Chapter 5

EDUCATION IN THE KNOWLEDGE AGE – ENGAGING LEARNERS THROUGH KNOWLEDGE BUILDING

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Abstract: In this Knowledge Age or innovation-driven age, knowledge is a key asset for a society to create value. The health and wealth of societies depend increasingly on the capacity of people to innovate (Scardamalia & Bereiter, in press 2002). Since schools are responsible for preparing the young for the future they have to be models of innovation, where teachers and students are "willing to take new routes, try different methods, and occasionally break the mould" (Shanmugaratnam, 2003). Too often, however, we find classroom pedagogies varying between two extremes: didactic knowledge transmission where teachers are the "sage on the stage", or constructivist approaches where students are actively engaged on activities. The former approach is often criticized for treating students as a passive party, assuming that knowledge can be transmitted and assimilated into the student's mind. The latter approach, on the other hand, has the tendency to motivate students to complete tasks and activities, but not necessarily engaged with the knowledge creation process. In this chapter, we argue that we should engage our students directly in knowledge production, not so much of asking students to produce new knowledge or discoveries, but putting them into a development trajectory to be knowledge producers. Examples of knowledge building classrooms in Cananda and Singapore schools will be used to illustrate how we can engage students as knowledge producers, who take on ownership of learning by collaboratively and continually improve upon their initial ideas to better ideas, thus advancing collective knowledge within the community.

Keywords: engaged learning, knowledge building, constructivist learning, Knowledge Forum, professional development, Computer-Supported Collaborative Learning

1. CONSTRUCTIVIST EPISTEMOLOGY AND ENGAGED LEARNING

In the past two decades, constructivism has become a dominant epistemology, gradually replacing the objectivist and positivist paradigm in many parts of the world. Constructivism, deriving from multiple roots in the

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psychology and philosophy of the last century (Perkins, 1991), holds that meaning is imposed by our interpretation of the world; there are many ways to structure and interpret the world, and there are many meanings and perspectives for any event or concept (Duffy & Jonassen, 1992). Constructivist learning is manifested as different types of classroom activities: guided discovery, learning through problem solving, curiosity-driven inquiry, etc. (Bereiter & Scardamalia, 1996).

One of the strands of constructivist educational reform that involve educational technology is the notion of *engaged learning.* Engaged learning is based on studies from the North Central Regional Education Laboratory (NCREL), Stanford Research Institute (SRI), and other research institutions. The notion of engaged learning is represented in the indicators for engaged learning developed by Jones, Valdez, Nowakowski, and Rasmussen from NCREL (1994). There are 8 proposed indicators, which are summarized as follows:

1. Vision for learning: The vision is to nurture engaged learners who are actively involved and committed in their own learning, who develop a repertoire of thinking/learning strategies, and who develop new ideas collaboratively, with passion for learning.
2. Tasks: Learning tasks should be authentic and addressing personal interest, should be challenging yet not too frustrating, and should involve multidisciplinary knowledge.
3. Assessment: assessment should be performance based, which is integrated in the learning process and is culturally fair.
4. Instructional model: The instructional approach should be interactive and generative, gearing towards meaning construction.
5. Learning context: Learning should occur collaboratively, valuing multiple perspectives and diversity.
6. Grouping: grouping should be heterogeneous and flexible, providing equitable experience for all students.
7. Teacher roles: Teachers act as facilitators, guiding students in learning or acting as co-learners.
8. Student roles: Students act as explorers of new ideas, cognitive apprentice of their mentors, instructors to their peers, and producer of products of real use to themselves and to others.

Engaged learning adopts a problem-based or project-based learning approach (Meehan & Nolan, 2001). Developed by K-12 teachers, a project typically includes an authentic ill-structured problem, data or data collection activities, learning units, references, and report writing. Instructions are

provided to teachers to help them in scaffolding the students towards completing the projects.

