Project-Based Learning: A Framework for the Design of a Constructivist Learning Environment

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Abstract

This paper considers an approach to designing project-based, constructivist learning (PBL) using Jonassen’s (1999) framework as a guide. The articles synthesized in this paper consider all aspects of PBL from the development of a driving question to the tools, techniques and resources designers should consider when developing a PBL environment. Specifically, articles referenced in this paper look at issues related to the best approach for presenting problems to learners, the significance of related cases and information resources, and the use of cognitive tools and technology for the promotion of meaningful learning. Particular emphasis is placed on how to support teachers in their role as facilitator and guide within a PBL environment and on the role that technology plays in the development of peer support networks for teachers. Specific methods of supporting learners such as modeling, coaching and scaffolding are also discussed.

Keywords: project-based learning, instructional design, constructivism, Jonassen, PBL
Project-Based Learning: A Framework for the Design of a Constructivist Learning Environment

When designed properly, project-based learning (PBL) embodies the values and assumptions of constructivism (Land & Hannafin, 2000). However, as Land and Hannafin (2000) point out, it is extremely difficult to develop a fully-inclusive model for the design of constructivist learning due to the complexity of these types of learning environments (De Villiers, 2002). Despite the complexities, Jonassen (1999) proposes a framework that can serve as a guide for the design of project-based learning.

Beginning with a driving question, or problem, the model considers all aspects of planning for PBL. The role of the instructional designer is that of a consultant working to lay the groundwork and provide support for teachers and learners throughout the PBL process (De Villiers, 2002).

What is Project-Based Learning?

Project-based learning, as defined by Thomas (2000) is a constructivist learning method in which learning is based on the development of a project. Thomas (p. 3) lists five criteria of PBL: (a) projects are the central component; (b) there must be a question that drives the learning; (c) learners are involved in “constructive investigation”; (d) the learners drive the project; and, (e) projects are authentic. Blumenfeld et al. (1991; Jonassen, 1999) describes two necessary aspect of PBL: (a) a driving question; and, (b) the development of an artifact over time that answers the driving question. Jonassen’s model for the design of constructivist learning environments meets the PBL criteria outlined by both Thomas (2000) and Blumenfeld et al. (1991).
A Framework for Designing Project-Based Learning

The model begins with the development of a central driving question or problem with the ultimate goal being to complete a project (Jonassen, 1999). Teachers, with the support and guidance of an instructional designer, provide learners with access to related cases and relevant information. Cognitive tools are supplied to help learners interpret, organize, manipulate and present the problem and associated artifacts. Conversation and collaboration tools should be made available to aide learners in “co-construction” meaning (Jonassen, 1999, p. 2). Finally, social, contextual, and learning supports should be provided to assist teachers and learners.

The Problem and the Driving Question

According to Dewey (1938; as cited in Savery, 1995, p. 2) it is the “problematic” that is the catalyst for learning. For PBL, the problem should be interesting, engaging and ill-structured and stated in the form of a question that will drive the learning experience (Jonassen, 1999). These are the characteristics that will lead to increased ownership of the project and the necessary motivation for completing it (Jonassen, 1999).

Jonassen (1999) describes three components of the problem phase of the model: the problem context, the problem representation/simulation, and the problem manipulation space.

The problem context. Constructivists believe that learning must occur in real-world contexts (Richey, Klein & Tracey, 2010). Smith and Ragan (2005, as cited in Richey et al., 2010, p. 133) refer to this as “anchored instruction”. In order to properly anchor instruction in a real-world context, practitioners can be interviewed about the physical, socio-cultural, historical and organizational climate of the performance environment (Jonassen, 1999).
Problem representation/simulation. Jonassen (1999) stresses that the presentation of the problem needs to be relevant, (i.e. motivating, interesting, appealing, engaging) and authentic in order to encourage learner buy-in and motivation.

Relevance. The problem must be presented in a way that will encourage learners to adopt it (Savery, 1995). As Hernandez-Ramos and De La Paz (2000, p. 168) suggest “it is critical that students should want to learn about the subject matter they are being exposed to in schools”. Soliciting problems directly from learners is one way to gain learner interest (Savery, 1995). Additionally, learners will feel motivated if they perceive that they have control over the pacing, sequencing, and content of their learning (Papanikolaoi & Boubouka, 2010). Occasionally it may be necessary for teachers to negotiate with learners to ensure the scope of a project is within the bounds of the learning context and timeframe (De Villiers, 2002).

