Chapter 2

ENGAGED LEARNING: MAKING LEARNING AN AUTHENTIC EXPERIENCE

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Abstract: This chapter attempts to make sense of engaged learning. Approaches such as problem-based learning should be advocated because it is an authentic form of learning encouraging students to be self-regulated and thus metacognitive towards their own thinking and behaviors. Contrary to passive forms of instruction where learners are not perceived to be active and engaged, neither reflective, we are highlighting alternative pedagogies which promote this sense of self-regulatory actions. We describe the engaged learning framework – focusing on both *problem* and *process* – which would be necessary for authenticity in learning experiences.

Keywords: engaged learning, authentic experience, self-regulated learning, problem-based learning, metacognitive strategies, collaboration

1. INTRODUCTION

The recent proliferation of literature and emphases in active forms of learning as opposed to passive and didactic methods of learning and instruction has promoted the moves towards problem-based and constructivist pedagogies. Educators and researchers all over the world are relatively cognizant to these initiatives, but may not be as familiar with the psychology or philosophy of these pedagogies. In this chapter, we will go into some depth of these engaged learning pedagogies and discuss, in particular, how such forms of learning encourage self-regulatory learning and metacognitive behaviors. We regard the importance of these behaviors as we believe that these skills are more critical in a complex and fast-changing society. In the sections below, we will be covering some literature on authenticity in learning or what it means to make learning engaging; how authentic learning environments encourage self-regulation and metacognition; and a description of how authentic engaged learning

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environments such as problem-based learning (PBL) promote self-regulatory learning. We describe the POMET framework – focusing on both problem and process – which would be necessary for authenticity in learning.

2. THEORETICAL FOUNDATIONS

Engaged learning is grounded on recent notions of active learning where learners take responsibility for their own learning. Learners are responsible for their own learning when they are actively developing thinking/learning strategies, and constantly formulating new ideas and refining them through their conversational exchanges with others. In other words, there is active engagement in the learning process when the learners are constructing knowledge from experience through their interactions with peers and teachers to make meaning or to interpret information and patterns observed. Congruent to constructivist notions of learning, knowledge evolves as a meaning construction and interpretation process, and where people negotiating with one another relating to their multiple perceptions of reality (Jonassen, Peck, & Wilson, 1999). Jones and his colleagues (1995) from the North Central Regional Educational Laboratory provided a comprehensive and useful set of indicators of engaged learning. This set of indicators of engaged learning is reproduced in Table 1.

Table 1. Indicators of Engaged Learning

Variable	Indicator of Engaged Learning	Indicator Definition
Vision of Learning	Responsible for learning	Learner involved in setting goals, choosing tasks, developing assessments and standards for the tasks; has big picture of learning and next steps in mind.
	Strategic	Learner actively develops repertoire of thinking/learning strategies
	Energized by learning	Learner is not dependent on rewards from others; has a passion for learning
	Collaborative	Learner develops new ideas and understanding in conversations and work with others
Tasks	Authentic	Pertains to real world, may be addressed to personal interest
	Challenging	Difficult enough to be interesting but not totally frustrating, usually sustained
	Multidisciplinary	Involves integrating disciplines to solve problems and address issues

Table 1. continued.

Variable	Indicator of Engaged Learning	Indicator Definition
Assessment	Performance-based	Involving a performance or demonstration, usually for a real audience and useful purpose
	Generative	Assessments having meaning for learner, maybe produce information, product, service
	Seamless and ongoing	Assessment is part of instruction and vice versa; students learn during assessment
	Equitable	Assessment is culture fair
Instructional Model	Interactive	Teacher or technology program responsive to student needs, requests (e.g. menu driven)
	Generative	Instruction oriented to constructing meaning; providing meaningful activities/experiences
Learning Context	Collaborative	Instruction conceptualizes students as part of learning community; activities are collaborative
	Knowledge-building	Learning experiences set up to bring multiple perspectives to solve problems such that each perspective contributes to shared understanding for all; goes beyond brainstorming
	Empathetic	Learning environment and experiences set up for valuing diversity, multiple perspectives, strengths
Grouping	Heterogeneous	Small groups with persons from different ability levels and backgrounds
	Equitable	Small groups organized so that over time all students have challenging learning tasks/ experiences
	Flexible	Different groups organized for different instructional purposes so each person is a member of different groups; works with different people
Teacher Roles	Facilitator	Engages in negotiation, stimulates and monitors discussion and project work but does not control
	Guide	Helps students to construct their own meaning by modelling, mediating, explaining when needed, redirecting focus, providing options
	Co-learner/ co-investigator	Teacher considers self as learner; willing to take risks to explore areas outside his or her expertise; collaborates with other teachers and practicing professionals

