Handbook of Research on Learning Design and Learning Objects:
Issues, Applications, and Technologies

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Chapter XII
Investigating Prospective Teachers as Learning Design Authors

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ABSTRACT

This chapter reports on findings from a recent project situated in the area of preservice teacher education. The project investigated prospective teachers authoring and using their own contextualised learning designs. The chapter describes how 17 secondary and primary preservice teachers adapted existing, well-researched learning strategies to inform the design of their own specific online learning tasks and how they implemented these tasks in the context of their teaching practicum. The prospective teachers used an online learning design authoring system as a tool and flexible 'test-bed' for their learning designs and implementation. An account of the ways in which the prospective teachers developed sophisticated understandings of their chosen learning strategy and developed fresh insights into online and face-to-face teaching issues is presented.

INTRODUCTION

A problem facing teacher education today is the resilient nature of teachers' beliefs that shape their (face-to-face and online) classroom practices and the need to provide them with opportunities to discuss and reflect critically on these beliefs. For example, preservice teachers study

a variety of learning principles and strategies in theory classes at university, and are exposed to an increasing range of online learning designs in their studies. (The term *learning design* (LD) in this study is informed by Oliver and Herrington (2003) and refers to a sequence of coordinated online learning experiences underpinned by a learning strategy, learning resources, and support mechanisms to provide guidance and feedback to learners.) However, preservice teachers often struggle to implement theory into practice (Fang, 1996), and there is good evidence that when faced with the hectic pace and demands of every day teaching duties, they revert to more traditional didactic teaching methods (Goodrum, Hackling, & Rennie, 2001). Furthermore, design of online activities tends to be pedagogically shallow and content-driven (Odlyzko, 2001).

This study investigated these problems by situating preservice teachers as learning design authors and examining how the process of authoring and implementing a contextualised learning design might help 'build bridges' between theory and practice in their university course. It explored the efficacy of teachers creating their own Web-based learning task using a learning design authoring system and how they can use, and reflect upon, these contextualised designs on their school teaching practicum. In this study, the scope of these learning tasks was at the level of 'lesson component' and typically comprised a 20–30 minute online learning activity. The main research question for this study is: *How does preservice teachers' authoring and use of contextualised online LDs enhance their development as teachers?* Subsidiary questions for this chapter include: *To what extent do preservice teachers develop knowledge of (online and face to face) teaching and learning?* and *To what extent is their understanding of specific learning strategies enhanced?* Although findings are mostly generalisable to all domains, the study was confined to math and science education contexts due to budget and time constraints.

BACKGROUND

This study aims to build on the current interest in LDs to investigate pertinent issues involved in preservice teacher education. It highlights prospective secondary and primary teachers as important stakeholders and introduces school-based classroom contexts to the LD research agenda. Research into teachers' use of LD authoring systems is a crucial but underdeveloped area of the LD research agenda.

Teachers, Learning Designs, and Learning Design Authoring Systems

Researchers have recently identified and explored the underpinning support structures and learning strategies incorporated in exemplary online learning designs, particularly from tertiary education contexts (Agostinho, Oliver, Harper, Hedberg, & Wills, 2002; Laurillard & McAndrew, 2003). For example, multimedia-supported predict–observe–explain (POE) tasks use the well-researched POE learning strategy (White & Gunstone, 1992) to effectively scaffold students' learning in an e-learning environment, presenting digital demonstrations set in real-life contexts as stimuli for their learning (Kearney, 2002). However, research into how teachers might adapt and use LDs is in its infancy (e.g., see Bennett, Lockyer, & Agostinho, 2004; Cameron, 2007; Kearney, 2006) and has mainly been confined to tertiary teachers. This study builds on the Kearney (2006) study by focusing on three exemplary learning strategies across two disciplines, and also involves participants' use of a LD authoring system—in this case, the *learner activity management system* (LAMS) (Dalziel, 2003)—as a 'test-bed' for teachers to contextualise and implement their specific LDs. LAMS (version 1.0 at the time of the study) was chosen primarily because its intuitive drag and drop authoring environment was considered user-friendly for novice (student teacher) participants; it was freely available as open source software,

provided local support, and has shown positive signs for engaging the teaching community (Masterman & Lee, 2005; Russell, Varga-Atkins, & Roberts, 2005).

Many studies have focused on technical aspects of LDs and associated authoring tools in great depth but only recently, an important new focus has emerged on pedagogical and procedural issues associated with teachers designing—and occasionally 'enacting' (Earp & Pozzi, 2006)—their own online learning tasks. Hernandez-Leo, Villasclaras-Fernandez, Asensio-Perez, Dimitriadis, Jorrin-Abellan, Ruiz-Requies, and Rubia-Avi (2006) investigated three tertiary teachers using a LD authoring tool to design collaborative learning experiences for their students, while Griffiths and Blat (2005) investigated issues relating to enabling teachers to participate in the LD process and also ways of representing LDs to teachers. Earp and Pozzi (2006) discussed two European projects (*Netform2* and *Remath*), including initiatives with novice teachers authoring and reusing LDs to support pedagogical reflection. Finally, Gibbs and Philip (2005) investigated a range of 10 teachers across both tertiary and school sectors using LAMS as an authoring tool and found positive teacher perspectives about opportunities for teacher reflection on pedagogy, as well as student collaboration, motivation, and engagement. Our study builds on this Gibbs and Philip study by focusing on preservice teacher learning and issues emerging from participants' design and implementation of their specific contextualised LDs on their practicum.

