce more "transcending," that create learning environments in which learners experience views of the world that are multimodal and that require a range of literacies not only to understand the different representative descriptions but also to employ tools with which learners can construct their ideas and communicate them to others. (p. 8)

Multimedia/Multimodal learning

The specific ICT considered in this study is multimedia, here in the form of a self-selected learning object from the Australian Le@rning Federation repository [http://tlf.edu.au]. The selection was deliberate and was partly informed by the observation by Jamieson-Proctor, Finger and Albion (2010) and pointing specifically to the Le@rning Federation established in 2001, that the pre-service teachers in their study had not expressed "a high level of competence … for any of the Web evolved in the past few years, as well as digital learning object repositories" (p. 10). It should be noted that the Le@rning Federation closed in June 2013, to be replaced by *Scootle*, an expanded service for educators [http://www.scootle.edu.au].

Given this selection for study, it is important to consider the presumed affordances of multimedia in learning. Learning *with* rather than *from* multimedia has been regarded as being "among the most complete and engaging of constructivist/constructionist activities" (Jonassen, Myers & McKillop, 1996, p. 94). Learning from multimedia has, more recently, come to be known as multimodal learning which has, in turn, been described as referring to:

> … an embodied learning situation which engages multiple sensory systems and action systems of the learner. This type of learning is traditionally emphasized for children with learning challenges, and can include a variety of visual inputs in addition to text. Some examples include pictures, art, film, video, and graphic organizers. Auditory inputs can include text-to-speech synthesizers, various forms of singing and musical instruments, rhyming, and spoken language games.
>
> (Massaro, 2012, p. 1)

Further to this, Sankey, Birch and Gardiner (2010) offered that:

> The increasing use of multimedia in teaching has provided many opportunities to present multiple representations of content (text, video, audio, images,

> interactive elements) to cater more effectively to the different learning styles and modal preferences of an increasingly diverse student body. (p. 853)

The effectiveness of multimedia or multimodal learning has been established for some time. The "modality effect" – particularly when audio replaces text – has shown to have significant impact on retention, transfer and matching (see, for example, Moreno & Mayer, 1999).

Documenting ICTE pedagogy

A motivation for the set tasks completed by the pre-service teachers in this study, including that selected for analysis in this paper, was to provide the opportunity for them to fulfil the criteria of the *Smart Classrooms Professional Development Framework* (DETA, n.d.). The state education system in Queensland (Australia) has developed a framework with three levels of ICT accreditation for teachers: ICT Certificate, ICT Pedagogical Licence and ICT Pedagogical Licence (Advanced). Students enrolled in selected teacher education programs in the state were, until recently, able to qualify for equivalence to the base – or entry – Certificate level through the criteria for the ICT Certificate (presented in full in Table 1). It includes core skills, knowledge and abilities as well as ICT in a pedagogical context. Its emphasis, although implicit, is on the technological pedagogical content knowledge (TPACK) described previously in this paper.

Table 1

Smart Classrooms ICT Certificate Criteria (Department of Education and Training (DETA), n.d)

Dimension	Criteria
Professional Knowledge	I understand that ICT can be used to benefit teaching and learning and is most effective when used in the context of learning and not as an end itself
Professional Practice	When planning, I incorporate the use of ICT in achieving curriculum goals: • I provide opportunities for students to use ICT as part of their learning • I provide opportunities for students to use ICT to gather information and to communicate with a known audience • I use a range of ICT resources and devices for professional purposes • I use ICT to locate, create and record information and resources • I can store, organise and retrieve digital resources

	• I use ICT to access and manage information on student learning.
Professional Values	I can identify when professional learning is required to effectively implement planning where ICT is integrated
	I select ICT resources appropriate for student learning in a range of contexts and for a diversity of learners
	I operate safely, legally and ethically when using ICT
Professional Relationships	I use ICT to communicate with others for professional purposes

The specific task at the centre of the analysis in this paper was explicitly linked to the second dimension of the Professional Values criterion, that is: *I select ICT resources appropriate for student learning in a range of contexts and for a diversity of learners.* [PV2]

The action of informed "selection" was central to the task and explains why the pre-service teachers (as subjects in the study) were asked to *select* something previously built on the basis of their understanding of the needs of particular learners. To do this is to directly demonstrate the TPK element of the TPACK model.

Method

The subjects for the study were a group of pre-service teachers in a postgraduate primary education degree in an Australian university (*N*=43). They were involved in an intensive ICT pedagogy program (3 days). As part of the low-stakes assessment associated with this program, they were asked to report their responses to five set tasks in an online journal. It did not carry "grades" but they had the opportunity to qualify for two levels of certification: the lower meeting program requirements with the higher equating to an externally accredited certificate previously discussed.

