2008

Creating A Web-Based Knowledge-Building Team: Design Of Tasks, Scaffolds And Social Affordances

Catherine McLoughlin
Australian Catholic University

Joseph Luca
Edith Cowan University

Creating a web-based knowledge-building team: Design of tasks, scaffolds and social affordances

Catherine McLoughlin, Australian Catholic University, Australia catherine.mcloughlin@acu.edu.au

Joe Luca, Edith Cowan University, School of Communications & Multimedia, Australia j.luca@ecu.edu.au

Abstract: In a blended learning environment, where students undertake professional skills development in the workplace, a flexible environment is designed in order to support problem solving in project management. The design of the environment, informed by socio-cultural theory, was intended to support knowledge building among students, and in particular to support exchange of ideas, peer review and commentary on solutions presented to problems, and a reflective space for exchange of ideas. The online environment incorporates a number of functional affordances that scaffold knowledge exchange, collaborative tasks and peer commentary. The design features of the online site are described and a proposed framework within which to evaluate the learning outcomes achieved is proposed.

Introduction

There has been widespread debate and indeed controversy over what it means to be an educated person in the 21st century, and the kinds of competencies needed for the knowledge society. While there is an emerging consensus that students need a wide repertoire of skills and generic attributes, there is also concern about how to design the most appropriate type of learning environment to foster self-regulated learners (Desharnais & Limson, 2007). Meanwhile the rise of the "Net Generation" (Oblinger & Oblinger, 2005) has also sparked interest in the changing approaches to teaching and learning, as preparation for the "knowledge age" is central to the economy, and institutions of higher education must be responsive the needs, interests and modes of learning that characterize the current generation. Within this context, an emerging focus is on fostering learning communities and virtual teams capable of collaboration, shared understanding and knowledge creation (Gibson & Cohen, 2003). The aim of this paper is to outline the design features on a blended learning environment and the technological affordances used to support a knowledge building community where exchange of ideas, knowledge creation and peer review were pervasive.

Knowledge building communities

Clarifying the nature of community and how it relates to knowledge building is important and challenging, as the word "community" is often tagged to learning environments and has become clichéd. Briefly, we distinguish between three types of communities that have some overlaps, using the typology of Riel & Polin (204):

- *Task-based learning communities*: small groups of people who work on a common task, and have strong affiliation links to the group
- *Practice-based groups:* Larger groups, often from the same occupation or career who collaborate, learn from each other and share knowledge (also called community of practice by Lave &Wenger 1991)
- *Knowledge-based learning communities:* Collaborative groups who focus on the deliberate recording, sharing, production of knowledge, beyond its immediate context.
- The type of e-learning environment described in this study is knowledge-based, where the emphasis is on the advancement of collective knowledge. A number of functional affordances were designed to scaffold the socio-cognitive dynamics that enable knowledge creation.

Theoretical Framework

According to socio-cultural theory, purposeful collaborative work is both the context and motivator for the interactions through which learning and development take place, and in this context, development of knowledge and skills requires the assistance of other participants who guide and model the learner toward independent mastery (Tharp & Gallimore, 1988). For learners, the capacity to create ideas and engage in knowledge construction is now a key expectation for successful participation in the knowledge age and networked society (Bereiter, 2002). Accompanying this expectation, ICT integration and increased connectivity are changing our conceptualization of learning environments, and metaphors of learning are also changing. For instance Sfard (1998) distinguished between two conceptualizations of learning, one being the “acquisition metaphor” and the other the “participation metaphor”.

The former represents a receptive/passive view of the learner, according to which learning is mainly a process of acquiring chunks of information, typically delivered by a teacher. An alternative model, based on constructivist theory is the participation metaphor, which perceives learning as a process of participating in various cultural practices and shared learning activities. The focus is on the processes of acquiring knowledge through active engagement, dialogue and sharing of ideas. According to this view, knowledge does not exist in individual minds but is an aspect of participation in cultural practices (Brown, Collins & Duguid, 1989). Individuals, as social beings, contribute to the processes of cognition, and learning is embedded in multiple networks of distributed individuals engaging in cultural and socio-cognitive activities.