Learning Strategies Used by Participants in This Study

The education literature details a range of effective strategies to support student learning. For example, *learning strategies* informed by a constructivist perspective (Tobin & Tippins, 1993) have been extensively reported in the math and science education literature, particularly strategies that support students' understanding of difficult concepts that are often encountered in these domains (e.g., Baird & Northfield, 1995; Skamp, 2004; Treagust, Duit, & Fraser, 1996). As these strategies were aligned with the constructivist philosophy underpinning the students' math and science education subjects, the preservice teachers in this study were encouraged to create specific online learning tasks underpinned by their choice of one of the following three well-researched learning strategies from this literature base:

- The *analogical reasoning* (AR) strategy (Harrison & Treagust, 2006; Treagust, 1995). This strategy supports learners' use of a familiar analogue to explore a 'target' concept;
- The *predict–observe–explain* (POE) strategy (White & Gunstone, 1992). This strategy scaffolds students' engagement with key demonstrations as stimuli for their learning;
- The (broader) 'interactive teaching' model (Biddulph, 1990; Faire & Cosgrove, 1993), subsequently referred to as the *learners' questions* (LQ) approach (e.g., see Baird & Northfield, 1995, p.240). This approach elicits learner questions as a basis for further investigations.

There was ample literature available to the students on these three strategies, including research authored by lecturers within the participants' programs (e.g., Aubusson, Harrison, & Ritchie, 2006).

STUDY METHODOLOGY

A qualitative methodology was employed to uncover preservice teachers' professional learning experiences during authoring and implementation of their own contextualised LD. This approach enabled a comprehensive and descriptive account

of the participants' experiences to emerge (Merriam, 1998). An interpretive approach to data analysis was employed and this provided insight into how participants made sense of their learning experiences (Mason, 1996). This methodology is supported by educational technology theorists such as Neuman (1989) and Salomon, Perkins, and Globerson (1991) who have advocated more naturalistic studies that provide appropriate data about relevant social and cognitive processes in order to explore the affordances of innovative technologies.

Participants

Participants in this study were 10 volunteer teacher education students from the fourth year of the Bachelor of Education (Primary) program and seven students from the Graduate Diploma in Education (Secondary) program in the Faculty of Education, University of Technology, Sydney (UTS), Australia. They were advised that participation in the study would not influence their grades in their course, and there was no background technical skill requirement. An initial survey of research participants revealed they had minimal background knowledge of designing or implementing an online learning task for school students and no participant had used LAMS. This survey also revealed that the preservice teachers had minimal background knowledge of the three learning strategies: predict–observe–explain, analogical reasoning, and learners' questions approach. The K–6 preservice teachers had more experience with the broad notion of using 'constructivist learning strategies' to elicit school students' conceptual understanding in math and science contexts, having already completed three years of their education studies and related professional experiences.

Procedures

The study took place during semesters one and two in 2006 and comprised four phases: Phase 1: Familiarisation (with LAMS and the learning strategies); Phase 2: Design of specific, contextualised LDs for school students; Phase 3: Implementation; and Phase 4: Reflection. The project utilised an online learning management system to support students with links to relevant articles and resources and provision of online discussion and communication tools.

As preservice teachers were not due to implement their final learning task until their second semester practicum, they spent the first semester engaged in several preliminary learning opportunities to become familiar with their chosen learning strategy as well as becoming acquainted with the LD authoring software (LAMS). These experiences included:

- *Introductory university lectures and background reading.* At the start of the project, preservice teachers attended two 90-minute lectures led by academic staff from UTS Faculty of Education who had conducted research on learning strategies. These sessions initially involved students participating (as learners) in sample, face-to-face tasks underpinned by relevant learning strategies. These tasks were completed using a range of individual, small group, and whole class structures and also included the lecturers modeling, explaining. and deconstructing exemplary teaching practices. The sessions culminated with further questions, critique, and analysis. Preservice teachers also were issued with several key articles from the science and math education literature (e.g., *AR strategy*: Harrison and Treagust (2006); *POE strategy*: White and Gunstone (1992); *LQ approach*: Biddulph (1990)) to give them a foundational understanding of their chosen learning strategy, consistent with information from the lectures. These readings were the subject of further participant-initiated verbal and online discussions (mediated by academic staff members) during and after other preliminary learning experiences

mentioned below. The lectures and readings informed the use and 'testing' of their chosen strategy in a whole-class, face-to-face setting on their semester one practicum.

- *Trial of strategies in their semester one practicum classes*. Their semester one practicum served as a pivotal opportunity for research participants to test their newly chosen strategy in typically whole class, traditional classroom environments. Many preservice teachers tried at least one of the strategies on this practicum as a face-to-face task. School staff and school students gave the participants valuable feedback.
- *Engagement with sample LAMS tasks.* After the semester one practicum, four contextualised learning designs were created for student teachers to engage with as learners: one underpinned by a POE strategy using a physics context; one using a LQ strategy in biology; and two using an AR strategy in physics and mathematics contexts. Informed by the science and math education literature surrounding the three learning strategies, these model tasks were created by the research team in conjunction with subject and pedagogical experts in the Faculty of Education, UTS, including critical friends of the project. They were placed on the 'public' section of our project's LAMS account (viewable only to project participants), so the preservice teachers could also access them in author mode and analyse their structure at a 'LAMS tool' level. This experience allowed the participants to engage in existing sequences from a student's point of view (i.e., learner mode); deconstruct the sequences from a design perspective (in author mode); and also learn about the particular learning strategies informing each online design. This approach is consistent with the principle of teachers needing to experience novel learning environments as learners themselves to consider changes in their teaching (Loughran, 1997).
- *Two Introductory LAMS workshops.* These sessions introduced participants to range of tools in the teacher 'authoring mode' of the LAMS environment and other LAMS tutorials and resources. At the time of the project, only version 1 of LAMS was available.

The participants then designed their own specific contextualised LDs before implementing them in a primary or secondary classroom during their second semester practicum. Participants shared their draft and final designs with their peers in the 'public' section of our LAMS project space. After implementation, the participants were provided with opportunities to reflect on the design and implementation process and changes for the future. Ethics approval was obtained early in the year from the university's research office to carry out this project. All names in this chapter are pseudonyms.