Authenticity. In order for a learning environment to be considered authentic it should engage learners in the same type of activities they would encounter in the real world (Honebein et al, 1993; Savery & Duffy, 1996; as cited in Jonassen, 1999). In order to replicate real world activities, Jonassen (1999) suggests using Leontev’s Activity Theory (1979; as cited in Jonassen, 1999) to analyze activities and identify the goals, physical setting and tools of practitioners (Jonassen & Rohrer-Murphy, 1998; as cited in Jonassen, 1999).

Problem manipulation space. The problem manipulation space can be an actual physical space or a simulated version of the real world---a microworld---(Jonassen, 1999) such as Second Life. Ideally, the problem manipulation space will include most of the materials learners will need in order to construct their artifacts (Jonassen, 1999).
Related Cases

Learners will likely have varying levels of experience, gaps in their knowledge, or inaccurate knowledge that is resistant to change, all of which can interfere with their understanding of a project (Blumenfeld et al., 1991). Novices, for example, may be completely lacking in experience within a specific domain (Jonassen, 1999; Blumenfeld et al., 1991). In order to assist inexperienced learners, designers of PBL should collect---and index for easy recall---a set of cases similar to the project being developed (Kolodner, 1993; as cited in Jonassen, 1999).

**Supplanting memory.** Related cases can act as stories for learners who may be lacking in real world experience in a particular domain (Schank, 1990; as cited in Jonassen, 1999). These stories can supplant memory by helping learners develop a mental role model, or schema, for problem-solving (Barron et al., 1998).

**Enhancing cognitive flexibility.** Presenting many related cases can provide multiple perspectives and contrasting points of view thus aiding learners in constructing their own understanding (Barron et al., 1998; Jonassen, 1999). By self-assessing after viewing multiple cases, learners can more easily identify gaps in their own knowledge (Barron et al., 1998).

**Contrasting cases.** Another method of scaffolding learning by reviewing cases is based on the theories of perceptual learning (Bransford, Franks, Vye, & Sherwood, 1989; Garner, 1974; Gibson & Gibson, 1957; as cited in Barron et al., 1998). By analyzing multiple, contrasting cases learners will often notice relevant features they might otherwise have missed if just one case was presented to them (Barron et al., 1998).
Information resources

Designers should determine what information learners will need to access in order to carry out the project. Information can be presented in many forms including text-based documents, printed graphics, video, audio or as hyperlinks within an online learning environment (Jonassen, 1999). Jonassen (1999) notes that, because many learners are not skilled researchers, the process of conducting research can actually be a distraction for some. Teachers may need to set parameters and provide instruction on how to navigate the internet, and how to distinguish between reliable and unreliable sources of information (Bell, 2010; Jonassen, 1999).

Cognitive Tools & Technology

Cognitive tools are utilized for a variety of reasons including visualizing, organizing, automating, or supplanting thinking skills (Jonassen, 1999). They can also be used to promote higher-order critical thinking that might not otherwise occur (Eskrootchi & Oskrochi, 2010; Jonassen, 1999).

Problem/task representation tools. During the activity analysis, processes that need to be presented visually may have been identified. In order to organize observations and ideas, concept mapping software (i.e. Inspiration, PicoMap), causal mapping software (Seeing Reason), and visual organizers (StorySpace and Inspiration) and other visualization software can be provided (McGrath, 2004).

Modeling tools. Modeling allow learners to answer the “what do I know?” and “what does it mean?” questions by using the same tools as the experts (Blumenfeld et al., 1991; Jonassen, 1999, p. 9). According to Pea’s framework of distributed intelligence, “computer assisted simulations can reorganize mental processes by closing the temporal gaps between thought and action and between hypothesis and experiment” (Lebow & Wager, 1994; as cited in
Eskrootchi & Oskrochi, 2010, p. 238). Lebow and Wager (1994, p. 238) refer to this as “what-if thinking”. As Eskrootchi and Oskrochi (2010) emphasize, simulation software should be used to expand the learner’s experience and not as a replacement for understanding and intuition.

STELLA is a simulation software program that provides learners with the opportunity to engage in “what-if thinking” while simultaneously developing higher-order thinking skills (Eskrootchi & Oskrochi, 2010, p. 238). Model-it is another simulation tool that allows learners to test their own models and observe output in the form of graphs, tables, or animations (Spitulnik, Studer, Finkel, Gustafson, & Soloway, 1995; as cited in Jonassen, 1999).