The journals were the single data source for the analysis presented in this paper. While the pre-service teachers were asked to complete five tasks, only one (related to learning objects) is reported on in this paper. The selected task, known as Task 1A and presented with the stated external criterion [PV2], required the following:

> Select one of the learning objects available to you from The Le@rning Federation website [http://www.thelearningfederation.edu.au]. Consider how you might use this to enhance student learning.
>
> *Journal entry*
> 1. Enter details of the learning object
> 2. Explain briefly how this learning object is appropriate for learning in a range of contexts and for a diversity of learners

In analysing the collated responses to Task 1A, open coding was used initially to identify emerging themes or categories. Axial coding (Creswell, 2005) was used as a second level coding procedure to make connections between the categories. The unit of analysis was the full text and multiple categories were assigned to each response.

Attention was paid to instances of exact word matches. For example, the use of the word 'diversity' was noted although typically defined in regard to differing age or needs groups. Attention was also given to synonymous terms; for example, the catch-all category of *customisation* was accorded to references to aspects such as open-endedness, own pace, and the ability to return/revise/repeat.

Further to this, a code- recode strategy was applied (Oriogun & Cave, 2008) through which the author returned to the data after an interval of time (2 months). From this iterative process, the 43 responses generated 180 instances across 22 categories including multiple intelligences, critical thinking and fun. Messages evidenced an average of 4.29 categories with a range of between 2 to 8 categories per response.

Discussion of findings

In this section, specific reference will be made to the task responses of three particular pre-service teachers. They will be referred to as Alpha, Beta and Gamma. Alpha's journal entry was typical in format (see Figure 1).

The learning object I chose was **L1149: Energy-efficient houses**. This interactive resource involves students exploring energy efficient design variables in a house, for example, varying the materials used for insulation, and the window direction and covering. By selection different options to reduce air leaks, the direction of windows, insulation in the walls and ceilings, students investigate how these changes affect energy savings. Students also have the option of locating the house in Sydney, Alice Springs or Dunedin, which allows them to investigate house design that suits a local climate.

How does this learning object enhance student learning?

The learning object is useful for a Grade 4-6 class when studying science, specifically energy and change or environmental/sustainability issues. The educational concepts that students explore include heat flow, energy efficiency, properties of materials (such as for insulation), and data interpretation. It allows for hands-on manipulation of sources without needing access to the range of materials. It is also very user-friendly and informative, and engages students' critical thinking, predicting and problem solving skills.

The learning object is appropriate for science learning as it is scaffolded to assist students' understanding. For instance, if students make an incorrect selection that results in poor energy efficiency, an explanation and suggestion will appear and an opportunity for students to rectify their choice. Teachers can use discretion and guide students investigating this resource by controlling or expanding the number of house design aspects to explore, thus catering for the learning needs in the class. Because this resource also incorporates a range of house design aspects, the teacher can guide students in further investigation on any number of topics relating to sustainable architecture, climate or energy, thus catering for the interests and abilities in the class.

Figure 1: Text of typical task response (Alpha)

In the first paragraph of the response shown in Figure 1, Alpha, as required, identified and described the learning object, *Energy-efficient houses* [http://econtent.thelearningfederation.edu.au/ec/viewing/L1149/index.html].

The second paragraph follows a sub-heading, *How does this learning object enhance student learning?* In this paragraph, Alpha spoke to the context and content of the learning object, for example, "is useful for a grade 4-6 class when studying science." Alpha also listed the educational concepts, here phrased as curriculum topics, related to the learning object, such as heat flow, energy efficiency, and properties of materials. Alpha also, critically in the demonstration of TPK, focuses on how students might interact with the learning object by referring to "hands-on manipulation," the concept of engagement and the more cognitive actions of critical thinking, predicting and problem solving.

The third paragraph refers back to the operational design of the learning object itself, here the feedback loop. In this, Alpha noted that "if students make an incorrect selection that results in a poor energy efficiency, an explanation and suggestion will appear and an opportunity for students to rectify their choice." Alpha has interpreted this feature as scaffolding student learning and goes further to indicate how teachers can manipulate the parameters of the learning object to cater "for the learning needs in the class."

It is of interest that Alpha did not deem the teaching and learning decisions as resting inside the learning object but rather being externally applied and controlled by the classroom teacher. This, in itself, is an indication of a growing awareness of technological pedagogical knowledge (TPK). This was similarly noted in the majority of student responses to the task.

As noted, the task responses were coded (and re-coded). The process yielded 22 discrete categories introduced in the previous section of this paper. A list and the comparative frequency of the categories is shown in Figure 2.