Data Collection and Analysis

Data were collected throughout the four phases using ongoing participant journals, two surveys, individual and focus group interviews, observation, and collected documents and artefacts. Participants kept an online journal for both semesters, documenting their development as teachers and their reflections on their professional learning. Two open-ended questionnaires probed preservice teachers' views about their pedagogical knowledge development. These were administered at the start and end of the project with responses to final surveys informing final focus group interviews. Sample participants also were interviewed immediately after the implementation of their LD during practicum. Preservice teachers were observed both during their practicum lesson and during final university class presentations. Written rationales for their designs and reflections on their practicum experiences were also collected for examination at the end of the project, as were their (LAMS-based) specific LDs.

This data were analysed according to emerging themes across all data sources and across the collective case. In the first instance, each researcher individually examined all of the data from either the primary or secondary teachers. Themes were independently established from the perspective of each researcher. The research team then came together and, through a process of negotiation and critical collaborative reflection (Bullough & Gitlin, 1991), identified common themes that were capable of capturing the experiences of the participants.

TEACHERS DEVELOPING UNDERSTANDING OF ONLINE AND FACE-TO-FACE TEACHING ISSUES

Exploration of the first subsidiary research question—*'To what extent do preservice teachers develop their knowledge of (online and face to face) teaching and learning?'*—drew mainly on data from interviews, surveys, and journals. Four key themes emerged relating to the participants' developing professional knowledge of online and face-to-face teaching: unit planning and programming insights; promoting independent learning in an e-learning environment; classroom strategies to facilitate online learning; and strategic use of digital media and Web-based resources.

Unit Planning and Programming Insights

The process of developing an online learning task for their practicum class encouraged participants to consider, in significant depth, the appropriate sequence of learning activities and the most suitable blend of online and face-to-face components to facilitate their students' learning. Recognising the value in having their online task integrated into a relevant unit of work, participants aimed to 'blend' their online task with other face-to-face lessons. However, this raised a new and challenging issue for many participants: 'I want to include so much [in the LAMS task] because I keep forgetting that this is only one tool to teach and that I can add to the lesson outside the program.' (Yasmine, journal). Indeed, many participants developed an appreciation for the complexities of unit planning involving a 'blend' of online and face-to-face strategies. For example, early in the project Hope mentioned in her journal:

I really need to get a unit plan laid out and decide what part could be online. But firstly need to know exactly what topic, content and online resources, syllabus requirements, teaching approaches and how to teach Earth and its Surroundings in order to get this unit plan—a lot of work beforehand!

Often the decision to locate the online task at the beginning, middle, or end of a lesson sequence depended on how the participant viewed the online task as a tool to uncover student learning and understanding. One participant, who designed an analogical reasoning task, thought it was important to use the LAMS tasks at the end of her unit of work 'so that the [school] students will have more knowledge to contribute' (Eleanor, journal). This was in contrast to many participants who used their LD task as an introductory, diagnostic activity and had to think about follow-up lessons.

In her final survey, Elizabeth stressed that she could better tailor follow-up discussion because of the variety of responses she received via her online POE task. The systematic nature of the online tasks to automatically record and collate individual school student's progress was highly valued: 'the ability to review every student's feedback since in class most of the views would not have been exposed' (Elizabeth, final survey). Mike concurred: 'one of the strengths…was being able to collect and store students' responses for further scrutiny at a later date' (Mike, final survey).

Promoting Independent Learning in an E-Learning Environment

Many participants became conscious of designing an online task that enabled their school students to work independent of the classroom teacher. They consequently developed insights into issues relating to scaffolding and self-pacing, and also into their new authoring and teaching roles. Each participant went to great lengths to consider the appropriate language, visuals, and sequence of tasks they believed necessary to enable their students to successfully navigate and complete the online activity with minimal teacher assistance.

It was noticeable that many preservice teachers discussed the affordances of self-pacing in their rationales, interviews, and surveys. For example, Natalie valued this aspect of her online design: 'they can go back and look at parts again (potentially) as a point of revision to start again. …Then continue on to new work at their own pace' (Natalie, final survey). Others thought the self-pacing aspect encouraged more school student ownership of task responses, and also supported less didactic teaching methods: 'The fact the kids were able to work at their own pace on the computer meant there wasn't a teacher at the front doing all the teacher talk' (Eleanor, final focus group).

However, one problematic issue to emerge towards the end of the project was the participants perceived level of 'teacher control' and the extent to which the online tasks supported students' control over their own learning. Most perceived the teacher control over the design phase as a positive aspect: 'The program gives teachers the ability to put exactly the information desired and makes students follow the path that teachers want, making learning very specific and efficient' (Yasmine, journal). However, others perceived the level of scaffolding to be problematic. For example, Lucy and Eleanor critiqued the level of student flexibility:

It's hard for students to have input in the direction the task takes. …There is not as much room for lateral movement in the task. (Lucy, final survey)

They [the students] get no choice in the sequence of events, nor a chance to investigate any misunderstood concept any further than the information presented to them. The program seems to speak to them, but cannot read their answers/responses and adapt the following sequence accordingly like a teacher could. (Eleanor, focus group)

Preservice teachers questioned the potentially constraining nature of their structured online tasks and the limited opportunities for school students to influence the direction of their task. Natasha emphasised the key role of the teacher here: 'you can't have it so the kids are in total control. …you need teacher input to give them stimulus and direction' (Natasha, focus group); while Anna advocated a balanced approach: 'I have found that such [online] activities need to … be designed to guide, but not excessively constrain, the students' exploration… promoting lines of inquiry that help students develop their understanding of the important concepts' (Anna, Rationale/Reflection).

While still acknowledging that the level of participation could vary between individual learners, all participants agreed that their online tasks gave their students an opportunity to actively participate in their learning compared to a general class discussion where only three or four school students might participate. Nick's comments were typical: 'it is no different from other "analogue" tasks in the classroom. We just have to guard against the passive use of the computer screen' (Nick, survey). Also, some preservice teachers felt that participation was promoted because online tasks provide a safety valve or a more 'risk-free' environment, which was less confronting, especially when anonymous postings were allowed. This enabled their school students to express their personal science and math beliefs

more openly and freely 'give answers without the fear of being ridiculed if they are incorrect' (Laura, survey).