Table 1. continued.

Variable	Indicator of Engaged Learning	Indicator Definition
Student Roles	Explorer	Students have opportunities to explore new ideas/tools; push the envelope in ideas and research
	Cognitive apprentice	Learning is situated in relationship with mentor who coaches students to develop ideas and skills that stimulate the role of practicing professionals (i.e. engage in real research)
	Teacher	Students encouraged to teach others in formal and informal events
	Producer	Students develop products of real use to themselves and others

A useful theoretical construct for framing an understanding of engaged learning is situated cognition. Situated cognition places learning within a participatory framework, and not just in an individual mind (Lave & Wenger, 1991). This means among other things, that learning is mediated through language by differences in perspectives among co-participants (Bakhtin, 1984; Lave & Wenger, 1991). In his work on linguistic meanings, Wittgenstein (1958) also adopts the view that understanding meanings in language requires insight into the activities or situations in which the language is involved. Learning often happens in a social setting, community, and context. The process of dialogue has not only the function of reaching understanding, but also of coordinating action and socializing actors as well (Habermas, 1984). From this perspective, human learning is best understood as a process of dialog, appropriation, and socialization (e.g., Bakthin, 1984; Maturana, & Verala, 1987; Wittgenstein, 1958).

Another implication of situated cognition is that if we view knowledge and thinking as inherently situated in social and physical contexts, much of what is learned is implicit. By immersing students in activities and authentic problem tasks which have rich conceptual meanings and encouraging them to explore and discover, they would begin to acquire the basic language and dispositions necessary to participate in a disciplinary discourse called “knowledge about a discipline”. When the students are given opportunities to actively engage participants who are already active in a disciplinary practice, these students would then develop the interpretive skills framework of that particular disciplinary practice. The extent to which students are able to acquire both knowledge elements the basic language/dispositions and the technical interpretive skills framework of a particular discipline--would determine whether are they are novices and experts in the disciplinary discourse.

3. AUTHENTICITY IN LEARNING

Authenticity can be seen from the perspective of a disciplinary community of practice, for example, a community of scientists or mathematicians. Students should be encouraged to engage in meaning construction in ways similar to inquiry paradigm of a discipline such as scientific thinking, and in producing artifacts and products like what practitioners do. Thus, authenticity from this perspective approximates what the real-world is engaged in, that is, the real world of scientists and practitioners. With respect to science learning as an example, Roth (1995) discusses five aspects of authentic learning in science. Students are engaged in authentic activities when

1. participants learn in contexts constituted in part by ill-defined problems;
2. participants experience uncertainties, ambiguities, and the social nature of scientific work and knowledge;
3. participants' learning is predicated on, and driven by, their current knowledge state;
4. participants experience themselves as part of communities of inquiry in which knowledge, practices, resources, and discourses are shared; and
5. in these communities, members can draw on the expertise of more knowledgeable others whether they are peers, advisors, or teachers.

Since the time of Dewey (1964), it has been a common goal to make the learning of a particular discipline to better resemble the actual practice of the discipline, for example, to make the learning of science to better resemble the actual scientific practice. The goals and potential benefits of aligning learning with actual practice are clear in that students become like scientists engaging in scientific knowledge and inquiry within a meaningful and realistic context. Brown, Collins, and Duguid (1989) argued that "Authentic activity … is important for learners, because it is the only way they gain access to the standpoint that enables practitioners to act meaningfully and purposefully" (p. 36). "Authentic activities provide learners with the motivation to acquire new knowledge, a perspective for incorporating new knowledge into their existing knowledge, and an opportunity to apply their knowledge" (Edelson, Gordin, & Pea, 1999).