By adopting a participation metaphor, we imply that learners engage in social processes such as “enculturation”, “guided participation” or “legitimate peripheral participation”, all of which are linked to socio-cultural theory (Lave & Wenger, 1991; Vygotsky, 1978).

However, constructivism also states that learners are capable of creating and generating novel meanings, concepts and perspectives, and the ultimate goal of learning is to enable this form of creativity (Wells, 2002). Current views of knowledge regard the notion of an instructor-dominated classroom and curriculum as obsolete, and embrace learning environments where students take control of their own learning, make connections with peers and produce new insights and ideas through self-directed inquiry.

Thus, to keep pace with the content creation processes enabled by Web 2.0 and social software tools, it appears to be necessary to go beyond the acquisition and participation dichotomy. For these reasons, Paavola & Hakkarainen (2005) propose the knowledge creation metaphor of learning, which builds on common elements of Bereiter’s (2002) theory of knowledge building, in which the key principles are collaborative activity, co-construction of ideas, progressive improvement of ideas and the capacity to solve problems in situations of social and cognitive importance.

Approaches to conceptualizing knowledge building

Apart from the knowledge creation metaphor, the literature proposes a number of other approaches to conceptualizing knowledge building in e-learning. To evaluate the extent of knowledge construction between the learners and the teacher or with other learners, educators might want to consider Gunawardena's et al (1997) model as one possible approach. Gunawardena et al (1997) theorized that the active construction of knowledge progresses through five phases, and that although every instance of socially constructed knowledge may not move linearly through each successive phase, these stages are nonetheless consistent with much of the literature related to constructivist knowledge creation (Kanuka & Anderson, 1998).

The five phases, based on discourse processes among participants can be described as shown in Table 1. These authors separate the characteristics of knowledge-building discourse into three categories:

1 First, the focus of dialogue is on problems and depth of understanding where explaining one’s idea is a major challenge
2 Second, knowledge building is asymmetric and open with a focus on the collective knowledge of the group. More knowledgeable learners (or teachers) are not mere observers of the learning process, but

participate actively, while less knowledgeable participants can play an active role, for example by indicating areas and ideas which are complex and require explication and discussion

3 Third, there is productive interaction within the community with continuous adaptation and review of ideas. Learners add knowledge and build on knowledge added by others.

This framework is similar to the knowledge building principles proposed by Scardamalia and Bereiter (2002) but the latter has a strong focus on sociocognitive dynamics, while Kanuka & Anderson focus on the quality of dialogue.

Table 1: Five phases in the active construction of knowledge (based on Kanuka & Anderson, 1998)

Phase 1	Sharing and comparing of information. For example, areas of agreement or corroborating examples from one or more other participant.
Phase 2	Discovery and exploration of dissonance or inconsistency among the ideas, or statements advanced by different participants, ie identifying and stating areas of disagreement or asking and answering questions to clarify the source and extent of the disagreements.
Phase 3	Negotiation of meaning, e.g. of terms, areas of agreement/disagreement or overlap among conflicting concepts.
Phase 4	Testing and modification of proposed synthesis or co-construct e.g., testing the proposed synthesis against formal data collected or against contradictory information from the literature.
Phase 5	Application of newly constructed knowledge, e.g. summarizing of agreements or self-reflective statements that illustrate knowledge or how thinking has changed as a result of online dialogue

Nevertheless, as learners interact and construct knowledge with one another using online tools, one area of concern for educators is the high dropout rate due to the lack of social cues, proximity and interpersonal interaction (Roval, 2002). Tinto (1993) emphasized the importance of community in reducing attrition with the observation that learners would increase their levels of engagement and the likelihood of continuing to participate if they feel involved in the learning community and develop relationships with other learners. These socio-cognitive dynamics are incorporated into the principles of knowledge building proposed by Scardamalia & Bereiter, (2002). Hence, this framework was chosen to guide the design of tools and tasks in the blended environment of this study.

Table 2 shows the knowledge building principles adopted from Scardamalia's framework, the socio-cognitive dynamics accompanying these principles and exemplars of scaffolds and tools provided in the e-learning environment for the study reported here to support knowledge construction.

