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ENSURING HIGH QUALITY THINKING AND SCAFFOLDING LEARNING IN AN ONLINE WORLD

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Abstract

This paper will review some qualities of effective technology-based learning resources and how they can support conceptual professional development and scaffold thinking through the use of cognitive tools. It will also explore factors that are important to professional development, as teachers participate in online learning networks and communities. It will demonstrate examples of effective design that must be present to ensure that participants learn in meaningful and motivating ways.

Keywords

Online learning, cognitive tools, instructional design

Introduction

Over the past decade, there have been several major developments that have helped the growth of interactive multimedia and more recently the concept of e-learning. Along the way the reality of creating innovative products that represent good practice and embody modern educational principles has been driven by several factors, most importantly, the choice of learning tasks and the ways in which the tasks have been combined to produce intriguing learning environments.

Significant efforts have been made to develop and implement alternative frameworks for learning often based on a class of theories collectively referred to as constructivism. Fundamentally, constructivism asserts that we learn through a continual process of constructing, interpreting and modifying our own representations of reality based on our own experiences. Indeed many books enumerate a long list of ideas about how these principles might be applied to the design of learning environments, but how to place the ideas strategically into the learning experience is often omitted (see for example, Khan, 2001; and Mills, Lawless and Merrill, 2001). Often the advice is very broad and covers all aspects of pedagogical design, from methods to integrate new technologies to potential assessment strategies. The integration of technologies, which may allow the representation of ideas in many different media forms, provide opportunities for the designer or teacher to customise instruction and place learners in open-ended, rich, student–centred tasks.

This paper explores what has been effective through an examination of some examples which show both product and combinations which produce learning environments which have:

1. Fostered judgement and learner responsibility.
2. Supported critical inquiry and creative approaches to problem-solving.
3. Created engagement through the effective combination of learning task, visual representation and authentic assessment of the product goals.

Principles, assumptions and quality

Like past revolutions in education, e-learning will go the way of previous technologies unless there are changes to the design framework used as the starting point. Savery & Duffy (1995) described four principles that should be applied to modern technology-based learning environments based on constructivist views. These were:

1. Learning is an **active and engaged process**. "Learners are actively engaged in working at tasks and activities that are authentic to the environment in which they would be used." (p.37).
2. Learning is a **process of constructing knowledge**. Learners need structures and challenges from which to develop their understanding of ideas and of the world.
3. Learners function at a metacognitive level. Learning is **focused on thinking skills** rather than working on the "right answer the teacher wants." Students generate their own strategies for defining the problem and working out a solution. Student can gain wisdom through reflection.
4. Learning **involves "social negotiation**." Students are able to challenge their thoughts, beliefs, perceptions and existing knowledge by collaborating with other students thus assisting their cognitive development process.

These characteristics therefore become the defining attributes of each project and, through an examination of the examples, the implementation can vary widely and still employ these attributes. Other writers such as David Boud and Mike Prosser (2002) have attempted to specify the characteristics of high quality learning outcomes. They suggested that the four major areas of concentration in a high-quality learning environment should be:

1. How do learning activities support **learner engagement**? The reasons for the learner wishing to become involved with the learning tasks and the way the tasks require them to reflect or employ their previous interests and understandings.
2. How does this learning activity **acknowledge the learning context**? In the case of e-learning, there are unique characteristics. Learners are often in a real context and assessment can be made to employ real world skills. Furthermore, assessment can support the transfer between learning context and professional practice.
3. How does the learning activity seek to **challenge learners**? Novices need supportive structures, experts require information to fill in the missing blanks in an existing knowledge structure, too much ambiguity can turn a novice student away, too little and they become bored. Students might need support to extend the information provided as part of a problem–solving scenario.
4. How does the learning activity **provide practice**? As with most effective learning contexts the matches between assessment, learning tasks and the transfer tasks might align and model performance. To ensure that it occurs, the feedback must support the ongoing development of the learning.