An example of an attempt at authentic learning in science is the CoVis (Collaborative Visualization) project. The researchers work with K-12 schools within a revised curriculum activities to enable a focus 1) on studying local phenomena such that the students were able to experience science concepts within their local and personal environment; and 2) on multi-school community that took advantage of networking technologies to replicate a diverse community of perspectives and experiences that make up the scientific community. According to Edelson (1998), in order to make science learning authentic in the classroom, the key features of scientific practice have to be structured along these three categories: attitudes, tools and techniques, and social interaction. In terms of attitudes, scientific practice is characterized by uncertainty or unanswered questions and the commitment to pursue answers to these questions (Edelson, 1998). The tools and techniques are those that have been developed and refined over many years of scientific practice. And science includes the sharing of results, concerns, and questions among scientists. For scientists, their attitudes, tools and techniques, and social interaction are all supported by a body of knowledge that provides a meaningful context for scientific activity (Edelson, 1998). "Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry ...." (National Research Council, 1996, p. 105).

4. SELF-REGULATED LEARNING

Similarly, when we simulate scientific processes in the classroom, students need to have the opportunities to engage in the development of attitudes which involves self-regulatory behaviors through the use of practice-oriented tools in the context of social discourse and interaction. Self-regulated learning involves students' ability and propensity to be "active participants in their own learning" (Zimmerman, 1994, p. 3). We conjecture that, at this stage, the fundamental difference between active and traditional forms of learning is in the exercising of self-regulation behaviors such as planning, organizing, and other monitoring actions.

In the 1980s and 1990s, conceptions of self-regulated learning evolved to comprise interactions between students' knowledge (e.g., metacognitive, domain specific, and epistemological), metacognitive skill (e.g., planning and monitoring), motivation (e.g., self-efficacy beliefs), and cognition (e.g., application of a cognitive strategy). More recently, the social dimension of self-regulation has been included focusing on individuals acting in social contexts (e.g., Paris & Paris, 2001). Self-regulation also "involves a social aspect that includes interactions with peers and teachers" (Patrick & Middleton, 2001) who facilitate and design learners' tasks by co-regulating learning (Meyer & Turner, 2001). Hence, "self-regulation is now thought to occur when students are motivated to reflectively and strategically engage in learning activities within environments that foster self regulation" (Butler, 2002, p. 60). Definitions of self-regulated learning that includes a dimension of it being socially influenced recognize that students' regulation of learning can be guided by others in co-regulation of learning activities such as discourse, supportive materials, procedural facilitators, etc.

In other words, self-regulated learning is usually associated with the attempts of students engaging in project work or problem-based learning as these efforts require learners to investigate a driving question or problem; construct explanations and artifacts; collaborate with others; and use technology to support inquiry (Patrick & Middleton, 2002).

Literature of self-regulated learning and metacognition is situated within the context of authentic activities where learners have opportunities to reflect and monitor their behaviors in the context of solving problems with social others. Situated within contexts such as communities of learners, students are 'simulated into' situations where they have to plan and monitor their actions and activities, including the use of appropriate tools and strategies in order to achieve these goals.

Metacognitive activities within the concept of communities of learners can be both explicit and implicit. By explicit, we mean the structuring of activities where learners need to engage in explicit processes of reflection such as researching, sharing, and performing (Brown & Campione, 1996). Students begin by researching complex domain-specific issues and share what they have learned in their sub-groups to others. Through reciprocal teaching, students are exposed to comprehension and monitoring strategies which guide them in the sharing process.

In other examples, Computer-Supported Intentional Learning Environments provide scaffolds in the form of procedural cues to assist learners in conjecturing, providing personal theories, find more information, etc. (Scardamalia & Bereiter, 1991). The Scientific and Mathematical Arenas for Refining Thinking (SMART) program facilitates the generation of ideas, multiple perspectives, researching and revising, testing one's ideas, going public with one's ideas, and reflecting on the process, and looking for newer challenges (Barron, et al., 1998). The above two examples anchor around authentic problems and ideas.

