Bridging Multiple Expertise in Collaborative Design for Technology-Enhanced Learning

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Abstract: Designing technology-enhanced learning requires merging technological, pedagogical, and content knowledge domains, and thus often carried out by multi-professional expert teams. However, working in such teams may involve challenges resulting from participants' different knowledge bases and ways of thinking. This research examined the collaborative design process of three teams who were part of a university initiative to develop technology-enhanced learning. We found that each of the teams: (1)suggested design solutions only after extensive group exploration of the various aspects of the problem, (2)made design decisions in a balanced process in which all domain experts were equally involved, (3)appreciated each other's expertise and used team meetings to learn from each other, and (4)carefully provided ideas that were not in their own domain of expertise. The success of the three teams in designing solutions that were based on their shared knowledge is explained in light of the management process of the university initiative.

Introduction

Designing technology-enhanced learning requires merging of knowledge from several different domains. Mishra and Koehler (2006), who studied how teachers integrate technology into their teaching and design, claim that three major knowledge domains are involved in such processes, namely, knowledge about technology, about pedagogy and about content. They describe a unique type of knowledge merging the three, which they name Technological Pedagogical Content Knowledge (or TPCK). Markauskaite et al. (in press) show that when experts collaboratively design technology-enhanced learning, the knowledge they bring to the table goes even beyond TPCK, and involves merging of knowledge about technology with constructs originally described by Shulman (1987), such as knowledge about: (a) curriculum, (b) learners and their characteristics, (c) social, cultural and institutional organization of the environment, and (d) educational purposes and values.

Naturally, when major design endeavors are at hand, and when the knowledge domains involved require high-level expertise, people prefer to work in multi-disciplinary collaborative teams (Bell, Hoadley, & Linn, 2004; Mercier, Goldman, & Booker, 2009,). There are many advantages in such collaborative design efforts, however, challenges have also been documented, which may lead to the development of artifacts that lack integration between knowledge domains brought by different team members, or in the words of Winters et al. (2010):

> "…each participant may maintain their own disciplinary approach, effectively creating silos within the team that can lead to little or no integration" (p. 234).

Such lack of integration can lead to the development of programs with attractive graphics and state of the art technology, but with low educational value (Goldman, DiGiano, & Chorost, 2009). It can also lead to programs with sound pedagogical ideas that are delivered in a poor and unattractive manner. These incongruent products stem from what might be called *'disciplinary cultural gaps'* or lack of *'disciplinary respect'* between team members. Sometimes they are caused by *imbalanced competencies* within a design team, as described by diSessa, Azevedo, & Parnafes (2004):

> "Some teachers found it difficult and sometimes intimidating to participate as equal contributors in a technology-based development process. Technological developers involved with educational implementation often have, in addition to technical competence, considerable experience with instructional design and in mathematics and science as well. This may put teachers in a weaker position in which they do not have authority in technology-related issues, but neither can they act with clear authority with respect to content and educational issues" (p. 121)

The current research examined the collaborative design work of three teams who were part of an initiative to develop innovative technology-enhanced learning resources within a university setting (Ward, Atkinson, & Peat, 2010). The artifacts they designed were: (a) an ePortfolio environment designed to connect between knowledge gained by students in various courses in a nursing program, (b) a Web-based environment designed to support social-work student reflect on their out-of-campus training, and (c) a Smartphone application designed to assist health-science students explore medical cases,. Each design team came from a different knowledge domain (Nursing, Social Work and Health Science), and consisted of a few academic staff-members (domain experts) and one or two non-academic staff-members (eLearning design experts). The goal of the research was to decipher what makes a collaborative design process a productive one.

Method

We broadly followed an ethnographic case-study approach. About 90% of the teams' meetings were observed over a course of four months, in which a major part of the design work was conducted. Our data includes audio-taped team-meetings, observation-notes, team e-mails, and some interviews.

To answer the above question we: (a) chose the episodes to analyze by identifying sections in which many design decision were made, (b) developed and refined a coding scheme, (c) coded the data, and (d) developed our claims. Our coding scheme combined two frameworks. The first is Mishra & Koehler's (2006) TPCK, which enabled us to characterize participants' contributions in terms of the type of knowledge they brought to the design meeting discussions. The second is a framework described by Damsa et al. (2010) for the analysis of shared epistemic agency in the context of collaborative design. This approach enabled us to distinguish between different types of collaborative knowledge-building activities in the group such as seeking information, sharing ideas, structuring ideas and producing ideas, which Damsa et al. (2010) view as "knowledge related activities of shared epistemic agency".