While moving away from the knowledge transmission model of the objectivist paradigm, problem-based or project-based learning may suffer from one common pitfall – focusing on activities rather than knowledge creation. No doubt starting with good intention, if the instructions are not executed appropriately, the end results might be students buzzing with activities – collecting data, preparing presentations, locating references, writing reports – but not engaged in deep understanding and creative work with ideas. These approaches engage students in interesting tasks through which they actively construct meaning, but often remain focused on the completion of fairly short-term tasks or projects with pre-defined rather than emergent goals. When the task is over there is need for someone to set the next motivating activity for them, as they have not internalized the processes through which ideas of value to a community are generated and continually improved. The agency for and power of knowledge creation remain in the hands of others, instead of the learners. In this chapter, we embrace the vision of engaged learning, but we suggest engaging students through knowledge building, that is, to "move ideas to the center" where students deal directly with the problems of knowledge (Scardamalia, 1999). In the following sections, we shall explain the knowledge building approach and Knowledge Forum, the supporting technology. We will then illustrate the notion of knowledge building with an example in professional education of a group of Master degree students.

2. ENGAGING K-12 LEARNERS THROUGH KNOWLEDGE BUILDING

What is knowledge building and why might it be an appropriate method of education in the Knowledge Age?

> "Knowledge building may be defined as the production and continual improvement of ideas of value to a community, through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions and part of broader cultural efforts." Scardamalia & Bereiter (2002)

Knowledge building engages learners (K-12 and beyond) directly in knowledge creation. The process involves theorizing, invention, and design, as in real world knowledge creating communities (e.g. scientific communities). It is collaborative in nature, with the goal of advancing "public knowledge" – ideas that are available to members in the community

to work on and improve upon. Unlike many constructivist activities, the learners deal directly with the problem of knowledge. In the process they complete tasks and activities, but the driving force is their wonderment and efforts to deepen their understanding, not the requirement to complete an assignment.

Perhaps an example will best illustrate the knowledge building approach. In a study by Lamon, Reeve, & Scardamalia (2001), 22 students in one Grade 5/6 classroom at the Institute of Child Study Laboratory School of the University of Toronto were engaged in knowledge building in physical science over the course of an academic year.

> "The teacher began by asking students to bring in questions and ideas from newspapers, television and other sources that interested them. As so often happens, events in the world coincidentally met with learning goals: At the beginning of this year the Swiss Air Flight 111 crashed off the coast of Nova Scotia and Ontario had an earthquake both of which became objects for ongoing discourse.
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> All questions were written on index cards and posted to a bulletin board in the classroom and each day several were discussed. As one example, there were reports that American currency had been on the Swiss Air Flight 111. Students wondered whether the money would disintegrate in salt water. One student's parent was in Scotland and was directed to bring back salt water from the Atlantic Ocean. Students submerged an American dollar into the salt water, put the container in the refrigerator and observed what happened to the money. This was the beginning of inquiry time, a single period each day of the week, with students' questions leading the work and little teacher guidance at this point. We have found that a slow period of getting started, where the children feel ownership of the questions and the teacher keeps the 'ends-in-view', is very productive as a way into sustained investigations by the children. The emphasis on conducting experiments as the dollar example shows was also important to students."
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> During this time students also began to create their Knowledge Forum database. The teacher had intended to call the database "Wings, Weather and the World" to follow the intended curriculum focus but students came up with the name "Chance, Challenge and Change" which they believed mapped onto their questions and concerns more closely so this was the name used…"

In the above example, the students took ownership in initiating questions and ideas that lead to problem investigations about physical science based on their feeling about some real life event. It was a collaborative process and

ideas were made public in Knowledge Forum, an online forum, so that they can be built on and improved upon. The teachers are engaged along with students in identifying and refining goals and plans as they pursue investigations. The learning episode demonstrated the indicators of engaged learning (Jones, Valdez, Nowakowski, and Rasmussen from NCREL, 1994). Most importantly, the students were engaged directly in sustained investigation of problems related to concepts of physical science, instead of solving problems pre-selected by teachers. Like the NCREL's model of engaged learning, knowledge building uses technology (Knowledge Forum) to augment the generative and interaction processes among learners.

3. TECHNOLOGY SUPPORT FOR KNOWLEDGE CREATION

Knowledge Forum can be regarded as a Computer-Supported Collaborative Learning (CSCL) tool, or more specifically a knowledge building environment (Scardamalia, 2003) that mediates the process of collaboration among learners; promotes inquiry, sense-making and reflective thinking; facilitates knowledge building; and provides record keeping. It is designed based on research studies by Scardamalia and Bereiter and Scandamalia (1996) aimed at fostering knowledge building communities in schools. It provides an environment where ideas are discussed and improved through discourse in a productive knowledge building community.