In the next section of this paper, we discuss the pedagogical approach of problem-based learning (PBL) and consider how learning can be anchored or centered around authentic problems with the potentials for self-regulated learning and metacognitive activities on the part of the learners. We discuss how PBL can be situated within the concept of communities of learners and not just as a stand-alone pedagogy.

5. PROBLEM BASED LEARNING

"The principal idea behind problem-based learning is … that the starting point for learning should be a problem, a query or a puzzle that the learner wishes to solve" (Boud, 1995, p. 13). Problem-based learning starts primarily with a focus on real-life problems and activities, rather than intense disciplinary knowledge (Hung, 2002). The approach attempts to move students towards the acquisition of knowledge and skills through a staged sequence (serving as a scaffolding process) of problems presented in context, together with associated materials and support from necessary sources, for example, teachers and experts.

PBL which originated with Medical school as real-world case studies has these objectives (Barrows, 1986) for the students:

- construction of clinically useful knowledge;
- development of clinical reasoning strategies;
- development of effective self-directed learning strategies; and
- increased motivation for learning, and becoming effective collaborators.

The fundamental approach as adopted in PBL as practiced in medical schools is as follows (Bereiter & Scardamalia, 2000):

- Problems play a central role in the educational process;
- Dialogue is a central vehicle for problem solving;
- Finding out what needs to be found out is critical to the learning process;
- Small groups work together to solve the problem;
- Information gathering and other tasks as distributed among group members; and
- The focus is on a cognitive outcome rather than producing an artifact or product thus distinguishing it from project-based learning.

Barrows (1986) has identified two factors that affect the probability that any of these objectives might be achieved. The first factor is the nature of the case: whether it is a complete case, a vignette, or a full problem simulation. The second factor is the locus of control of learning: whether it is teacher-centered, student-centered, or mixed. In medical school, the patients are real patients. Barrows worked with the doctors in gathering the details of case studies used for PBL.

There are three reasons why the problems must address real issues. First, because the students are open to explore all dimensions of the problem, there is a difficulty in creating a rich problem with a consistent set of information. Second, real problems tend to engage learners more – there is a larger context of familiarity with the problem. Finally, students want to know the outcome of the problem (Savery & Duffy, 1998).

The original conceptions of PBL as derived from Barrows (1986) within the Medical school context had a strong linkage with the medical community of practice. Developed in the mid-50s, it is now spread into more than 60 medical schools. Traditionally, in the first 2 years of medical school, students were given the traditional lectures such as in anatomy and physiology. The PBL approach transforms this method into one in which upon reaching medical school, students are divided up into groups. A group of five to seven medical students, for example, and a facilitator meet to discuss a problem (Barrows, 1986). The facilitator provides the students with a small amount of information about a real patient's case, and then the group's task is to evaluate and define different aspects of the problem and to gain insight into the underlying causes of the disease process. Hypotheses are generated and issues are also raised. The group members may choose to divide themselves up to investigate the various issues and discuss upon the findings subsequently. The students re-gather to share what they have learned, to reconsider their hypotheses, or to re-construct new ones based on their consolidated understanding. The facilitator's role is to help the students' learning processes by modeling hypothesis-driven reasoning and other forms of metacognitive skills (Savery & Duffy, 1998) for the students and by encouraging them to be reflective. As students become more experienced with the PBL method and take on more of the responsibility for identifying learning issues, the facilitator is able to fade this type of support, or scaffolding.

Barrows is adamant that the facilitator's role and interactions be kept at the metacognitive level when engaging learners' on issues and with the problem at hand. The facilitator should constantly ask questions such as: "Do you know what this means?"; "What are the implications of this?"; or "Is there anything else?". Through this process, students are encouraged and expected to similarly think critically and monitor and regulate their own understanding (Savery & Duffy, 1998).