The choice of technology infrastructure and its deployment are crucial to support the effective learning outcomes in the e-learning context. Therefore, the above lists suggest not only the goals for constructivist design and high quality outcomes, but also the choice of tools and the range of pedagogical options that the tools themselves either constrain or facilitate. David Jonassen (2000) has sought to emphasis the importance of the design of learning tasks by suggesting a range of problem types that vary in the degree of structure and the linkage they have to authentic real world tasks. Providing structure and support for the more ill-structured task is the challenge for the designer working in a constructivist framework. Jonassen described learning designs that support knowledge construction as problem-based learning settings and described eleven problem-types in a form that suggested a continuum of problem tasks based on the application of rules; activities based on incidents and events; through to solutions that require strategic planning and activity; and problem solutions based on learners' performances. His tasks provide a comprehensive set of design guidelines to ensure that learning tasks challenge and provide an open-ended opportunity to devise and share the learners solutions (See Table 1).

	Rules	Incidents	Strategies	Roles
Description of the design focus	The learning task requires learners to apply standard procedures and rules in the solution. Learners meaningfully and reflectively apply procedures and processes.	The learning activity is focused around learners' exposure and participation in authentic and realistic events or incidents. The learning activities require learners to reflect and take decisions based on their responses to events	Learning is focussed around the strategies employed to achieve the task goals. Often the strategy options are generated as part of the solution. Often tasks have time and performance constraints.	The learning is achieved through learners' participation as a player and participant in a setting that models a real world issue. Learners negotiate, apply judgements . experience subrogation and employ multiple perspectives.
Jonassen Problem Design Types	Logical Problems Algorithmic problems Story Problems Rule-using problems	Scenarios* Decision making Case study tasks	Troubleshooting Diagnosis solution problems Strategic performance tasks Design tasks	Dilemmas Social dilemmas*

Table 1: Learning tasks as the basis for high quality designs (Problem types with an asterisk were not part of Jonassen's original paper) Modified from Hedberg et al, (2002)

Design intentions for digital media

With an understanding of the shortcomings of much of the commercially generated available learning packages, a combination of ideas taken from constructivist learning environments, situated learning and problem-based learning in rich information landscapes can be used to form the basis for effective design. Hedberg et al (1994) proposed that learning outcomes in digital environments depend on starting points such as the learning environment; the learner's view of the purpose of the task; and the motivation of the learner. The process of learning involves the construction of meanings by the learner from what is said, demonstrated or experienced. Thus, the role of the teacher is one of facilitating the development of understanding by selecting appropriate experiences and then allowing students to reflect on these experiences. Often constructivist learning situations *suddenly* throw students on their own management resources and many fend poorly in the high cognitive complexity of the learning environment. Cognitive support tools and the explicit acknowledgment of the double agenda of metacognitive self-management and learning can help. The scaffolding and coaching of the cognitive apprenticeship model offers yet another solution, a strategy which many design teams have explored with a great deal of success. Several multimedia design models have been developed which illustrate the combination of complex learning environments and which also give students control over their learning environment. Jonassen (1999) has suggested six factors that should be available within the environment.

1. **Problem space.** The starting point might be any of the problems listed in table 1, the more challenging problems will be ill-structured and require reference to authentic situations which inform choice of strategies. Several approaches to the design of problems can be found in the professional preparation literature such as medical problem based learning (See for example, Pross, 2002).
2. **Related Realistic Materials**. To provide support and inform the learner, several examples or cases need to be provided which form the basis of experience from which the learner can extrapolate. These resources might come from different problem tasks. For instance, case analysis or decision-making tasks might provide hints of structure or process that might be applied. At a base level, rules and stories can illustrate key issues. As part of the process, students will explore these and other resources and reflect on best strategies comparing what they choose to strategies that experts choose.

3. **Information resources.** Information resources might include references to relevant sources of information including readings and Web sites, pro-forma templates might provide a scaffold for students to begin to collect information on which to reflect and generate potential strategies.
4. **Cognitive tools.** Several specific tools might be employed to support the data collection and sifting process. One such tool the *Notes Wizard* will be described later in this paper. Tools can be extremely simple depending on the task to be supported. In the *StageStruck* and *123 Count with me,* examples a notebook is provided and the results can be saved into word processors or spreadsheet if the analysis warrants further analysis.
5. **Conversation and collaboration tools.** Most online implementations involve discussion forums and synchronous chat. Whiteboards might also help in sharing visualisation over a distance. Sharing files such as concept maps may be a more robust and detailed method of gaining shared representations and plans. At the basic level, mail and listservers might form a simple grouping mechanism.
6. **Social/Contextual support.** Social and contextual support can be provided through a discussion forum for general communication. Many implementations also include the role of a mentor who can provide shared and individual feedback.