Classroom Strategies to Facilitate Online Learning

Although participants focused on creating an online learning task which facilitated learner independence, they all chose to design a task that was completed by the school students under their guidance, in a face-to-face school-based learning environment. They emphasised the importance of this face-to-face role: 'students feel more secure in the sense that the teacher is available to answer questions and guide them in the right direction' (Natalie, final survey) and 'from an educational view, to discuss ideas, clarify and focus, recap, etc' (Lucy, final focus group). They also highlighted the spontaneous nature of learning and the crucial presence of the teacher: 'although very accommodating, computer technology is not able to deal with spontaneous learning that happens in the classroom, it can only aid it' (Laura, final survey).

The face-to-face environment was seen as particularly important for younger learners and practical considerations such as typing skills were a consideration for this age group: ' Since the students are not likely to be able to type their responses, I may ask them to orally respond their answers and opinions and have it more as a discussion' (Alice, journal). Indeed, the participants who had younger learners tended to adopt more authoritative roles in their classrooms: 'I will involve all students, have them working in pairs, and use a modelled and guided version of talking the students through each stage of the software to use the analogy and enter their findings' (Amy, journal).

With a teacher present in the room, school students appeared to have a reliance on them and this was a surprise to many preservice teachers, given the emphasis they had placed on independent learning in their designs. Participants also experienced the dilemma of how much (face-to-face) guidance to give their students—a common problem with trainee teachers in their practicum classrooms. They again seemed surprised that they would experience this dilemma after consciously incorporating adequate scaffolding and prompting in their designs. Nick and Mike tried to keep a facilitatory role: 'it was hard not to prompt and keep out of the way' (Nick, final survey), and similarly, 'I tried to lean over their shoulder and ask them to work through the LAMS task …I'd give them some hints there' (Mike, postlesson interview). Lucy developed an awareness of this issue: 'I've come to realise how fine a line there is between giving students the answer and helping them find it—they can need a lot of guidance sometimes.' (Lucy, final survey).

Participant reflections indicated they revised and developed their views on face-to-face strategies in these e-learning environments. A significant number of participants reported that next time they would further integrate more (face-to-face) questioning and discussions during the online task and 'chunk' or reduce the length of their design accordingly. Natalie designed her task with the notion of complete learner independence but upon review of her students' evaluations began to see the importance of her face-to-face role:

The task was designed so that the teacher was not required to provide feedback to students during the task on their ideas and answers, allowing them to work independently. However, from a number of the student's comments, they may have benefited from more teacher feedback either directly in the classroom or indirectly or by having the teacher involved in an online 'group' chat at the same time. (Natalie, reflections)

Participants' emerging understanding that online and face-to-face activities are able to be more readily integrated than they had initially thought was evident. For example, Elizabeth

came to realise that she didn't have to think of her online task as an isolated e-learning episode with distinct face-to-face lessons before and after it: 'I think that online and face-to-face teaching could be effectively sandwiched throughout a lesson rather than devoting lessons to one or the other' (Elizabeth, final survey).

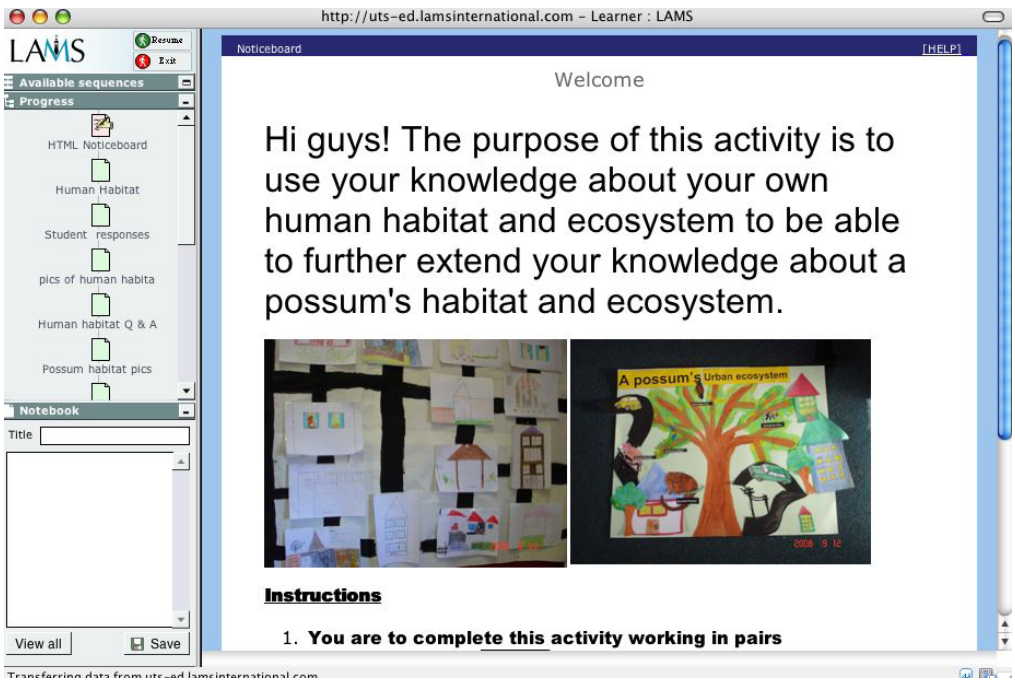
Strategic Use of Digital Media and Web-Based Resources

Participants also developed sophisticated skills in selecting appropriate media and Web-based resources for their LDs. Many participants became mindful of utilising these resources to create rich contexts and enhance their students' interactivity. Some participants used appropriate media to enhance learners' observation of phenomena, and subsequently, the level of school students' visual literacy skills was raised by participants as a key issue.