"Through problem-based learning, students learn how to use an iterative process of assessing what they know, identifying what they need to know, gathering information, and collaborating on the evaluation of hypothesis in light of the data they have collected." (Stepien & Gallagher, 1998, p. 44)

> [P]roceeding through the PBL process requires the learner's metacognitive awareness of the efficacy of the process. In this regard, PBL is inherently self-regulated. Yet, PBL does not exist in a vacuum. Rather, it is a social system within a larger cultural context. The knowledge that the learner seeks is embedded in and derives from social sources—in this case, the world of medical practice. From this perspective, the learner is seen as both transforming and as transformed as the processes of practice and their underlying symbol systems are internalized through dialectical activity … In this sense, learning is not an accumulation of information, but a transformation of the individual who is moving toward full membership in the professional community. This identity-making is

> marked by observing the facility with which cultural tools, or the ways of thinking and using language, are invoked. The sociocultural context of PBL is the group meeting that simulates the social process of medical problem solving in a scaffolded way. (Hmelo & Evensen, 2000, p. 4)

Hung (2002) synthesized that the process of PBL requires that students adopt active and metacognitive learning strategies though posing their own problems, questions, and seeking the respective solutions. PBL approaches converge with the notion of communities of learning engaged in disciplinary engagement. Engle & Conant (2002) discuss the elements of disciplinary engagement as (1) problematizing subject matter; (2) giving students authority to address problems, (3) holding students accountable to others/peers and shared disciplinary norms, and (4) providing students with the relevant resources. These elements are congruent to the processes underpinning PBL. Students are encouraged to question theories and challenge previously accepted facts by presenting evidence of their conjectures. The basic approach taken is to engage learners in inquiry processes similar to experts and practitioners in the discipline.

Similar to PBL approaches is project work science or PBS. The American Association for the Advancement of Science (1993) and the National Research Council (1996) have in the last few years been recommending that students be engaged in the activities of scientific inquiry – asking questions, conducting experiments and investigations, collecting data, interpreting results, and reporting findings (Roth, 1995).

Project-based science (PBS) is one example where authentic learning occurs, emphasizing inquiry and social constructivist learning activities. PBS is characterized by (1) a driving question, (2) investigations, (3) artifact development, (4) collaboration among students, teacher, and others in the community, and (5) use of technology tools to support inquiry (Singer, Marx, Krajcik, & Chambers, 2000).

By adopting a driving question that contextualizes the science project, PBS makes the inquiry process authentic (Patrick & Middleton, 2002). "The driving question uses students' real-world experiences to contextualize scientific ideas and subquestions and anchoring events to help students apply their emerging scientific understandings to the real world, thus helping them see value in their academic work." (Singer, Marx, Krajcik, & Chambers, 2000, p. 167)

Between PBL and PBS, the starting point is an authentic problem or driving issue which learners can possibly relate to. In both, students collaborate with peers within their groups and with others outside the classroom. Due to challenging driving questions and problems, students are compelled to address subquestions to an overarching question and develop strategies to monitor their progress. Assisting in this developmental process and transformation from novice ways to methods which experts adopt is fundamental to understanding how we learn (Bransford, Brown, & Cocking, 1999)

Self-regulated learning and metacognitive strategies involved in PBS is particularly interesting (Patrick & Middleton, 2002). Cognitive and meatcognitive strategies are needed when students have to think systematically and deeply about questions and subquestions; use the appropriate technological tools to create models; connect different pieces of information; represent their ideas in different ways; monitor their progress; work together with others; etc. Thus, success in PBS requires the cognitive, metacognitive, motivational, and collaborative engagement that comprises self-regulated learning (Patrick & Middleton, 2002).

6. IMPLICATIONS FOR ENGAGED LEARNING ENVIRONMENTS

Designing authentic learning environments is an important concern for teachers and educators. Inherently, these authentic activities are fundamentally learner-centered in nature allowing opportunities for learners to reflect and plan for their actions. Such monitoring and regulatory behaviors are crucial for learners. Tenets for engaging students in authentic learning experiences whether in PBL, PBS, or in any similar such settings include the following (as discussed in the above settings):

- Meaningful problems – usually project based;
- Staging activities – structured activities and investigations that introduce learners to investigation techniques, background knowledge, and processes needed in inquiry similar to particular disciplinary practices;
- Supportive tools – cognitive and reflective tools and other forms of social collaboration tools which enable learners to think and collaborate;
- Embedded information cases – embedding a library of resources that is linked directly to an investigation process; and
- Monitoring and Planning – allowing learners to record the process and intermediate products of an extended activity.