In Knowledge Forum, a graphical interface known as a View (Figure 1) allows conceptual organization of ideas. A main View can be linked to other Views which represent alternate representations of the same ideas or provide more detailed information. Messages (called Notes) are linked graphically, showing the flow and development of ideas. Learners can post, reflect, link, relate and question ideas posted by themselves or others, thus making the knowledge-construction process overt and traceable.

Another unique feature of Knowledge Forum is customizable scaffolds that facilitate knowledge building discourse. For instance, to support inquiry-based knowledge building, student may be asked to post notes using the following labels: "My theory", "I need to understand", "My theory doesn't explain", or "A better theory is". These are cognitive supports which model and encourage learners to engage in more in-depth inquiry rather than superficial chatting.

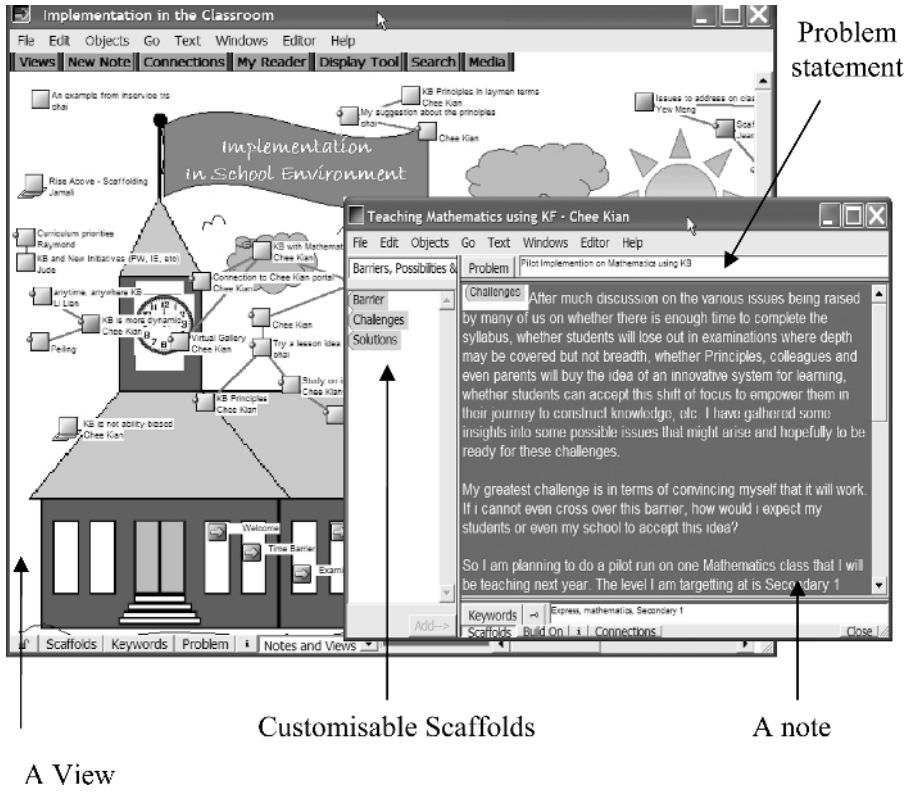

Figure 1. A discussion in Knowledge Forum®

Scardamalia (2004) explained the affordances of Knowledge Forum in supporting knowledge building process:

1. It fosters multiple perspectives, multiple literacies, and team work by providing a graphical medium where *views* (a new view is like a blank sheet of paper where graphics and notes can be added) can be created for discussion on different topics; allowing use of text, graphics, and multimedia to input ideas; allowing individual or group design of views and notes.
2. It creates connections and pubic knowledge by allowing ideas to be linked in various ways: building on, citation, annotation, and references.

3. It supports knowledge building through its customizable scaffolds and it emphasizes problem of understanding by providing a problem field at the header of a note.
4. It encourages rise above and improvable ideas by allowing review and revision of notes, publications of views, and a "rise above" function which allows users to synthesize or summarize ideas at a higher level.
5. It affords building of individual and group portfolios through creation of individual or group "views" that can be linked.
6. It makes ideas and artifacts as objects of inquiry. By putting ideas in Knowledge Forum, they are subject to review, critique or comment by other members. The historical interactions of these processes are automatically captured in the database. Thus ideas in mind (implicit knowledge) become "objects" that can be acted and improved upon.
7. It allows embedded and transformative assessment by allowing searching and tracking of contribution from individuals and groups, and concurrent feedback to these processes.