**Performance support tools.** Jonassen (1999) points out that, based on the activity structure analysis, tasks that are going to be cognitively overwhelming for learners may have been identified. Designers should provide tools to support learners in carrying out these complex tasks. Performance support tools can include spreadsheet templates, databases, calculators, and note-taking facilities (Jonassen, 1999).

Project management tools can also be introduced to help with goal setting, tracking progress and with the production of artifacts (Blumenfeld et al., 1991). Personal organizers can have a positive impact on the development of self-reliance skills as learners set daily agendas and report on how well they met their daily goals (Bell, 2010). Lenschow (1998; as cited in Gulbahar & Tinmaz, 2006) found that, given this opportunity for self-control, learners will often explore and progress without waiting for step-by-step instructions from teachers.

**Information gathering tools.** Tools to help learners gather information should be provided. Technology tools can include probes, digital microscope cameras, digital voice recorders with speech recognition (for interviews or idea generation), handhelds (for field work,
data collection, interviews, or note-taking), remote access to electron microscopes (i.e. Bugscape hosted by the University of Illinois) and virtual museums (McGrath, 2004).

**Conversation, collaboration and reflection tools.** Publishing using tools such as websites, blogs, Powerpoint, and wikis gives learners the opportunity to visually display their artifacts (McGrath, 2004). The resulting conversations, collaborations and reflections with their peers lead to further opportunities for meaningful learning (Eskrootchi & Oskrochi, 2010; McGrath, 2004).

**Conversation.** Providing learners with access to newspapers, magazines, TV, email, chats, newsgroups, and discussion boards can facilitate communication and collaboration with communities of learners who share common interests (Jonassen, 1999). According to Barron et al. (1998), it is these types of connections with like-minded communities that provide new opportunities for meaningful learning.

Papanikolaou and Boubouka (2010) found that learners appreciated receiving immediate feedback from their peers. Furthermore, learners also benefit from receiving feedback from a variety of audiences in addition to their peers (Barron et al., 1998).

**Collaboration.** Designers of PBL should provide access to tools that will help learners collaborate via small group interactions, peer reviews, and access to shared artifacts thus allowing for a synthesis of thinking (Barron et al., 1998; Jonassen, 1999). Bell (2010) notes that group work promotes student accountability due to the expectations of peers and the natural consequences of not following through. Group work also encourages active listening, respect for others, teamwork and the ability to generate ideas (Bell, 2010). Papanikolaou and Boubouka (2010) found a beneficial reciprocal effect of individual work on group reflective thinking and group work on individual reflective thinking.
Reflection. An important part of a PBL environment involves providing an opportunity for reflection on both the content and the learning process (Savery, 1995). The process of self-reflection encourages learners to take responsibility for their own learning. This leads to “doing with understanding” and “learning with understanding” (Barron et al., 1998, p. 305-306). In other words, as they reflect on their learning experience, learners also begin to understand why they are learning (Barron et al., 1998). Teachers can assist learners by modeling reflective thinking and supporting learners as they self-evaluate and reflect on their projects and the learning strategies they employed (Bell, 2010; Savery, 1995).

Technology

There is no doubt that technology can support meaningful learning activities (Roschelle et al., 2000; as cited in Eskrootchi & Oskrochi, 2010). However, as several researchers have found, it is not the kind of technology that matters as much as how it is used (Dyrli & Kinnaman, 1994; Ehrmann, 1995; Green & Gilbert, 1995; as cited in Eskrootchi & Oskrochi, 2010).

Learners need guidance when using technology (Bell, 2010). For those who are avid computer users, providing access to computer tools taps into this ability which can result in highly engaged learners (Bell, 2010). For those who are less comfortable with computers, technology will not be motivating if learners perceive it as being too difficult to learn (Blumenfeld et al., 1991). The designer’s job is to decide which technological tools will be the most effective for supporting learners and teachers in a PBL environment (Jonassen, 1999).

Supporting the PBL Teacher

For many teachers, PBL is an unfamiliar concept (Blumenfeld et al., 1991). These inexperienced teachers need to be supported when implementing PBL for the first time. The type of support teachers need varies but might include help with designing a project question,
organizing activities or with the implementation of PBL strategies (Blumenfeld et al., 1991).

Because assessment in PBL is less structured and more time-consuming than traditional methods, teachers may need assistance in learning how to assess artifacts, notebook entries, and portfolios (Barron et al., 1998). Additionally, teachers not only need to have an understanding of technology, they also need to understand how students learn from technology (Hennessy, 2006; as cited in Eskrootchri & Oskrochi, 2010).