In order to facilitate self-regulatory and metacognitive behaviors in our students, the problem selected and the process of solving the problem ought to be authentic to the learner. Authenticity, in other words, is both at the *problem* and *process* levels. Not only should the *problem* be an authentic one, but at the *process* level, we mean the use of authentic tools and strategies to solve ill-structured problems within a social context. Moreover, by *process*, self-regulated learning in authentic learning situations such as PBL can be facilitated under the following conditions:

- Adopting the kinds of thinking and questioning processes of experts;
- Appropriating the kinds of tools and strategies used in communities of practices;
- Developing artifacts and products related to the problem; albeit in a simplified form as those produced by experts;
- Dividing the problem into sub-problems;
- Peer sharing and critique;
- Experts' consultation and advise;
- Access to relevant sources of information and materials;
- Opening ideas for challenge;
- Opportunities to reflect upon trials and experiments; and
- Opportunities to explain issues, findings, and conclusions.

The above conditions for authentic learning situations are realized in our proposed engaged learning framework described below.

7. A PROPOSED ENGAGED LEARNING FRAMEWORK

Summarizing the above discussion, we derive the engaged learning framework – *Problem, Ownership, Collaboration, Monitoring, Experts, and Tools* (see Figure 1) – the five tenets of Authentic Learning Environments. In essence, the framework involves the following tenets:

1. the design of *Problem* task which needs to evolve based on the learners' learning goals and needs to understand;
2. *Ownership* of learning towards the problem at hand and an engaged responsibility towards the ideas and concepts being explored;
3. *Collaboration* with others as a central means of problem solving;
4. *Monitoring* and regulatory processes which lead to closure of experimentation and ideas' discourse;
5. the role of *Experts* and facilitators in the learning process; and
6. the role of supporting *Tools* in the generation of ideas and problem solving.

We would stress that 'authenticity' in learning cannot be based on problem authenticity alone. "Authenticity" is *both **problem** and **process***. Hence the design of authentic problems should include both problem design and process design. The set of design principles for authentic problems can be seen as follows:

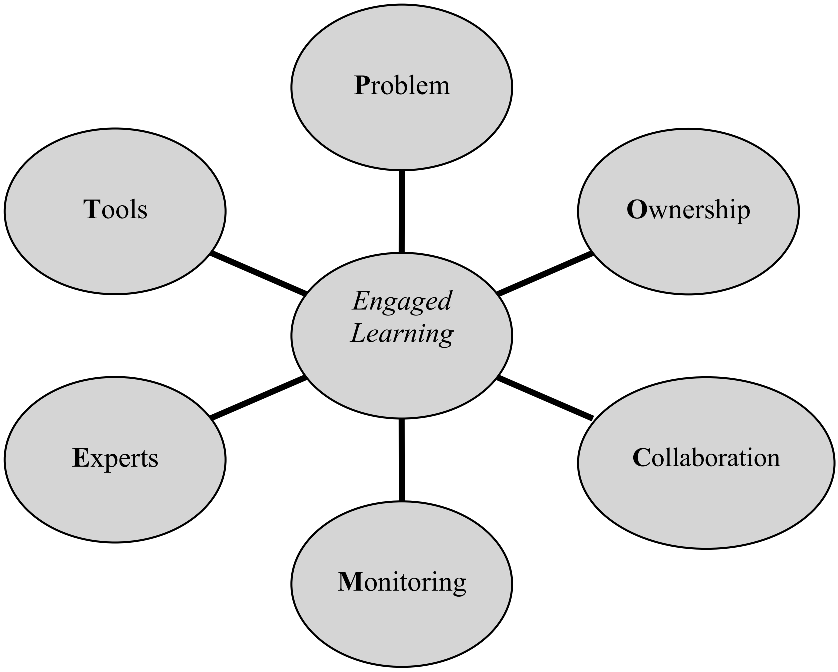

Figure 1. The Engaged Learning Framework

Problem Design – Problem (P)

Problems should be ill-structured with real life as anchoring problems/context. These problems should contain relevant learning issues also related to the syllabus which students have to learn in the schools. In this sense, problems should be identified collaboratively by teachers and students. The problem should be an integration of disciplines in problem solving so that students are given the opportunity to practice linking knowledge and skills of different disciplines in problem solving.