The main components supporting knowledge construction were: tasks that engage students in problem solving and discussion, peer review processes to foster reflection and refinement of ideas and scaffolding by tutors who provide ongoing feedback on learning processes and the development of content knowledge.

There was also a focus on challenging students to reconceptualise and make changes to existing ideas and solutions, to produce evidence for ideas presented and to legitimate their proposals and projects by referring to authoritative sources. Key principles underpinning the design of the environment are also depicted in Table 2. These principles and characteristics of knowledge building clearly define the socio-cognitive aspects of intentional engagement among participants (Scardamalia & Bereiter, 2006).

Table 2: Knowledge building principles with exemplars of scaffolds

	Socio-cognitive dynamics	**Exemplars of scaffolds provided**
Real Ideas, Authentic Problems	Problems are ones that learners really care about – complex real world issues, unlike textbook problems	Tasks are set to engage student in real world applications of mathematics
Improvable Ideas	All ideas are treated as improvable. Participants work to improve the quality, clarity and utility of ideas	Problem solving tool allows students to comment of the solutions of others
Idea Diversity	Learners are open to new ideas. Idea diversity creates a rich environment for ideas to evolve into new and more refined forms	Problem solving tool enables multiple views to be presented and viewed by others
Epistemic Agency	Learners articulate their ideas and negotiate a fit between personal ideas and those of others, using contrasts to spark knowledge advancement	Peer review tool allows students to compare answers and review comments
Community Knowledge, Collective Responsibility	Members build on the contributions of others, ensuring that views are informative and helpful for the community.	The peer feedback process ensures that that information flow is reciprocal
Democratizing Knowledge	All participants are genuine contributors to the shared goals of the community; all take pride in knowledge advances achieved by the group	The assessment process is transparent and encourages students to strive for excellence
Symmetric Knowledge Advancement	Expertise is distributed within and between communities. Symmetry in knowledge building occurs as a result of knowledge exchange	Students are all participants in an open community where dialogue supports knowledge creation
Pervasive Knowledge Building	Knowledge building is not confined to particular occasions or subjects but pervades all activity, informal and formal	The course, tasks and interaction structure all support the advancement of knowledge
Constructive Uses Of Authoritative Sources	Learners are in touch with the present and emerging state of knowledge in the field. This requires use and understanding of authoritative sources, combined with a critical attitude	Students must present for the views and contributions they make via the online tools
Knowledge Building Discourse	Knowledge is refined and transformed through the discursive practices of community members who have the advancement of knowledge as their explicit goal	Students are encouraged to reflect on and refine their solutions and to provide feedback to others

Learning Design and Context

The context of the study was the creation of a learning environment to support a group of final year students enrolled in a media production course at university. One of the essential tasks required learners to create a web site for real-world clients by forming teams and taking on the roles and activities of programming, graphic design, media creation and project management. Teamwork was used to help meet industry needs, as well as support the development of students' professional skills. A custom built online courseware management system was used to help deliver the course content, assessment tasks and to scaffold social and cognitive processes.

Students are required to create a project proposal (needs analysis, feasibility, scope and legal contract), design specification (storyboards, concept maps and rapid prototypes), design of evaluation rubrics, creation of protocols related to development of their own professional skills and teamwork processes. The unit consists of 13, three-hour sessions over one full semester. Each session consists of a one-hour lecture followed by a two-hour tutorial. Team skills and collaboration are continually promoted with teams of four students working together to develop project management processes that could be applied to the project. Student learning outcomes include:

- Applying a range of project management and communication skills including generic self management skills such as time management, collaborative planning, communication, self-assessment, peer-assessment, task management, problem solving, information management and teamwork skills;
- Making a significant contribution to a team-based multimedia project;
- Demonstrating an understanding of project management models, feasibility studies, needs analysis, design specifications, timesheets, categories, planning, scheduling, costing, metrics;
- Creating and applying quality assurance procedures for testing, formative/summative evaluation strategies, procedures, file naming and templates development; and
- • Demonstrating an understanding of the nature of the specialist roles of instructional designers, content experts, programmers, graphics designers, project managers, and being able to assume these roles as the task required. Assessment strategies were intended to ensure that students develop domain knowledge, knowledge building processes and generic skills as follows. The following outcomes were included:

- Creation of a project proposal, design specification and rapid prototype;

- The development of a web product, with a presentation to a large audience;

- Completing six online problems solving tasks and giving feedback to other students. Students worked in teams to research and produce a solution that was assessed by three other teams, as well as the tutor;

- Applying a self and peer assessment score, negotiated with the team. This encourages students to carefully consider their role and contribution in relation to the others while working in a team.