Naomi recognised that inclusion of appropriate media (in her case, videos of recent cyclones), allowed her students to view rich, out-of-class, and possibly very current contexts that would not be possible to observe in traditional resources such as textbooks:

LAMS allows children to access ... class contexts, such as cyclones, that they otherwise would not be able to access in real life circumstances and also allows kids to have the opportunity to view or learn about very recent occurrences or concepts (that textbooks would not yet include). (Naomi, survey)

Figure 1. First page of Eleanor's task (LAMS learner mode) containing her children's work samples



Hope made similar comments:

Multimedia content serves to motivate students into engaging into science learning because resources are fun, novel, can be controlled by students (e.g., when watching videos and simulations), multisensory (e.g., watching, listening, playing, and directing materials), and reflect real world materials used by scientists themselves. Additionally, without ICT such diverse resources are not easily accessible in textbooks at school or within children's lives for them to examine. (Hope, Rationale)

Although many participants used external sources of media, some created their own. Virginia, for example, created a car racing video-based demonstration to provide rich stimulus material for the boys engaging in her Year 9 Mathematics POE task on 'rates.' Similarly, Eleanor used photos of her students' work in her analogical reasoning task designed to help her Year 2 children learn about animal habitats (see Figure 1). She reasoned that this would not only help her students to visualise the analogy but also create learner ownership of the task.

An interesting point raised by the prospective primary teachers in the project concerned school students' background visual literacy skills, especially young children's ability to interpret key photographs and videos in their online tasks. This was a particularly pertinent point in the context of the crucial observation stage of the POE strategy; and also in the AR strategy where media can help learners make connections between the analogue and target concept. For example, Laura was concerned about her children's interpretation of a time-lapse photography video that condensed the life cycle of a butterfly. She explained the problem in her interview: 'Due to the student's lack of experience with time lapse movies, they had difficulty ascertaining whether their initial prediction was correct or if they correctly observed the phenomenon.' Amy also was concerned about her Year 1 children's interpretation of a satellite image. Various solutions were discussed. Laura suggested inclusion of an 'extra page' in her LD, after the time-lapse video, containing key still images extracted from the movie to enhance observation of the phenomena. Lucy made a similar suggestion, discovering that a focus question or statement was necessary immediately after her video-based demonstration to help people understand the analogy in her task. Amy suggested the possibility of preliminary lessons devoted to interpreting media and also minor editions to photos such as labels on key photos in her task.

Ten participants carefully selected and embedded external Web-based resources such as applets, wikis, and online drawing tools to provide extra interactivity. This was of prime concern for Mike who embedded a Maths applet that helped his students develop their knowledge of angles: 'The relevance of the relationship between angles is seen clearer and easier than drawing many forms of the relationship by hand to get the same effect' (Mike, Rationale). Similarly, Natalie included an interactive graphing tool from an external Web site to help her students manipulate changing slopes on a graph. She also included a range of other resources and recognised the efficiency benefits in being able to 'wrap' these experiences into one task for learners: 'This task makes use of Web links, applets and video in one package, …enabling [students] to be involved in discoveries through the technology that wouldn't be achieved as quickly in a paper environment' (Natalie, Rationale).

In summary, the participants demonstrated increased awareness of planning and sequencing activities along with design issues relevant to promoting independent learning. This subsequently raised their awareness of issues surrounding the integration of online and face-to-face activities and the role of the classroom teacher during such learning experiences. They also showed understanding of the use of appropriate media to support student learning.

TEACHERS DEVELOPING AN UNDERSTANDING AND VALUE OF SPECIFIC LEARNING STRATEGIES

Exploration of the second subsidiary research question—*'To what extent are preservice teachers' understanding of specific learning strategies enhanced?'*—drew mainly on journal entries, final survey and interview data. Pre-service teachers developed deeper understandings of their chosen learning strategy, how it can be used to inform an online learning task and other relevant classroom issues.

Participants Choosing the Predict–Observe–Explain (POE) Strategy

Participants who chose this strategy developed new insights into all stages of the POE procedure. They generally used the survey and question and answer (Q&A) LAMS tools for the prediction and reasoning stages of the POE procedure (e.g., see screenshot of Laura's authoring mode in Figure 2).

Although some, like Elizabeth, preferred the Vote and Journal tool. Indeed, Elizabeth experimented a little with the observation and explanation phases of the POE procedure, before giving a verdict on the best combination of (LAMS) tools in her final survey:

I tested using the 'Share Resources' [LAMS tool] followed by a 'Q&A' tool as well as the combined 'Resources and Forum' tool. The first worked much better. [My] Students found the step by step sequence easier to navigate. I would change the next time to have a 'Q&A' [LAMS tool] following.

Laura, who developed a task on 'life cycles' for her Year 2 children, developed new understandings of the 'reasoning' and 'explain' stages of the POE procedure: 'Using this teaching strategy gave me an insight into the importance of asking children to explain their answers and how many children actually have great difficulties answering why they think a certain way.' Troy commented on the value of the observation stage: 'The observations give students a real world connection between what they are learning and how it can affect them.' (His task incorporated a video-based demonstration of lightning.) Elizabeth also valued the prediction and reasoning stages and, like many teachers who chose this strategy, appreciated the potential use of students' elicited views as stimulus for follow-up class discussions: 'I think the questioning (predict and explain) of learners was very valuable in truly understanding my students' (Elizabeth, final survey). She thought the whole procedure helped her students to appreciate their own personal beliefs: 'Students need to be coached in the fact that they can learn from identifying wrong perceptions as much or even more than confirming right ones.'