Ownership of inquiry where learners feel that the development and solution of the problem is meaningful is crucial to the design of authentic learning environments. Experts who are linked with learners in projects should coach and model the disciplinary thinking process through the use of support tools. Opportunity must be given to learners to reflect on the problem solving process together with facilitators and experts.

Process Design – Ownership (O), Monitoring (M), Experts (E), and Tools (T)

Ownership

i. Students should identify their own learning goals through the facilitation of teachers and experts;
ii. Students should be engaged in all the different aspects of the inquiry process such as investigation, experimentation, reflection, etc.; and
iii. Students need to know how to break down the problem into sub-problems and to engage in the problem solving process.

Collaboration

i. Students could be working in groups where they collaboratively solve problems.
ii. Students need to divide their projects up into respective roles and sub-tasks in order to achieve the objectives; and
iii. Students can account to each other on the work done.

Monitoring

i. Monitoring should be holistic which emphasizes on process rather than product, involving more than one form of evaluation techniques;
ii. Self-regulatory processes are needed on the part of the learners in order to monitor their progress in the problem solving process; and
iii. Monitoring should be done as a process similar to multiple evaluation in-situ which is at different crucial points of the problem solving cycle to assess learning as well as to inform the extent of support to provide in subsequent activities.

Experts

i. Experts together with teachers should provide a well guided inquiry/problem solving framework for problem solving;
ii. Experts and teachers should provide mediating tools and techniques for inquiry that are modeled after those used by the experts;
iii. Experts and teachers should provide sufficient/appropriate support for inquiry process, metacognition, collaboration and communication to bridge the gap between what the experts' knowledge and skills and that of the students'; and
iv. Experts and teachers should provide opportunities for students to play multiple roles in solving problems.

Tools

i. The problem solving process should be done collaboratively through *open* communication tools between the students, teachers, and experts; and
ii. The problem solving context should be collaborative and communicative through tools that are modeled after those used by experts.

Importantly, the engaged learning framework can be seen as a staged process similar to cognitive apprenticeship methods where problems are provided in terms of increasing complexity and diversity. The degree of progress in terms of the levels of ownership, monitoring behaviors, collaboration, expert-participation, tool-support can also be similarly conceived as progressive.

8. TECHNOLOGIES WHICH SUPPORT ENGAGED LEARNING

Mindtools (Jonassen, Peck, and Wilson, 1999) are one example where learners actively engage in the creation of knowledge through tools such as concept-maps, reflecting their comprehension of the concepts rather than focusing on the presentation of knowledge. Jonassen proposes a model of constructivist learning environment that aims to engage learners in active and meaningful learning. The kernel of the constructivist learning environment is the issue, problem or project that serves as the focus of the learning episode. Jonassen believes in using interesting and authentic problems to motivate the learners towards the learning goal. Jonassen proposes using ill-structured problems arising out of real life context, which usually contain some emergent aspects that are definable by the learners. One major difference between expert and novice problem solvers lies in their experience in domain-specific problem solving. Experts possess knowledge and past experiences that are often encoded as stories; when met with a new situation or problem, they can readily search their memories for related cases. Jonassen proposes using related cases to supplant student experience and to provide multiple representations of content that reflect the complexity of the domain knowledge. In a constructivist learning environment, relevant and appropriate information, including web-based materials, could be made accessible as embedded hyperlinks at appropriate juncture.