The assessment tasks were aligned to course objectives and designed to go beyond acquisition of facts to collaborative knowledge building on the core project management skills and to develop deep and constructive thinking and problem-solving processes.

The Online Tool

An online tool was developed with a view to foster knowledge creation by encouraging students to engage and interact with others in teams in order to advance collective knowledge and their own understandings. These learning processes occur as students review and evaluate the evidence obtained through various forms of inquiry required by the tasks, and attempt to arrive at a consensual description, solution or explanation of issues under investigation. Six online questions were designed to instigate reflection on content covered in class each week and available in the textbook, lecture notes and through other online

sources.

To arrive at solutions to the tasks and questions, students needed to collaborate, research, synthesize information and reflect on the results. The tool allows peer and tutor grades/comments to be shown, so that students from different tutorial groups have the freedom to see a wide variety of solutions as well as how other tutors and peers assess others.

These focus questions (Table 3) required students to use a variety of resources and evidence, to synthesize information from the team and generate workable solutions. Students worked collaboratively in teams of five and developed agreed processes to share the tasks. For example, each week 2-3 students would collectively research the topic, and then send a proposed solution to peers who would give feedback. For that week the three students who review the solution also review the solutions of other teams. This gave each student an opportunity to consider at least three other solutions and take turns in researching and synthesizing information, before providing feedback. Teams were required to complete the following tasks:

- Create and post solutions to weekly questions by researching a variety of materials from appropriate sources such as the Web, readers, books, online resources and library databases;
- Perform peer evaluations by assessing the solutions of three other teams by assigning a score as well as providing appropriate feedback justifying this mark;
- Review their individual and team success by viewing results for all the teams, while considering scores from tutors as well as three other peers. These solutions spread across all the different tutorial groups in the unit.

Table 3: Weekly tasks

	Questions
1	Why is project management necessary? What are the important issues to consider in the initial phases of a project? How can you improve the effectiveness of meetings and team communication?
2	What is a project's scope? Why is it important to define it accurately? Why is it important to have a baseline plan and milestones identified at the beginning of the project? Describe scope creep and why it's important to control.
3	When in the design phase, how can the team be sure that they're working to the client's and end user requirements? How can formative evaluation be used in the design phase? How can you implement good usability design principles during the design phase?
4	As a project manager, what process would you use to cost a project? In your answer, discuss any other tools, processes or supports that you might use to assist you with this process and to ensure that the project remains on schedule.
5	Discuss the key issues you would need to consider when developing a Gantt chart. In your answer, discuss key attributes/terms needed. What is the purpose of conducting a postmortem review?
6	What is the purpose of the final project report, and final client meeting? How does "conformance to requirements" or "fitness for use" provide a definition of quality for the end product?

Figure 1 depicts the online peer feedback interface. Students submit a solution to the weekly problem using the online tool by a set date/time. The 'Post' option then deactivates and students are randomly allocated three teams for assessment of team solutions. Assessments are made anonymously to avoid possible bias or favoritism among groups and individual when assessing the solutions. The tutor also assesses each solution (Figure 1).

An important part of the reflective process was the opportunity to discuss exemplar solutions and also feedback given by others. This is where the Online Forums and discussions conducted in lectures and tutorial proved useful, and established the element of a learning community. A number of solutions were openly discussed, along with the evidence for viability of each. There were also opportunities for voicing of ideas and experiences that were in disagreement with majority views, as well as common problems experienced by different teams, thereby enabling feedback from a variety of different perspectives. The promotion of collaborative exploration of issues was encouraged through positive reinforcement and feedback from tutors, and included both content related and experiential comments that fostered reflection.