However, in addition to these practical elements, if one of the primary goals of e-learning is to stimulate active involvement, then educators and instructional designers need to better understand the design of learning tasks in promoting and sustaining learner engagement. Engaged learners are intrinsically motivated to perform. They direct their efforts to understanding the tasks and challenges in a learning context; and they strive to construct knowledge and derive meaning from their prior experience and available resources. Well designed tasks can help stimulate learner engagement or, conversely, disengage learners if they are poorly designed. Poor design can place high cognitive demands upon the learner that can reduce interest and divert attention away from the primary learning tasks. The combination of visual clarity of knowledge representation and manipulation and the sensitivity to outcomes of the learning task creates challenge and engagement (Metros and Hedberg, 2002).

In her seminal book *Computers as Theatre,* Laurel (1993) suggested ways to use the notion of theatre, not simply as a metaphor, but as a way to conceptualise human-computer interactions. Laurel defines this type of engagement as, "what happens when we are able to give ourselves over to a representational action, comfortably and ambiguously. We gain a plethora of new possibilities for action and a kind of emotional guarantee" (p115). Laurel is referring to 'flow state', a term coined by Csikszentmihalyi (1996) to describe the state of total engagement. Users attain 'flow state' when they have no conscious awareness of the passage of time. 'Flow state' occurs when users enjoy a sense of playfulness, a feeling of being in control, a period of concentration when attention is highly focused, an interlude of enjoyment of an activity for its own sake, a distorted sense of time, and a rewarding match between the challenge at hand and one's personal skills. The design on e-learning environments which emphasis the flow state and create motivating tasks provides the teacher with a challenge.

Thus, to support the translation of learning into online forms, Jonassen and Tessmer (1996/7) proposed that we need to develop learning strategies that support:

- Active learners to engage in interaction with and manipulation of the exploration environments that we construct.
- Exploratory learners to strategically search through these environments.
- Intentional learners willingly trying to achieve cognitive objectives.
- Conversational learners engaged in dialogue with other learners and with instructional systems.
- Reflective learners articulating what they have learned and reflecting on the processes and decisions that were included in the process.
- Ampliative learners who generate assumptions, attributes and implications of what they learn and 'extend' the information given.

The descriptions can help teachers understand the forms of learning tasks that are required and the supports and resources required to ensure that their students can complete them. Hannafin, Hall, Land, and Hill (1994) suggested that appropriate forms of learning settings are open-ended and characterised by learner engagement in cognitively complex tasks involving activities as problem solving, critical thinking, collaboration and self-regulation.

E-learning environments for quality inquiry

In moving toward e-learning, we are faced with a variety of technologies and strategies. It should not matter whether the e-learning environment is CD-ROM or Web based, it has to be designed to enable both learners and instructors to function in a number of roles. Consider the options available within a networked learning environment. At one extreme, we have the typical classroom, where the teacher and learner share the same space at the same time, and learners may work individually or in groups. At the other extreme, the teacher and learner can be at different venues, communicate asynchronously, and learners may or may not congregate to share their experiences or collaborate/cooperate with learning tasks. Several authors have sought to enumerate the range of issues that can be included or considered in e-learning contexts (See for example, Sims, 2001).