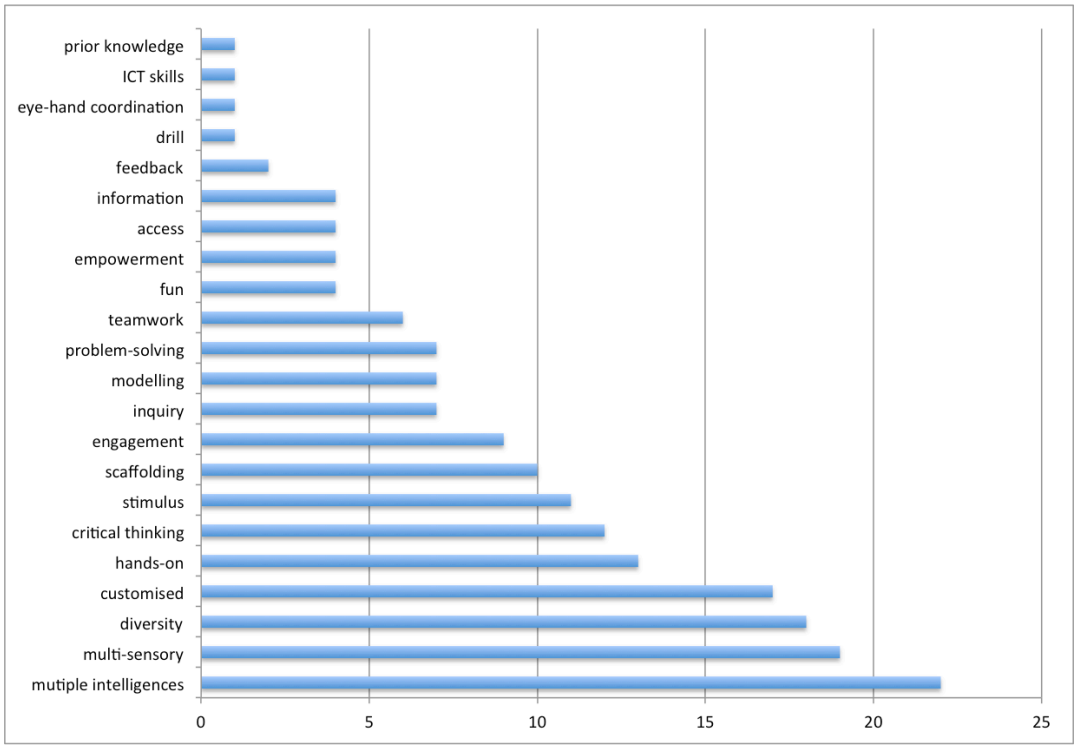

Figure 2. Graphic presentation of learning objects

Table 2 presents details of the five most frequently occurring categories presented in reverse order to Figure 2. These together represented half of all responses (*n*=89, 49.44%). Each category is illustrated in Table 2 by an excerpt from the responses including Beta and Gamma who, as will be discussed later, selected the same learning object for analysis but with differing interpretations.

Table 2
Frequently-occurring categories of affordances of learning objects

Category	Definition/Illustration	*N* (43)	%
multiple intelligences	[L1149 Energy-efficient house] … *would also cater for a number of Gardner's Multiple Intelligences, most notably Spatial, Logical-Mathematical and Naturalistic, and if the activity was performed in a group setting, Interpersonal intelligence.*	22	12.22%
multi-sensory experience[1]	[L20 Day sky, Night sky] *It has both audio and text to allow those with difficulties to still participate in the game. … this will cater to the students who are visual, audio and body kinetic learners as they listen, read and play.*	19	10.56%
Diversity	[Eco-Farm Learning Object] *A range of diverse learners would benefit from this, especially visual and kinaesthetic learners, as the activity requires these skills for*	18	10.00%

	involvement. Students who have learning difficulties can also work through this learning activity (with assistance, if needed) and learn the concepts through play and interactivity.		
customisation[2]	[L20 Day sky, Night sky] *This Learning Object, suitable for years Prep, 1 and 2, enables students to explore the changing day and night sky and to identify the movement of celestial objects. The use of an interactive ICT model facilitates a student-centred approach whilst catering for diverse learners. Supported by visual, audio and interactive components, students can build a day or night scene and are given facts and feedback on their selections*.	17	9.44%
hands-on (interactive)	[L700 Pushing and Pulling] *In this activity, students experiment with force and mass by using non-standard units (e.g. monkeys) to help move recently arrived animals to the zoo. ... The size of the animals being moved may vary or students may be limited in the number of monkeys available to do the work.*	13	7.22%

Note to Table

1. Beta
2. Gamma

As noted, the five most frequently occurring categories representing half of all responses are: (i) multiple intelligences (*n*=22, 12.22%); (ii) multi-sensory experience (*n* =19, 10.56%); (iii) diversity (*n* =18, 10%); (iv) customisation (*n* =17, 9.44%); and, (v) hands-on (interactive) (*n* =13, 7.22%). The predominance of references to multiple intelligences, frequently by a direct reference to the concept and to its key author, Howard Gardner (Gardner, 1983), could arguably be linked to the pre-service teachers' concurrent studies in educational theory. They similarly referred to standard teacher educations texts, particularly Marsh (2008) and Reynolds (2009). This could be said to show a blurring of the *T* (Technological) and *P* (Pedagogical) in these pre-service teachers' burgeoning TPACK.