4. KNOWLEDGE BUILDING IN TRANSITION IN SINGAPORE SCHOOLS: SETTING THE CONTEXT

Knowledge building, supported by Knowledge Forum, has been introduced to K-12 schools in Singapore over the last few years, through collaboration with the Ontario Institute for Studies in Education. The initial implementations were disappointing. Knowledge Forum was not seen as an integral part of the curriculum and learning activities; students used it to chat about social issues rather than to present ideas and develop knowledge. When interviewed, students' responses exhibited no motivation or disposition for knowledge construction and knowledge building. Classroom practices were generally traditional where teachers' talk occupied most of the curriculum time.

As a result of these frustrations and the inability to penetrate into the traditional epistemologies and pedagogies of the standard classroom, we decided to begin the process among our graduate students who were school teachers. We hypothesized that if we could gradually enculturate these teachers into the process and epistemology of knowledge building, they would be able to make an impact with their learners in the classrooms. These graduate students needed to do a thesis as part of their Masters' course and the dissertations centered on a problem or issue (e.g. problems in knowledge building.) For example, one of the graduate student-teacher implemented knowledge building among the low-achievers in her school, and because

these students had a more flexible curriculum where technology was central, knowledge building was a success.

As we reflected on the different attempts made by these graduate students, we recognized that professional development and deep integration of knowledge building into the life of the classroom are essential to the success of knowledge building pedagogy and technologies. In the sections below, we describe our attempts at developing a professional development framework for teachers.

5. KNOWLEDGE BUILDING IN PROFESSIONAL DEVELOPMENT AMONG TEACHERS AS LEARNERS – A CASE EXAMPLE

In this example, we describe a class taught at the National Institute of Education in Singapore, which served as a basis for engaging professionals in a design process for next-generation educational environments. We elaborate the ways in which these professionals have been able to integrate knowledge building into their own work and into classrooms in Singapore and Canada.

The class consisted of 16 adult learners participating in a Master level course on knowledge building. Among the participants, there were 11 K-12 teachers, one Education Technology Officer from the Ministry of Education and four adult learners working in training industry. In addition, 12 other participants were purposefully invited to encourage greater diversity of ideas among the group. These nine participants include officers from the Ministry of Education, teachers, and post-graduate students. The instructors were the authors of this chapter, as well as the principal and two teachers from the Institute of Child Study, Ontario. We were also joined by several researchers from Canada. In the discussion that follows, participants refer to both the post-graduate students and the invited guests.

The course started with a 5-day workshop and sharing of case examples of knowledge building in Canadian and Singapore classrooms. The participants then discussed the theoretical and practical issues of knowledge building in Singapore context. We shall first summarize how it corresponds to the NCREL's indicators of engaged learning, followed by discussion of participant engagement in sustained knowledge building.

Vision for learning	The course fostered the creation of a knowledge building community; participants engaged in theoretical discussions and practical implementation of knowledge building in their schools or work place.
Tasks	During the five-day workshop, the participants were engaged in group discussions about knowledge building principles and issues. After, they explored the theoretical issues further, implementing the approach in their work place, or contributing to the knowledge of the community in other ways.
Assessment	The participants were assessed based on their continual contributions to the knowledge of the community, using Knowledge Forum database as the main medium for recording the contribution. There was no special paper or assignment to deliver; the participants were assessed based on their participation and contribution. The participants could choose their own way of contributing to the knowledge database – contributing new ideas, sharing experience in implementation, conducting a literature review, etc.
Instructional model	Knowledge building pedagogy, as discussed in the earlier section, was adopted.
Learning context	The approach was collaborative. All discussions or implementation of knowledge building were based on local context.
Grouping	As described above, the participants came from diverse background. Diversity of ideas was evident throughout the course, which will be elaborated below.
Teacher roles	The instructors shared their experience, encouraged diversity of views, and learned from and mentored participants who wanted to implement the knowledge building approach.
Student roles	The participants contributed new ideas and improved on ideas suggested by their peers so that the knowledge was useful to the community. A number of participants formed small teams to support each other in the implementation of the approach in their work place.