Alice emphasised in her rationale the importance of choosing familiar and interesting contexts for POE tasks (in her case, she chose ice cream for her Year K children's task on melting). She stressed the importance of children being 'comfortable' with the details of these rich scenarios to allow them to make confident predictions. She thought the designing process helped her to become more sensitive to her children's science views: 'In doing this [design process] you need to place yourself in the children's shoes and really think about what they think.' Indeed, both Alice and Tom chose to create follow-up POE tasks, with one crucial variable changed in each subsequent task (e.g., in Alice's case, the colour of the ice cream)—a technique advocated by White and Gunstone (1992). Tom's three consecutive POE tasks (see Figure 3) helped probe his Year 9 students' understanding of sound waves.

Figure 2. Screenshot of Laura's POE task (LAMS author mode)

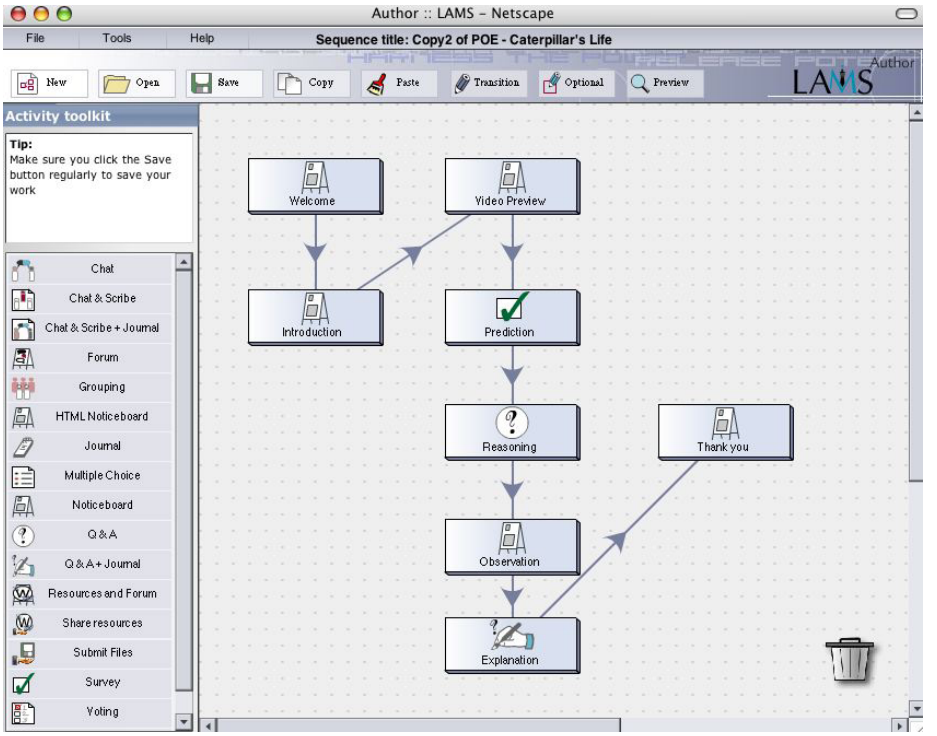
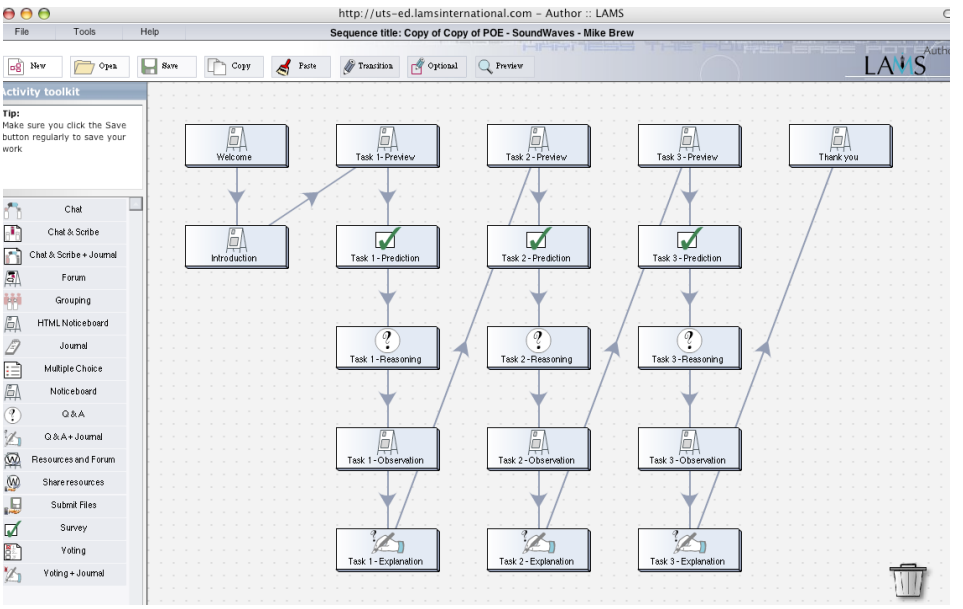


Figure 3. Screenshot of Tom's multiple POE tasks (LAMS author mode)



Participants Choosing the Learners' Questions (LQ) Approach

These participants used their online task to scaffold the 'exploration' and 'children's questions' stages (see Background section) of the interactive teaching model (Hand & Prain, 1995, p. 200) to elicit meaningful questions from their students. There was some interesting discussion about grouping and the best way to elicit questions from learners and how to conduct the subsequent 'investigation' stages. These preservice teachers developed an awareness of the strong locus of control afforded to the learner engaged in these LQ tasks. Naomi appreciated this factor but also recognised the difficulty of eliciting appropriate questions from her students for later investigation:

Its strengths lie in the fact that children are in control of their own learning which is motivating for them. Weaknesses include the actual questions the children may pose in that they may not be 'investigative' type of questions and may need to be rephrased.

Nick's rationale showed that he valued this strategy in helping his students take control of their learning. His task was used to elicit investigative questions for children to address in their upcoming excursion to a pond. He wanted them to 'construct their own ideas on how to investigate the pond, rather than [use] my ideas as a teacher on where the activities should lead' (Nick's journal).