To return to the initial enthusiasm of this paper, focus needs to be placed on the breadth of categories that emerged from the responses. The responses, too, were drawn from educational theory, for example, critical thinking (*n*=12, 6.67%), scaffolding (*n* =10, 5.56%), inquiry (*n* =7, 3.89%), and problem solving (*n* =7, 3.89%). The categories with the lowest frequency were those that could arguably be seen to belong to older ideas of computer literacy and ones which do not display mastery of TPACK. For example, eye-hand coordination, ICT skills, and drill each appeared only once in the responses. The notion of the ICT resource as an information source appeared more frequently (*n* =4, 2.22%) but was some way down the list of purposes and placed well below more cognitive and affective factors. This is arguably further

indication of a significant change in this cohort of beginning teachers at least that computers were an end rather than a means to an end, a process rather than a solution.

There was similarly no reference to the use of ICT as idle amusement for students. Where fun (*n* =4, 2.22%) was listed, it was reminiscent of Chen and McGrath's (2003) definition of engagement in developing multimedia, that is, a complex experience comprising of enjoyment, concentration, perceived control, exploration, and perceived challenge. An example was:

> [L20 *Day sky, night sky*] The object allows students to learn at their own pace, while having fun playing a game. It has both audio and text to allow those with difficulties to still participate in the game. As there are different types of intelligences in the classroom, this will cater to the students who are visual, audio and body kinetic learners as they listen, read and play [Gamma].

An unexpected category was teamwork (*n*=6, 3.33%) indicating that these pre-service teachers were thinking of the dynamics of the classroom and had embraced the notion of ICT as an aid to collaborative learning. An example was noted in the following response:

> [L5207 *Making a difference: The Day of Mourning protesters*] … the learning object can be used for individual students or for groups of students. If used for groups then this would subscribe to constructivist approaches to education as there will be a collaborative investigation conducted with a group consensus reached through negotiation, discussion and discovery. Even when conducted individually the student is encouraged to synthesise the data in order to form an opinion that is then recorded in their Notebook. If this is then linked to a group discussion, the individual students are able to reconsider their answers and make changes, based on their new understandings.

The pre-service teachers (*N*=43) selected 32 distinct learning objects. Six learning objects were selected more than once. There were three selections of: L3248 *Making a difference (Windaryne)* and L700 *Pushing and Pulling*. There were two selections of: L5207 *Making a difference (The day of mourning protestors),* L9518 *Discovering Democracy (Law)*, L949 *Playground Rules* and L20 *Day sky, night sky*. There was wide interest, motivated by concurrent studies in social sciences, in the *Making a difference* series, devoted to Indigenous issues with 19 instances (57.57%) of selections from this series.

The two pre-service teachers (Beta and Gamma), cited through this paper, who selected L20 *Day sky, night sky* differed in their analyses. Both indicated that the learning object could be customised and appealed to multiple senses (see Table 2). They then differed. Beta's responses spoke of empowerment and feedback while Gamma referred to multiple intelligences and fun. Same tool, different outcomes! For me, this indicated that part of the TPACK model which calls for teachers to know how teaching, here meaning their own teaching practice, might change as the result of using particular technologies. This close but not matching response occurred in all other instances of repeated selection. This would indicate personalisation or internalisation of how to teach with and through learning objects. These pre-service teachers were embracing the opportunity to work with new tools in new times, new tools to teach old things as well as pushing out to teaching new things.

Conclusion

This is small-scale, this is localised, this is personal, but, sadly, this is not conclusive. Still it feels like a liminal moment. There is something coming, something good. This group of pre-service teachers described in this paper seemed to grasp TPK – defined as the knowledge, existence and capabilities of technologies– and, without fail, chose a learning object to match a learning context or the needs of a particular group of students. They "knew" that this would change the dynamics of a classroom and they knew how to position formal and well-worn theories of learning into new places of learning. That their responses differed from each other is also encouraging as it spoke of a genuine individual ownership and an integration of TPACK into their practice.

There is a message here, too, for teacher educators and those leading professional learning. That is, to use the TPACK framework as the way to frame learning tasks rather than as a post hoc tool for analysis; and, to allow teachers to show rather than self-report on TPACK.

Something's coming. Something good.

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