To help engage the learners in higher order thinking, Jonassen suggests the use of cognitive tools, including visualization tools, knowledge modeling tools, performance support tools and information gathering tools. These tools help to facilitate cognitive processes and support learners in performing problem solving tasks. Premised on the notion of social constructivism, which emphasizes learning through collaborative construction of socially shared knowledge, Jonassen suggests using computer-mediated communication tools to support dialogue and collaboration within a communities of learners, who share similar knowledge and values and are pursuing similar learning goals. Collaborative tools include simple discussion forum and scaffolded environments such as Knowledge Forum. Besides devoting our effort to the design of a constructivist learning environment, Jonassen argues that a crucial factor for successful implementation of the learning activities is the social and contextual support. Without social and contextual support, which includes the physical infrastructure readiness and training to instructors and learners, the learning activities may be rendered ineffective.

Another example of technologies for engaged learning is anchored instruction. Anchored Instruction situates classroom learning in real life problem-solving scenario in order to engage students in problem solving. By anchoring learning in real life contexts, we are encouraging students to apply the knowledge they learn in classrooms to solve real-world problems, thus linking the "school knowledge" with everyday applications. An example of anchored instruction is the series of video-based program called *The Adventures of Jasper Woodbury Mathematical Problem Solving Series* developed by the Cognition and Technology Group at Vanderbilt.

Unlike traditional instructional videos that record "talking heads" to emulate lectures, each Jasper video contains a short realistic story that represents sufficiently complex problems. Since learning is demand-driven, the detective-like adventures help to motivate the students to engage in problem-solving tasks. Using "embedded data design" principle, the videos contain all the data necessary to solve the adventure with purposeful inclusion of irrelevant data to simulate the complexity of real life problems. Jasper adventures also contain "embedded teaching" episodes that model expert's approaches to solving problems. Leveraging on digital video technology, the video can be viewed and revisited as the learners solve the problems. While traditional mathematics teaching focuses on teaching of heuristics and problem solving steps, followed by "practice questions" that have single correct answer and one best method of getting the solution, the Jasper videos challenge the students to identify the problems, generate sub-goals, source for relevant information, cooperate with peers in planning and problem solving, compare perspectives, present possible solutions, select best solution and justify for the final solution. By taking up the challenge, the students apply their mathematics knowledge and concepts, critical thinking, and communication skills.

In summary, Table 2 describes the kinds of tools which can support the engaged learning framework.

Table 2. Technological supports to engaged learning framework

	Design considerations and tools for Engaged Learning
Problem	There is a need to provide or problem that is co-formulated by the students and teacher(s). The problem can be simulated into a learning environment after being co-formulated. The specific goals must be related to real-life cases according to the realities of the community of practice. Videos such as in anchored instruction can be adopted to describe the problem.
Ownership	The problem or case example must be interesting to the community (both students and teachers, and even experts)
Collaboration	The cases/problems are situated in a real life context. The learners, teachers, and practitioners each play a different but realistic role in solving the problem.
Monitoring	Students need to have tools to monitor and reflect on their learning experiences such as reflection logs, peer critiquing tools, and other forms of monitoring aids.
Experts	There should be plenty of opportunity for experts such as practitioners to operate within the learning environment. These activities can be scaffolding in terms of increasing complexity and diversity.
Tools	Tools are used throughout the process, in particular, social-constructivist tools for collaboration / communication between the students, teachers, and experts, in particular the co-formulation of problems, co-setting of goals, co-experimentations, co-explanations, and co-explorations of "what-if" questions. Mindtools and other forms of constructivist learning tools (e.g., concept mapping and visualization-simulation tools) are useful here. Information resources of precious cases, problems, and related information are crucial. Learners should receive appropriate feedback from each other, the teachers, and experts through the supports provided.

9. CONCLUSION

To orchestrate an engaged learning approach, it must start with the design of the anchoring problem. However, the process of problem solving should also be authentic. Authenticity should then be seen as both problem and process. The entire engaged learning framework of learning should be an authentic co-construction process on the part of learners, teachers, and experts where ownership in problem and process is an integral part of the learning experiences. Most importantly, the engaged learning framework differs from traditional learning in that learners are engaged in self-regulatory behaviors and that personal and collaboration knowledge construction are the tenets for authentic and engaged learning.

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