6. ENGAGEMENT IN KNOWLEDGE BUILDING

In this professional education case, the participants were building knowledge on knowledge building (perhaps we can call it meta-knowledge building). In the following section, our discussion focuses on some indicators of engaged learning that arose from the interactions among the participants.

1. There was collective responsibility for contributing to community knowledge.
   Throughout the workshop, we saw active engagement of all participants (including MA students, guests, and instructors) discussing knowledge building issues. There were scheduled sessions during which the instructors shared their views or experience in knowledge building, but they were conscious about giving sufficient opportunities for the participants' voices to be heard. As such, the participants did not hesitate to seek clarification, voice different opinions, offer suggestions, propose solutions to problems, etc. This active participation occurred both in face-to-face interaction, as well as in online discussion via Knowledge Forum. Data on Knowledge Forum use showed that more than 450 notes were contributed within the 5-day workshop, with an average of about 14 notes contributed by each participant. The average number of notes read by each participant was about 240. This suggests engagement and collective responsibility by all members contributing to the knowledge database of the community.

2. Participants, as epistemic agents, initiated discussion of authentic issues in their local context.
   The instructors were mindful of the power relationship in class. While sharing of theories and experience were typically initiated by the instructors, they consciously engaged the participants in conversation. The instructors were addressed by first names instead of by professional titles (which is uncommon in an Asian classroom culture). The participants took ownership of the knowledge building tasks, often initiating discussion of real life issues in local context. For example, in the discussion of implementation issues of knowledge building in classrooms, the participations raised concerns on various pertinent issues: obstacles presented by exam-oriented culture, sustaining student motivation, limitation of curriculum time, using Knowledge Forum for mathematics education, challenge of scaffolding students, and viability

of other system besides Knowledge Forum. This particular forum was entirely "owned" by the participants, with about 120 notes contributed.

3. Diversity of ideas was professionally handled.
   In the class, it was common for participants to voice differing opinions, presenting arguments for their positions with good reasons. Respect for differing ideas was evident in discourse recorded in Knowledge Forum. The following extracts show several participants reacting to the comment on examination initiated by one participant (words in square bracket [ ] are scaffolds provided in Knowledge Forum):

   A: [Opinion] My opinion is that we, the teachers, are bounded very much by the requirements of exams. [Evidence] The fact that schools are ranked based on their Exam results itself restricts and confines teachers to what needs and has to be taught.

   B: [Opinion] KNOWLEDGE FORUM is supposed to help pupils get better results when they sit for examination at the end of the year - isn't it? [Elaboration] Idea : I teach a topic on Water - pupils have problem with water cycle and its processes like condensation, evaporation, etc. I get the pupils to discuss the topic of water cycle via KNOWLEDGE FORUM. And HOPEFULLY at the end of the year when they sit for the examination, they will be able to fare better, with a deeper understanding of the topic due to their active participation on the KNOWLEDGE FORUM - what do you all think?

   C: [This theory cannot explain] why the philosophy and pedagogy of KNOWLEDGE BUILDING cannot find a place in our school and society. [My theory] Is that it does not reside in our culture because teachers and parents do not see the far reaching implications of education? That we are ultimately producing citizens of the future and not just people who can pass exams. Even though we idolise these "icons" of out antiquated education system.

   D: [Opinion] I feel that we should also consider our students. Many of them have been 'inculcated' into an education system which has not really emphasised self-learning but has become rather 'exam focused'. Students tend to expect answers from teachers and any attempts to get them to do self-learning is a best met with apathy. They do not want to take responsibility for their learning as they want just the answers to get 'A's in exams.

4. Ideas were improved continually.
   One of the affordances of Knowledge Forum is making idea public to the members within a community, thus achieving inter-subjectivity among the members and ideas could continually be improved. The following extracts of discourse showed a typical example of idea improvement. The idea of co-constructing learning environment becomes more defined through the discussion.

   A: [My theory] The use of knowledge building in Classrooms would require a lot of classroom participation from the students. What I should do so that my students would be in a 'safe and secure' environment that they be able to express their views freely without being laughed at or put down.