The combination of the two frameworks enabled us to relate types of knowledge (combinations of Technology, Pedagogy and Content) with the types of knowledge-building activities (Seek, Share or Suggest any type of knowledge). To these two, we added another layer – the contributor of the knowledge (domain expert versus eLearning design expert). However, if we would have taken each and every combination of these three dimensions (for instance one combination is: seeking technological-pedagogical knowledge by eLearning designer), we would have had 42 possible outcomes (7 combinations of knowledge types: T, P, C, TP, TC, PC and TPC; 3 shared epistemic activities: Seek, Share and Suggest; and two types of contributors: Domain and eLearning experts). In order to get a more focused representation, but still get a sense of all three dimensions, we made the following decisions:

1. Due to the types of expertise in the teams (domain experts versus eLearning designers) we were more interested in distinguishing between the pedagogical content knowledge (PC) and the technological knowledge (T), than to distinguish between the pedagogical (P) and the content (C) knowledge. Thus, we reduced dimensionality of TPCK and considered: (a) P, C and PC as one broad category (PC); and (b) TP, TC and TPC as a second broad category (TPC).
2. Since most of the *seeking* and *sharing* of ideas were in terms of *pedagogical content* (PC) knowledge or *technological* (T) knowledge, and most of the *suggesting* were of design ideas that seemed to have taken all three aspects (*technological, pedagogical* and *content* – TPC) into account, our refined coding scheme included only the cells checked in Table 1.

<u>Table 1: Categories used for coding.</u>

	Seek	Share	Suggest
T	✓	✓	
PC	✓	✓	
TPC			✓

With these decisions, we were able to reduce the number of categories to ten (the five categories described in Table 1, times the two types of contributors: Domain and eLearning experts). Table 2 presents examples of utterances coded using these categories. To increase reliability of our analysis, the coding was performed individually by two of the authors of this paper. An eighty-four percent of agreement was reached prior to negotiation on the coding.

Table 2: Coding scheme and examples.

Category	Example Utterance
Seeking pedagogical content (PC) knowledge	*Just for the purpose of – because I'm still a novice in terms of my understanding of the purpose of the clinical log books, can you just give us a brief? …What's the main purpose of the log book to date? How might that change under new curriculum agendas? What's the 'must dos' – what's the bottom line?* (A domain expert seeking PC knowledge from another domain expert in the Nursing team)
Sharing pedagogical content (PC) knowledge	[going through a printed document] *So this is the overall set of Learning Goals or Learning Expectations … These are the things that we know that they've learnt about prior to starting their first placement. Then they go on their first placement. And then these are the things that we know that they've then got under their belt before they start their second placement…* (A domain expert sharing PC knowledge with an eLearning design expert in the Social Work team)
Seeking technological (T) knowledge	*Is it possible to set it up with Twitter and then if it becomes overwhelming I could wave the white flag and you could help me take it down and just replace it with an email address?* (A domain expert seeking T knowledge from eLearning expert in the Health Science team)
Sharing technological (T) knowledge	*You can do that* [refers to question regarding the possibility of the technology used to 'stamp' components of the learning environment called 'assets' with date and time]. *Almost every asset has something that you can put a date, time, thing on it. You can also put how long students need to do it.* (A technology expert sharing T knowledge in the Nursing team)
Suggesting design (TPC) ideas	*If you want to get them* [the students] *start working on a reflective journal and there's a reflection journal tool in Peddle Pad, then I would start them in Peddle Pad because that's what they're going to continue with, yeah - and part of their portfolio. But also it will give them some clues about their strengths and what they want to develop in field ed. … We could also add a component of that for professional practice so that across this first semester of the year, they're doing a reflective journal that's integrating a whole lot of learning that's going on this semester.* (A domain expert suggesting TPC design idea in the Social Work team)

Findings

Our analysis revealed four unique characteristics of the collaborative design process in each of the three teams:

1. *Multi-dimensional exploration.* Team-members did not attempt to provide solutions before they had a good understanding of the pedagogical-content and technological challenges they were faced with, as exemplified in Figure-1. The figure represents the collaborative design process that took place in one of the Nursing team meetings. The horizontal axis shows a timeline of about one hour, each tick showing one saying of a team-member. The vertical axis represents accumulation of T, PC and TPC knowledge. Each utterance representing T, PC or TPC knowledge, is counted as one knowledge unit. The gradual rise of the three lines in Figure 1 indicates how the progression of design ideas was intertwined with T and PC knowledge sharing.
2. *Balanced process.* Design decisions were made in a balanced process in which both academic team members and eLearning designers were equally involved. This is exemplified in Figure-2 by the interchange of red and blue light-bulb icons, representing design ideas suggested by academics and eLearning designers.
3. *Mutual respect.* Team-members appreciated each other's expertise and used the team-meetings to learn from their colleagues about aspects of the design challenge they were not aware of. This was evident in many instances in which participants sought knowledge either in their own domain of expertise or in the others' domain (e.g., see the question-marks in Figure 2 representing seeking of knowledge by both academics and eLearning designers).