Peer Mark 1	Peer Mark 2	Peer Mark 3	Tutor Mark	Overall /9
6.0	6.5		5.0	5

Peer Comments

Peer 1:
Not a bad effort.

Peer 2:
Your answers were good for the most part but seemed to miss the point in some areas. For example, the first question addressed the role of the Project Manager rather than the discipline of project management, you did mention what project management indirectly, but you didnt really explain why it was necessary. Some parts of the answers you gave weren't really related to the question and probably could have been left out.

Tutor Comments

1. Wrong. You have missed the question. It is about project management (principles, rules, and guidelines), not the person running the show.

2. You have mentioned minutes, this is good, but you need to explain how you successfully use the minutes as a "living document" to facilitate follow-up, and interaction with process tracking of timelines.

3. A good answer, perhaps you could have suggested a bit more emphasis on thorough involvement of the client, especially in the early stages.

Figure 1: Online tool for assessing other solutions

Evaluating the environment

As shown in Table 2, a number of socio-cognitive affordances were provided to support dialogue, exchange and review of ideas and knowledge building. We use the term affordance in accord with Norman's (1999) definition to refer to those "action possibilities" which are readily perceivable by a person within a particular context and environment. By creating socio-cognitive affordances, in the form of a peer-based assessment tool (Figure 1) that scaffolded learner interaction and problem solving, the environment supported social interaction and cognitive processes. Both interpersonally and cognitively, students were encouraged to consider the voice of the entire learning community, and their respective teams. The peer feedback tool, when perceived and used by students, invited them to engage in communicative interactions that support knowledge building. The scaffolds provided also created the conditions that supported the stages of knowledge creation described in table 1. Though students did not adhere to these stages at all times, their interactions did display exploration of ideas, negotiation of meaning and application of collective ideas and knowledge.

Some examples of students' capacity to share and create ideas and build knowledge can be seen in the following extracts:

> *"I agree with Joanna in regard to the need for a greater understanding of the project management process and its definitions…. [goes on to provide another example].*
>
> *However, I do not think that limited understanding of project management is what always holds back employers signing off -. Perhaps this is more a question of feasibility rather than lack of understanding of procedure.. but it's pretty annoying in any case*

Later in the same thread of discussions, another student commented, again providing a possible extension of knowledge

> *"Tom, From an – another perspective, I like your idea. But having current and up-to-date information about the budget, timelines and prototyping process put us in a position where we, might contribute to the dilemma*

The design features underpinning learning support in the environment were aligned with the elements of knowledge building, in order to ensure a high degree of fit between the principles of knowledge building and their implementation in the actual environment. For example, providing decontextualized information and tasks does not promote deep reflection on learning, and this problem was avoided by giving students a range of real world tasks that were linked to the learning outcomes. Also, a learning community was fostered by ensuring that tasks engaged students in dialogue, problem solving and sharing of solutions that took multiple perspectives into consideration.

Futher research needed

The extracts provided above provide a glimpse into student discourse and participants' engagement in knowledge building processes. However, full scale evaluation would need to investigate the strengths and weaknesses of the learning environment itself. The framework for evaluation would need to consider whether the joint tasks and activities set for students developed their understanding, skills and knowledge. It is also essential to evaluate knowledge building discourse among students, by considering their comments on others'work, their reflections and the actual outcomes achieved.

In the context of this particular study, students used the tools and tasks to effectively complete tasks set and to create new understandings of how to manage projects and work collaboratively in teams. In table 4, key principles of e-learning support are matched with knowledge building principles.

	Key principles of knowledge building
Team and individual tasks	Learners have both individual and collective responsibility for knowledge creation
An environment that promotes collaboration and social interaction	Students are equal participants in a social environment that is personalized
Promotion of self regulated learning	Students must present their own views and solutions via the online tools
Support for articulation and reflection on ideas	Learners articulate their ideas and consider personal and group perspectives
Support for use a wide range of resources	Learners are required to provide evidence for their views and solutions
Support for authentic tasks	Assessment tasks reflect real world concerns and outcomes

Table 4: Design feature of the knowledge building environment

Summary and Conclusions

The design of this environment was intended to build opportunities for knowledge creation, intentionally foster opportunities to review solutions and support students in challenging existing beliefs against new ideas, and to generate new solutions. Rather than adopt a transmissive paradigm of teaching facts and information, the aim of tasks for knowledge building is to help students recognize that all knowledge is open to improvement and review. Rather than creating tasks with one clear solution, the aim of the teacher is to guide students in progressive discourse and problem solving. Participation in the discourse community of the group and moving on to engagement in the larger community beyond the classroom ensures that knowledge created will have social relevance and consequences for action.