The multitude of ways the teacher and learner can communicate, and the time and feedback quality of those communications largely determine the success of the teacher/learner relationship and the quality of the learning outcomes. With developments in educational software and the proliferation of both bounded interactive multimedia titles on CD–ROM and unbounded resources available through the Web, the learner usually occupies the role of software user. Nevertheless, if we are to employ the ideas of the constructivists, it is reasonable to expect that the learner might actively design a problem solution, not only collecting resources but also sifting and making sense of diverse views and different cultural assumptions. If the emphasis is on the learning which occurs through the process of interactive multimedia construction — learner as designer (Jonassen and Reeves, 1996), then the nature of the product they produce is far less important than the knowledge construction process which the learner experiences along the way. The focus of the assessment tasks thus becomes critical to ensuring high quality learning outcomes.
The individual user in this more open-ended environment needs to display the motivation and metacognitive skills of a self-regulated learner to gain maximum benefit from the software without peer support. Groups provide a discussion forum for suggestions, ideas and debate, a multitude of learning and problem solving strategies to share, and immediate personal feedback on all communication channels (auditory, visual, body language). Such group benefits are only achieved once group members have acknowledged the need to refine such skills as negotiation and collaboration. These issues of "why e-learning" all lead to the basic question about the intent of the whole exercise. As mentioned at the beginning of this paper, often the reasons for e-learning are not focussed on the new opportunities for learning activities but rather on economic or, more problematically, educational faddism with little regard for the differences in design the new mediated learning contexts pose.

The following specific examples will show what is required in the development of effective on-line and digital environments that will ensure that higher-order leaning outcomes are achieved. In fact, if the e-learning experiences are well designed, learners who embrace these environments will gain a greater understanding of their own experiences than those remaining in the classroom expecting that the "knowledge" will be given to them!

Creating an open-ended game-like challenge

Several authors have criticised various computer strategies as being of little educational relevance. Jane Healy (1998) eschews some game-format software as of debatable value. But she goes on to admit the quality of such software is extremely variable. In one example, *StageStruck* (1998), we have been able to create open ended design problems and story problems which can challenge the students to invest their own creativity in the products they create. For instance in the following sequence, students were asked to:

1. Write an episode for Zena Warrior Princess. An open-ended task which required the creation of story and plot, and the selection of dialogue lines to match the author's intention.
2. Exchange their scripts with others in the class to "direct" a performance of some one's script.
3. Reflect on their own script and their production of another groups script
4. Compare the range of scripts produced by all members of the class.

This simple example not only involves an personal creation process, but it also involves a negotiation between the members of the pairs, together with feedback on how others attempt the same task and yet

produce a different outcomes. In our trials we have found that the whole exercise could take about an hour, but the motivation was so intense, that the commitment and interest in the task meant that after 90 minutes Grade 10 students were still actively involved in the challenge, improving both their script and the direction of their performance. Both the script and final productions can be shared easily with other students, the file size is very small. Thus it is possible for one group to work online with other groups, each responsible for an element of the final production: one group writes the script, another creates costumes, a third creates the set and a fourth directs the performance.

Professional development via e-learning

A CD entitled *123 Count with me*, developed by emLab at the University of Wollongong and published by the NSW Department of Education and Training in Australia illustrates an application of the model (Figure 1). The CD introduces basic mathematical concepts to K-2 teachers and demonstrates how they might introduce basic mathematical thinking and use an innovative instructional strategy to group students.