   B: [My theory] Ask your pupils how they could contribute to creating such an environment. They may have some good ideas. Sometimes, we forget that our key stakeholders, our pupils, can help us find the answers.

   C: Students and teachers co-constructing a new learning environment interactively. This will be a new environment.

   D: [I need to understand] the term co-construction, are you referring to an environment as a design product whose creators are the teachers or are both pupils and teachers co-creators? [A better theory] would be perhaps viewing design as a dynamic process where the environment is never fully completed i.e. the environment is in a constant state of flux (it is not a terminal product) where the designers design and re-design based on the constant feedback of the users into the design process (based on the work of Finnish product designers).

5. There was sustained knowledge building.
   Though the MA students could choose how to contribute to the knowledge building database, the majority (more than 60%) took the challenging option of implementing knowledge building in their classrooms. A few participants who could not implement it due to constraints helped their peers to co-design the knowledge building activities. As a result, the participants moved from the forum that talks *about* knowledge building, to forums in individual classrooms where school students were engaged in knowledge building, and eventually their reflections of the implementation experience in the original forum

further enhanced the community knowledge. The following extracts showed some of their reflections three months after the workshop:

A: One of the first thoughts that came to my mind was how this knowledge building concept can be built into the peer mentoring programme in my school. Teachers tend to be privatised in their practice. One of my greatest challenges is to get teachers to break out of this and share…How can the tacit knowledge and experiences of the teachers involved in the peer mentoring programme be archived in some form so that it can benefit a larger circle of teachers who may not be directly involved in this programme? These are questions where technology such as Knowledge Forum can help.

B: I have discovered that before I can start a knowledge building community, I need to have a community built first. I have observed that the students in my class were more or less not so enthusiastic in posting on Knowledge Forum when I first started. This could be due to the fact that the students were 'new' to each other and thus 'shy' and not so willing to share.

C: From what I've attempted so far and my own readings of research on collaborative knowledge building, I feel there are four main challenges I have to overcome. Balancing the tension of a traditional direct instructional teacher-centred approach to teaching and learning vs a student-centered constructivist approach to teaching and learning. The challenge is to get the students to become independent learners and be interested in actively engaging themselves in productive discourse about the content. Often students expect answers from teachers and are lazy to look for answers themselves. I have to foster in my students a 'knowledge building attitude'…

Teachers in Singapore are not accustomed to adopting knowledge building dispositions such as collective responsibility and the pursuit for the improvement of ideas. Such actions and thinking dispositions are not commonly present in the schools and classrooms. When these teachers were gathered together around the Masters' class taught at the National Institute of Education, a knowledge building community evolved over a period of time. During this period, these teachers became gradually acquainted with both the theoretical and practical dimensions of knowledge building. It was only through experimentation with these concepts in their own settings that the value of knowledge building became apparent. These powerful concepts of responsibility and engagement became fruitful and an eye-opening experience for these teachers.

7. CONCLUSION

To be a confident citizen in this Knowledge Age requires the ability to continually advance knowledge collaboratively. This is of great individual and social value, and applies not just to elite professionals, but to everyone.

The recent trend towards constructivist learning arises from changing demands as well as discontent with the didactic paradigm of instruction. Knowledge building is consistent with the social constructivist philosophy in engaging learners in meaningful learning. By engaging learners directly in working with knowledge, it avoids the pitfall of many constructivist approaches that focus on task completion. It empowers people to be knowledge agents, able to self initiate the creation of new ideas, to share ideas with the public, and to improve upon them. Moreover, learning provides access to existing knowledge and preserves the cultural capital of a society; knowledge building enhances the cultural capacity through new ideas and values that are continually generated and improved.

Our example tells a success story of fostering professionals in education in collaborative knowledge building by encouraging creation and continual improvement of ideas, making ideas accessible to participants in a knowledge building community, providing a shared workspace for collaborative works, and empowering participants to be epistemic agents. It is not an isolated success story; other cases of knowledge building have been reported (see Caswell & Lamon, 1998; Hakkareinen, 2003; Hewitt, 2001; Lamon, Reeves, & Scardamalia, 2001).

In short, we agree with the constructivist epistemology and the notion of engaged learning, but we advocate engaging learners through knowledge building.

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