4. *Crossing domain expertise.* In some instances, participants crossed their domain of expertise, and carefully provided ideas that were not in their own domain. This was usually followed by feedback from a domain expert, and was a productive way to move the discussion forward. (e.g., see red exclamation marks on the blue line representing academic team-members sharing technological knowledge, and blue exclamation marks on the red line representing opposite epistemic agency).

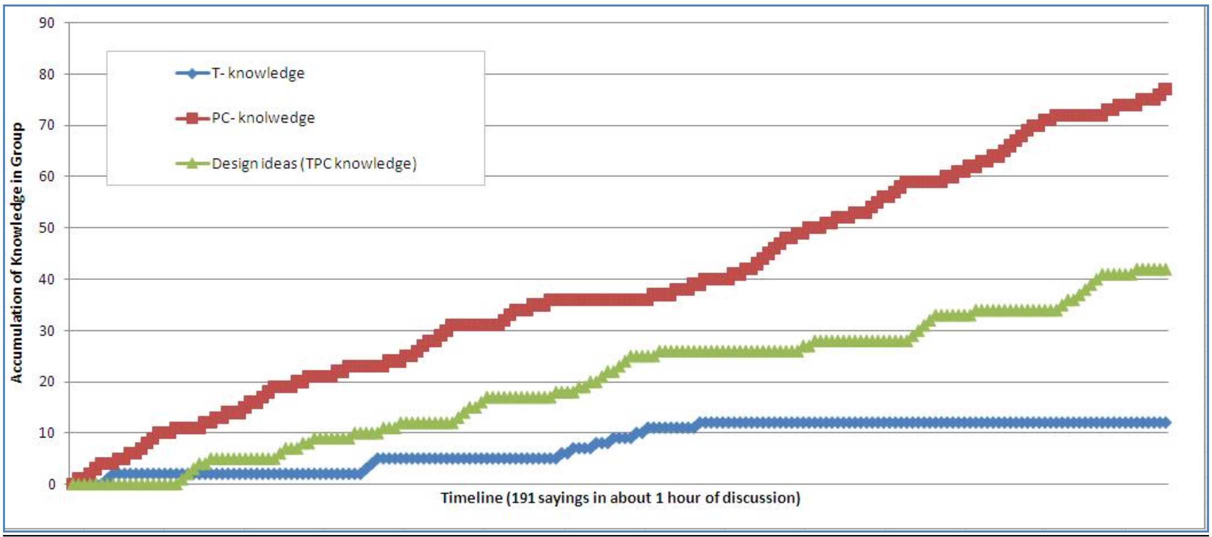

Figure 1. Example of a knowledge-building process in which design ideas gradually develop while one team (Nursing team) explores the pedagogical, content and technological aspects of the eLearning design challenge.