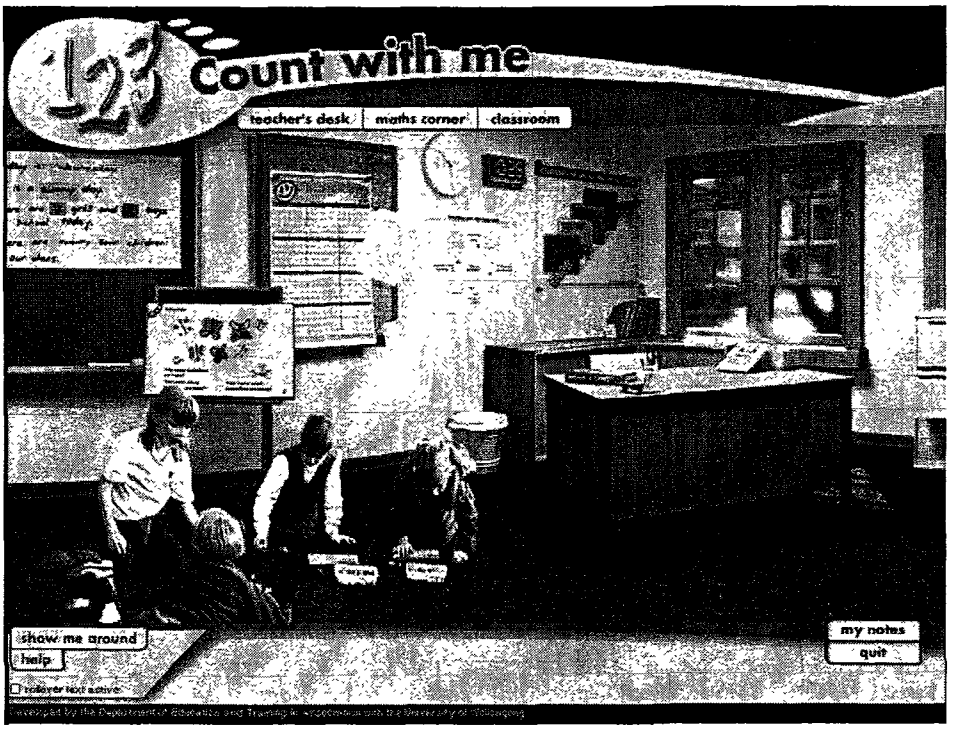

Figure 1. Modelling the information and the message in 123 Count with me through a spatial metaphor familiar to the intended audience. Teachers are familiar with a classroom metaphor

This particular example combines both a CD-ROM and an online component aimed at professional teachers. In the case of *123,* teachers have great difficulty in understanding the mathematical thinking involved in K-2 mathematics and this project was designed to model and provide support for assessing the mathematical skills of students. Classroom practice in the area of early mathematics is often poorly understood by teachers. Thus, the package had to provide background on the measurement approach, be simple enough for early childhood teachers to work with, use metaphors that were immediately comprehensible and provide a rich learning and professional development experience in a variety of settings. Most teachers accessed the package from the CD-ROM and used the online component to share with other teachers and get feedback from their mentor.

The *123* project is currently being evaluated but initial responses have shown the CD-ROM provided answers and scaffolds for the teachers to use. Teachers have particularly endorsed the added value by providing video models of different levels of student performance. The simple choice of the classroom metaphor has subtly modelled of classroom practice (see the small group in Figure 1). It also enabled

teachers to "view, use or manipulate" the content in different ways and help them group students into small groups. These groups could be easily made dynamic and could be used as the basis of efficiently moving the students from one stage of understanding to the next. Each student can be reassessed at any stage and the learning environment supports movement developmentally. Thus, the package ensured that novice assessors were helped to understand how the assessment was structured and how students were classified. Expert assessors with well-developed schemas can also use the same resources to test themselves and to compare their judgements with others.

The implementation of this program also includes a mentor who provides feedback, as well as a discussion forum that enables the participants to share their concerns and successes as they progress through the tasks. Given that the program is aimed at small schools and remote areas these collaborative aspects are critical to the shared professional knowledge being developed. It must also be noted that while the program in itself does not assume the community of practice, the sharing of thoughts and experiences of the participants has been very important in the implementation of the project. Current evaluation results will be complete by December and the evaluation of this type of professional development will be discussion in the presentation.

Comparing ideas and arguing a case

Another example of a relatively simple e-learning activity is the *Notes Wizard* (Figure 2). Students are encouraged to define the problem with or without a structured sequence of focus questions and then to collect evidence and construct a response to the task they identify. When reporting the tool supports the use of writing genres and argument structures, which scaffold the task of writing. As students become more proficient, they can reduce the need to the support and create their own structures. By presenting 'argument for' and 'argument against', students must explore both positions. They need to become familiar with the arguments that support their ideas and those they need to address if they are to refute their opposition. This act alone ensures critical thinking and inquiry to find evidence to support their contentions. This form of learning design provides a range of alternative perspectives to learners in a setting that supports different points-of-view. The main advantage of the tool is that it readily supports revision and reflection. Students compare their responses with others and are quite happy to spend increased amounts of time in polishing their responses, completing a complex task to a high standard with little 'apparent' effort. The students' perception that the task is achievable is a key attribute of the design of a cognitive tool.

Technology is thus influencing the way teachers and learners work and interact. Laurillard (1993) has argued that e-learning environments that involve activities in which learners communicate with each other asynchronously allow for reflection and learner control. Thus, learning outcomes do not have to be compromised in the digital world, in fact, in several areas the gains for understanding complex relationships and the important issues for solving tasks are emphasised in the experience.