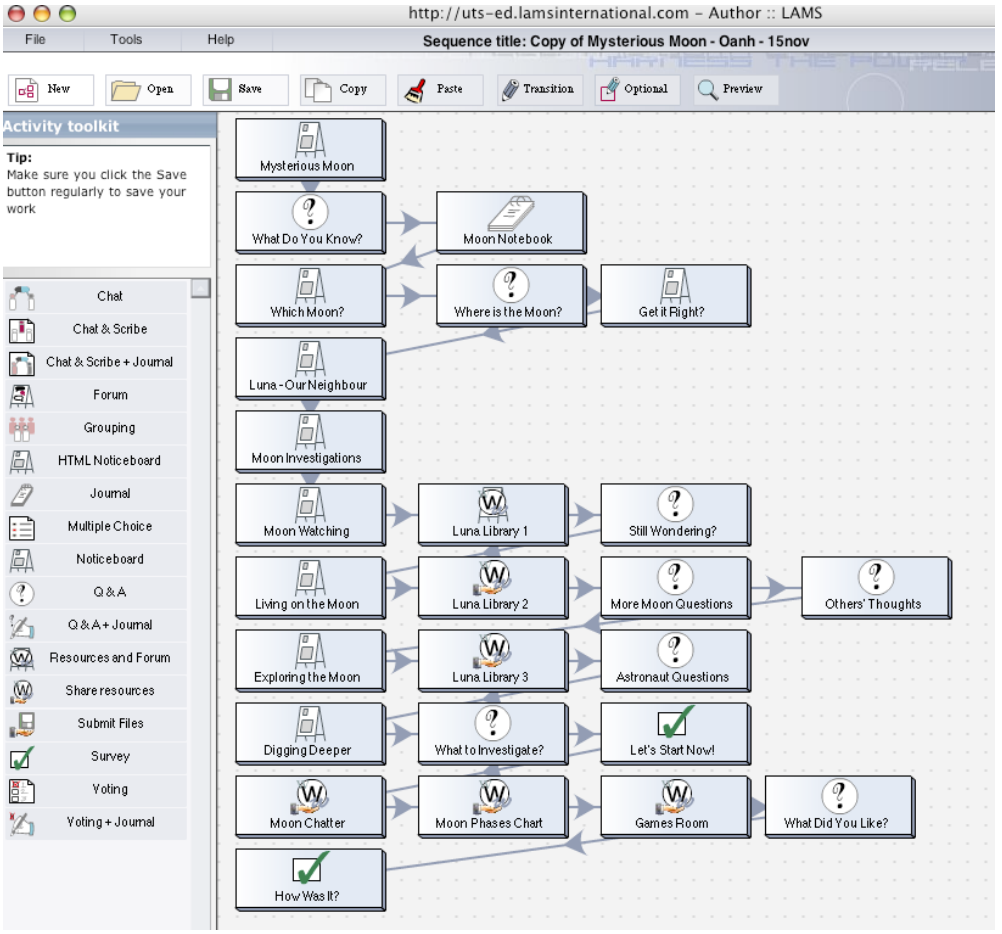
Naomi emphasised (in her rationale) the importance of collaborative (face-to-face) peer discussion at the computer as a crucial factor in eliciting questions. Indeed, in the feedback session after her lesson, school students said they enjoyed working in their small groups as they felt this helped them to generate more questions and ideas (researcher observation notes).

One issue raised by the participants was how best to approach the crucial phase (after learners' questions have been elicited) where learners negotiate an appropriate investigative question and suitable method to investigate this question. Naomi and Nick thought this was best done verbally in a whole-class discussion. For example, Naomi mentioned: 'better to print out the questions and then talk about them face-to-face and create an investigation from those questions' (final focus group). However, Hope chose to scaffold this (later) part of the model in her online LD designed to support her Year 6 children's learning about the moon. She did this by using the LAMS survey tool (see icon 'Let's Start Now' towards bottom of Figure 4) to ask children for their commitment level to questions they had chosen to investigate. In her rationale/reflection, she suggested further discussion forums or journals would be added to future versions of her task to mediate these later research phases of the interactive teaching model (Faire & Cosgrove, 1993). Like other participants who chose this strategy, Hope valued the authentic nature of this approach: 'It would demonstrate to students what it is like to answer real-life problems by themselves, through thinking through what they know, what gaps in their knowledge are…and thinking of how they would carry it out' (Hope, survey).

Participants Choosing the Analogical Reasoning (AR) Strategy

Preservice teachers who chose this strategy stressed the importance of using images to help their students' visualisation processes, especially in the initial 'focus' stage (Treagust, 1995) of the analogical reasoning procedure. Amy highlighted in her rationale that her use of images helped her students become familiar with the analogy, while Lucy explained the role of pictures and a video in her design to help kids visualise the comparison of positive and negative integers with fairies and monsters. Like many preservice teachers using this strategy, Eleanor wanted her students to have the confidence to explore similarities and differ-

Figure 4. Screenshot of Hope's LQ task (LAMS author mode)



ences between the analogue and target concepts and did so by incorporating her students' work samples into the design, as discussed previously. She also critiqued the strategy, showing concern for the possibility that an analogy may reinforce or even introduce alternative conceptions. She suggested teacher (face-to-face) mediation and follow-up as a possible solution here.

Lucy later explored the difference between teacher-created and learner-generated analogies (Aubusson & Fogwill, 2006): 'It [the project] really made me think about how much we develop the analogies for the kids and how much they should develop it themselves.' However, she thought that math contexts might be more difficult for school students to create their own analogies. She concluded in her survey: 'This project has really made me realise how hard it is to use analogies well in the classroom and how important it is to get students involved in creating them and talking about what the differences are.'