Blumenfeld et al. (1991) suggests several ways in which technology can be used to support teachers. For example, providing teachers with access to online peer support networks can help them learn about PBL. Through the internet teachers can connect with project-based content and learn new ways of presenting content to learners. They can view video clips to see examples of how their peers have implemented PBL and they can read reflections on what worked and what didn’t. Through online peer networks, teachers can also find existing projects that can be modified for their own use. Alternatively, they can plan new projects with the support of an online teacher peer network. Once a PBL experience is complete, Barron et al. (1998) suggest that project plans can then become artifacts to be shared, critiqued and revised by other teachers in the peer network.

Specific online resources that may prove helpful for teachers include websites like The Buck Institute (2011) and Edutopia (2011), both of which offer resources for PBL including videos, blogs, and discussion forums. In the case of the Buck Institute, there is also a “PBL do it yourself” button that walks teachers through the process of planning, managing, reflecting on and sharing their projects with one another (Buck Institute, 2011).
Supporting the PBL Learner

Lebow (1993) notes that “the ultimate concern of educators should be to develop an enduring faith that persistent effort guided by purposeful reflection will result in reaching meaningful personal goals” (p. 14). It is through the support and guidance of the teacher that learners are reassured that their efforts will be worthwhile.

Throughout a PBL experience, the teacher’s role involves: (a) providing students with access to information; (b) providing scaffolding, modeling and guidance to students; (c) encouraging the use of metacognitive learning processes; and, (d) assessing progress, diagnosing problems, providing feedback and evaluating results (Blumenfeld et al., 1991). Jonassen (1999) describes three specific types of instructional supports that teachers can provide. These include: modeling, coaching, and scaffolding.

**Modeling.** According to Jonassen (1999), modeling is the most common instructional support used in a constructivist learning environments. Behavioural modeling of performance is often carried out through worked examples during which every step and decision is communicated (Jonassen, 1999).

Modeling of cognitive processes, also known as “reflection in action”, involves communicating reasoning and decision-making processes while actively solving a problem (Jonassen, 1999, p. 13). Jonassen (1999) states that the purpose of cognitive modeling is to “make the covert overt, so it can be analyzed and understood” (p. 14). In this way, learners gain an understanding of “why”, as well as “how”, to carry out a task (Jonassen, 1999, p. 14).

**Coaching.** This type of instructional support involves having learners attempt to perform like the model (Jonassen, 1999). When coaching, the teacher’s role is to provide support by motivating learners, providing hints, analyzing performance, prompting the use of appropriate
thinking strategies, cognitive tools or informational resources; providing feedback and advice; and, encouraging reflection on the learning, assumptions and strategies employed (Blumenfeld et al., 1991; Jonassen, 1999).

If novice learners have inaccurate or incomplete mental models about a problem they are solving, an instructional coaching strategy known as “perturbing the learners’ understanding” can be used (Jonassen, 1999, p. 16). Jonassen (1999) describes how this technique involves asking the learner provoking questions in order to promote self-reflection and encourage awareness that the problem can’t be solved with their current mental model.

**Scaffolding.** Scaffolding refers to temporary supports that help students bridge the gap between their knowledge and their skills (Bell, 2010). Scaffolding is critical for students who aren’t proficient in using thinking strategies (Blumenfeld et al., 1991). Jonassen (1999) suggests three approaches to scaffolding: adjusting task difficulty; restructuring the task; and providing alternative assessments (Jonassen, 1999).

**Conclusion**

Although designing for PBL is complex, frameworks such as Jonassen’s (1999) model can serve as a guide for instructional designers. Because it is based on constructivist values, the model emphasizes the centrality of the learner and the importance of engaging learners in meaningful and relevant activities that help them construct new learning.

The model suggests the tools, techniques and resources that teachers will need for successful implementation and management of PBL. Because the teacher’s role is so critical to the success of PBL, designers need to ensure that ongoing support systems are established through peer networks, websites and other PBL teacher resources. Ultimately, it is through the
role of consultant that the instructional designer will be most effective in laying the foundation for supporting teachers as they guide learners through the PBL experience.
References


Tracy,

Thank you for an excellent paper and I enjoyed reading it. You did a fantastic job outlining the design strategies for PBL. I like how you based your discussion on Jonassen’s framework and brought in other relevant literature to enrich the discussion. I see a clear focus and the target audience of the paper – instructional designers. I feel that this paper is well written for the designers because all the practical suggestions provided in the paper. I find the paper very informative and hope this paper will guide your future endeavors of designing for constructivist learning environments, especially a PBL environments.

Very well done! 😊

Yu-Hui

Grade: 99%
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