Summary

Thus the principles that might be suggested from this exploration about how we as learning designers create challenging environments for professional development via e-learning include the following:

1. **Define the learning task space** — what is the focus of the problem or learning task. Are you attempting to get learners to use procedures and rules to apply them to solve a problem or complete a task? Are you interested in how they can analyse a situation or incident and work out what should be done to solve the task? Are you interested in what creative approaches they develop as they solve a task that is open-ended and ill-structured? Are you interested in how they view a problem or situation from a particular perspective? Refer to the table derived from David Jonassen (Table 1). Creating a task that is based on an inquiry whether it is a large task or a small one will have the elements of motivation, however, if the challenge is too great or the task too trivial then learners will not engage with high levels of motivation.
2. **Describe the learners**, and why any particular approach is required. Identify what are the critical processes that the learning environment must provide to ensure the outcomes are achieved. What is the key message that must be understood? What aspects do novices have problems with understanding?

3. **Collect resources that can support the resolution of the learning task**. Authentic examples; scaffolds such as templates or checklists; cognitive tools which can support the problem solving process.
4. **Identify what supports are required** for the task completion, teacher or tutor feedback and at what times, build these into the sequence.
5. **Establish reasons for social communication** that are critical to resolving the task. If possible, constructing a staged process where the resources are collected in a shared way and then used by all to complete the task.

Thus e-learning requires a challenging task well chosen to provide motivation and engagement. Well designed learning environments provide added interest and excitement that the users both students and teacher feel when they find the experience intriguing, reusable, simple and relevant.

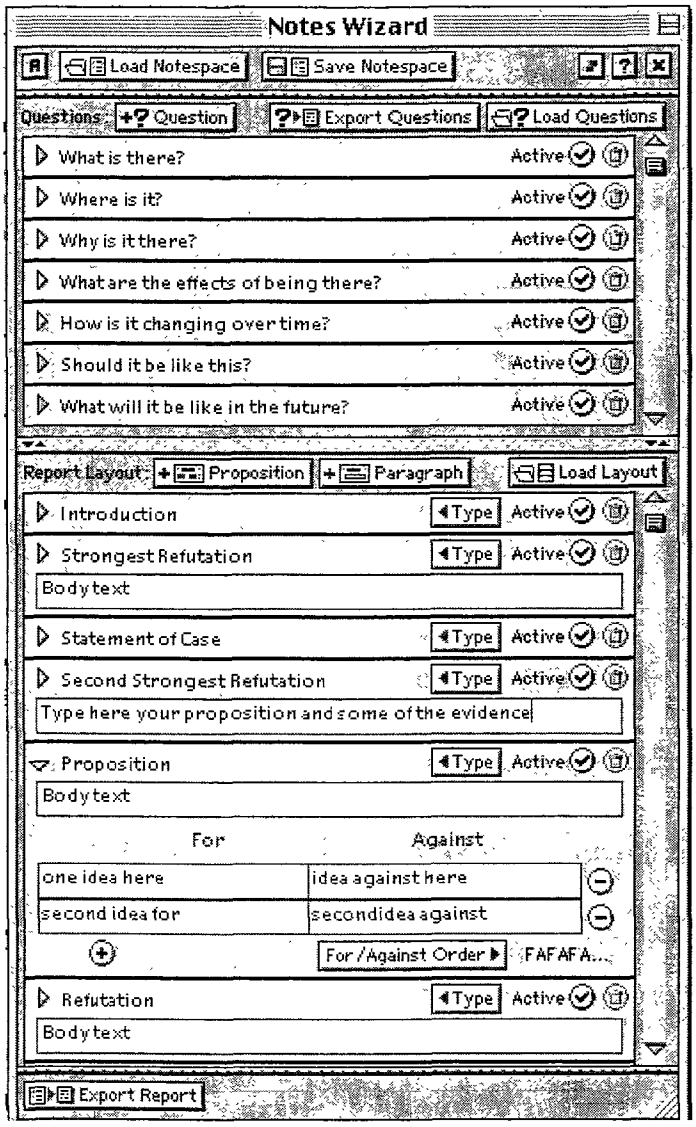

Figure 2 Notes Wizard.

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