In summary, providing sufficient resources and time to enable preservice teachers to familiarise themselves with a chosen learning strategy

was invaluable in fostering participants creative design and use of an online learning task. Having preservice teachers actually implement the design in an authentic context enabled in-depth reflection of the pedagogical issues associated with a particular learning design.

DISCUSSION

The preservice teachers explored appropriate ways to design and use an online task to facilitate their school students' learning. The preservice teachers 'unpacked' and thoughtfully critiqued the chosen learning strategy which informed their design. They evidenced a thoughtful approach to the use of media to ensure that it actually served to facilitate their students' learning. In some instances, where the use of media proved less effective for student learning than expected, participants reflected on appropriate solutions. Opportunities to reflect on the implementation of their LD in a real-life, school context encouraged thoughtful analysis of related pedagogical issues Of particular importance to them was the sequencing and blending of their online tasks with other face-to-face activities. The issues surrounding the creation of independent learning tasks but still wanting to be present to assist their students, created some conflict for the beginning teachers in understanding and managing their teaching roles.

The study has implications for support structures needed in this type of e-learning design exercise to promote preservice teacher reflection on pedagogy. If possible, the design of an online learning task should not be treated as an isolated exercise in teacher education courses and needs to be embedded in the authentic context of school practicum. The process of implementing their design gave the preservice teachers greater opportunities for reflection and evaluation of their role as a designer and a learning facilitator in a blended learning environment. Furthermore, preservice teachers need time to read about and 'test' their new understandings of strategies informing their designs, time to learn how to use LD authoring tools, and opportunities to reflect on their school-based implementations. This 'purposeful' design and implementation process gives preservice teachers further opportunities to form 'bridges' between theory and practice (Richards, 2005).

To build on this study, larger longitudinal studies should follow preservice teachers as they enter the profession and observe how they represent, document, and reuse their LDs in their own classrooms, with their colleagues, and across the school. Also important are ways in which they share and discuss their LDs with larger audiences such as the LAMS and Education Network Australia (EDNA) online professional communities. The practice of creating, implementing, and sharing LDs has enormous potential to reduce the traditional isolation of teachers, and it would be useful to explore how, when, and why teachers use their LDs to remove some of the barriers to professional collaborations across disciplines. One outcome of this project, after further analysis of the students' contextualised LDs, will be the drafting of visual representations and text-based formal descriptions (Agostinho, 2006) of generic LDs associated with the AR and LQ strategies used in this study. These representations will inform the creation of (LAMS-based) content and context independent 'e-templates' for other teachers to use in a similar fashion to the 'e-templates' created by Kearney and Wright (2002) for the multimedia-based POE design. Indeed, this study also raises the question of how other established, well-researched classroom learning procedures, especially from school-based contexts (e.g., see Baird & Northfield, 1995) might inform useful generic online LDs for teachers to adapt to their specific contexts.

The importance of LD research in naturalistic settings such as schools has been highlighted in this study. It emphasises the realities of school-based e-learning environments, where online

LDs are typically enacted in a face-to-face school computer laboratory. LD research needs to have stronger emphasis on these types of classroom environments to be relevant to school practitioners. Indeed, there is a need for further research into how prospective teachers might learn how to 'orchestrate' a mixture of online and face-to-face strategies in a lesson. Related to this issue is the need for further research into the nature of physical learning spaces provided for these types of lessons (Dillenbourg, 2006), including suitable furniture and mobile technologies conducive to quality learner interactions and collaborations. However, just as noticeable in this study was participants' minimal discussion (for example, in their rationales) of temporal and location affordances of the online medium. Further work is needed in teacher education courses to help future teachers reconsider the traditional 'same time, same place' framework of the typical school-based learning environment.

Finally, this study promotes teachers as important stakeholders in research on LD. It is important for the LD research agenda to further explore this area and continue a strong focus on practical and pedagogical issues. Participants in this study raised the issue of 'flexibility' and the danger of LDs being viewed by inexperienced preservice teachers as self-contained entities encouraging scripted, 'plug and play' teaching, too easily ignoring the diverse range of students' background knowledge and learning styles. Teaching is a complex 'business,' and good teachers take advantage of serendipitous pedagogical opportunities arising from learners' unanticipated 'ah-ha' moments (Fuller, 1992). At the very least, LD descriptions and representations need to acknowledge the flexible and dynamic nature of learning in school classrooms and fully detail a range of pedagogical issues in order to be useful for educators, especially novice teachers.

CONCLUSION

The study promotes good practice for teacher educators (and professional development programs) aiming to improve teachers' understanding of issues associated with new e-learning approaches. It also speaks to schools about problems facing teachers in trying to embrace online learning in environments that may not be ideal for flexible, integrated learning approaches.

The findings highlight the efficacy of preservice teachers authoring and implementing their own specific, contextualised LD to facilitate in-depth thinking and reviewing of a range of important teaching issues. In creating these tasks for use in their own practicum classes, preservice teachers started to think about blended learning issues and how to utilise the affordances of an online environment to promote independent learning. They developed skills and insights into the strategic use of media and Web-based resources in their designs to create context and interactivity, and developed an understanding of integrating appropriate face-to-face classroom strategies with their online task.

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KEY TERMS

Edna Community: Education Network Australia's free online network for educators (see http://www.edna.edu.au/).

LAMS Author Mode: Refers to the *learning activity management system* interface used by designers to author their task.

LAMS Community: The global online community for all teachers, administrators, and developers that use LAMS (see http://www.lamscommunity.org).

LAMS Learner Mode: Refers to the *learning activity management system* interface used by learners.

Learning Design: Refers to a coordinated set of online tasks designed to support conceptual change among learners (Oliver, 2001). The framework of these online designs consists of a learning strategy, learning resources, and support mechanisms to provide guidance and feedback to learners (Oliver & Herrington, 2003).

Learning Design Authoring System: Refers to software used to support the creation and delivery of online learning tasks.

Learning Strategy: Refers to conceptual change procedures and techniques that help learners develop their ideas (Skamp, 1998).