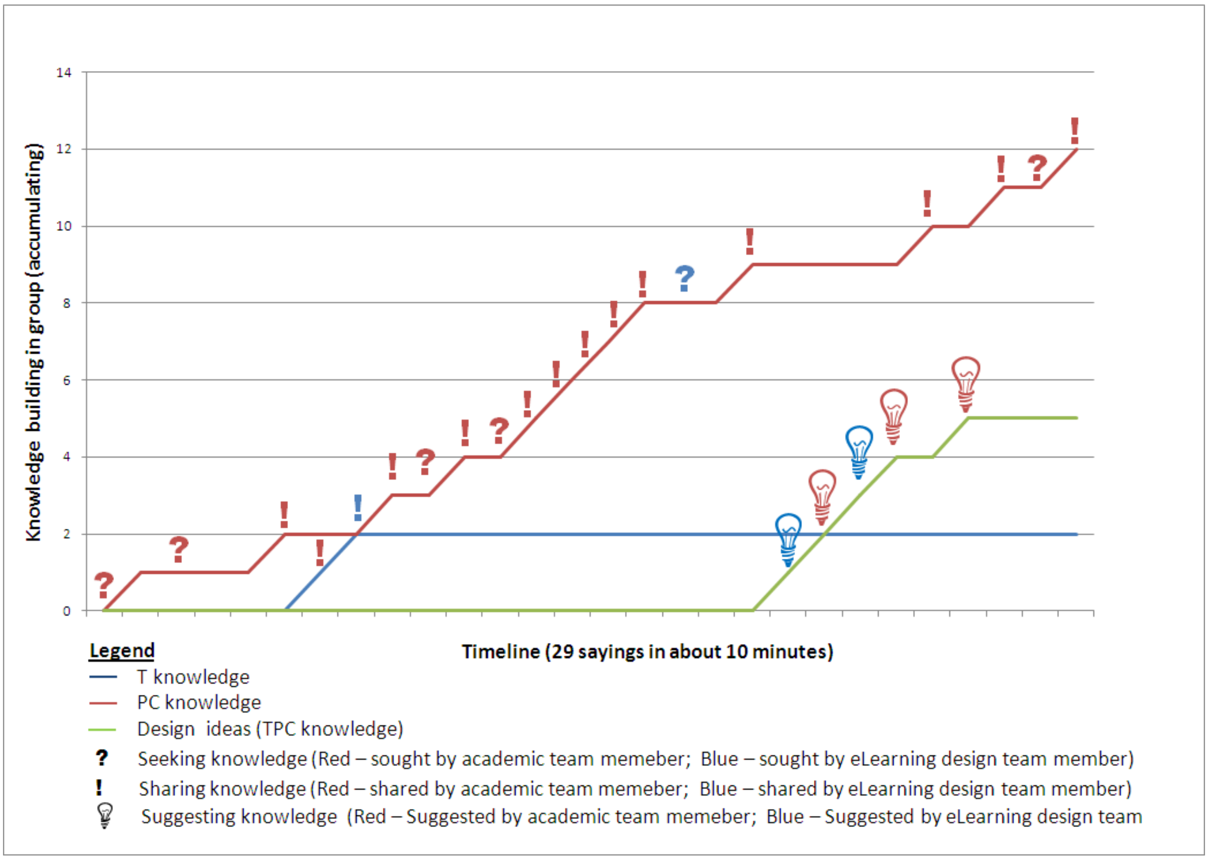

Figure 2. An example of epistemic agency and knowledge-building processes in about 10 minutes of a team discussion (Social Work team).

Discussion and Conclusion

Despite the challenges described in the literature regarding collaborative design, the three teams that we observed were highly successful in designing solutions collaboratively that were based on different epistemic moves and a growing body of the domain (PC) and technological (T) knowledge within the group, which was pretty equally contributed by the academics and the eLearning designers. The question is why? What was there in the specific settings of these three groups that enabled them to succeed so well where others have failed?

One possible answer is the thought-through process of the university eLearning design initiative which these teams were part of (Ward et al., 2010). We see at least two aspects of this process, which might have contributed to the mutual epistemic sensitivity and respect that academics and eLearning designers had to each other's expertise. First, the eLearning designers in the university initiative are carefully chosen to have a significant pedagogical background. Second, the projects are chosen via an extended application and planning period, in which expert committees help to articulate and prioritize projects. In this way only academic teams that have a good sense of the affordances of technology to support pedagogy are chosen. These two aspects of the management process probably helped minimize epistemic and cultural distances, allowed to see fusion points and enabled the mutual respect that we found in our analysis.

Another possible answer has to do with the technological tool used for developing the online courses in the current study. An important aspect of the tool is that it enables non-programmers to develop sophisticated eLearning environments. Such tools are becoming more and more abundant in universities and schools, and require less technological expertise than older generation tools. The result is that pedagogical experts nowadays do not have to be in an inferior position, as described by diSessa et al., (2004), in the collaboration with technologists. If that is the case, and gaps between pedagogical and technological experts are about to diminish, we can expect to find more and more multi-disciplinary eLearning design collaborations, not only between experts, as in the case of the current research, but also among pedagogical and technological practitioners in schools, and other work areas. The four characteristics found in the current research, i.e. *multi-dimensional exploration*, *balanced process*, *mutual respec*t, and *crossing domain expertise*, can serve as principles for guiding such collaborative design endeavors.

Finally, we would like to note that combining the TPCK and the shared epistemic agency frameworks helped shed light on the complex process of collaborative design of technology-enhanced learning in the current study. We see a great potential in this combined framework and recommend continuing to explore its use.

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