This approach to collaborative knowledge building is particularly appropriate to the knowledge age, where increasingly, people learn through connecting and communicating. Preliminary observation of emerging skills and dynamics among student participants is positive and attests to the power and applicability of the knowledge building framework adopted for the design of this e-learning environment. Future research will extend the range of affordances provided to students to support more complex team building, knowledge creation and metacognitive skills.

References

Bereiter, C. (2002). *Education and mind in the knowledge age*. Hillsdale, NJ: Erlbaum. Brown, J, Collins, A.,& Duguid P. .(1989) Situated Cognition and the Culture of Learning. *Educational Researcher*: 18 [1]: 32-42. Collis, B. (1998). WWW-based environments for collaborative group work. *Education and Information Technologies, 3*, 231-245.

Desharnais, R. A., & Limson, M. (2007). Designing *and implementing virtual courseware to promote inquiry-based learning. Journal* of Online Learning and Teaching, 3(1), 30-39. Retrieved October 11, 2007, from http://jolt.merlot.org/vol3no1/desharnais.pdf.

English, S., & Yazdani, M. (1999). Computer-supported cooperative learning in a virtual university. *Journal of Computer Assisted Learning, 15*(2), 2-13. Gibson, C. B., & Cohen, S. G. (2003). *Virtual teams that work*. San Francisco: Jossey-Bass. Gunawardena, C.N., Lowe, C.A. & Anderson, T. (1997). Analysis of a global online debate and the development of

an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal Educational Computing Research,* 17(4), 397-431. Kanuka, H. & Anderson, T. (1998). On-line social interchange, discord and knowledge construction. *Journal of Distance Education,* 13(1), 57-74. http://cade.icaap.org/vol13.1/kanuka.html

Klemm, W. R., & Snell, J. R. (1996). Enriching computer-mediated group learning by coupling constructivism with collaborative learning. *Electronic Journal of Instructional Technology*, 1(2), http://www.usq.edu.au/electpub/ejist/vol1no2/article1.htm.

Lave, J., & Wenger, E. (1991). *Situated learning: legitimate peripheral participation*. Cambridge, England: Cambridge University Press. Norman, D. A, (1999). Affordances, Conventions and Design. *Interactions of the ACM* 6(3):38-43, May 1999, ACM Press. Oblinger, D., & Oblinger, J. (2005). *Educating the Net Generation.* Available online at http://www.educause.edu/educatingthenetgen. Paavola, S., & Hakkarainen, K. (2005). The knowledge creation metaphor – An emergent epistemological approach to learning. *Science and Education,* 14(6), 535-557. Rovai, A. P. (2002). Development of an instrument to measure classroom community. *Internet and Higher Education,* 5, 197-211. Scardamalia, M., & Bereiter, C. (1996). Computer support for knowledge building communities. In T. Koschmann (Ed.), *CSCL: Theory and practice of an emerging paradigm*. Hillsdale NJ. Sfard, A. (1998) On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, **27**, 4–13. Tharp, R. G., & Gallimore, R. (1988). *Rousing minds to life: Teaching, learning, and schooling in social context.* Cambridge, England: Cambridge University Press.

Tinto, V. (1993). *Leaving College: Rethinking the causes and cures of student attrition.* (2nd Ed.) Chicago: University of Chicago Press.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Riel, M., & Polin, L. (2004). Online learning communities: Common ground and critical differences in designing technical environments. In S. A. Barab, R. Kling & J. H. Gray (Eds.), *Designing for virtual communities in the service of learning* (pp. 16-52). Cambridge: Cambridge University Press.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press Wells, G. (2002). Learning and teaching for understanding: the key role of collaborative knowledge building. *Social Constructivist Teaching, 9*, 1-41.