# Problem-Based Learning (PBL) In Distance Education: A Literature Review of How the Distance Education (DE) Environment Transforms the Design of PBL for Teacher Education

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## Abstract

*This paper expands on a poster presentation about the results of research in PBL in distance education environments integrated in the PBL design model as defined by traditional literature. The results will be laid out as they are relevant to each stage of the process. Research on discrete aspects of its design process is necessary to enlighten understanding of the particular areas that need to be modified when PBL is implemented over distance education. Nevertheless, these results need to be consolidated into design models that will guide designers in their pursuit of creating online experiences that benefit from constructivist principles of learning. A related goal is to make evident current strands of research and highlight possible directions for continued research that enlightens instructional designers as they translate the methodological specifications of PBL into DE environments. Continued study and incorporation of findings in this way can even provide evidence for the continued adoption of traditional PBL models for the DE design or the need of departure from them to create a specialized PBL for DE model.*

## Introduction

PBL has been characterized as an example of constructivist thinking (Duffy & Cunningham, 1996). The design principle of rooting educational activities in a realistic situation that embodies the knowledge and skills that students need to learn is one of the ways in which it implements constructivist principles. The use of this kind of authentic situation stimulates students to go beyond memorizing facts. It encourages them to analyze and evaluate facts and skills and integrate them into a cohesive approach to transform the current state of the situation into an ideal one according to the circumstances. Students are transformed into active role players with responsibilities that are similar to the ones they would assume in the world of practice. The pursuit of knowledge now becomes a dynamic undertaking that motivates students because of the immediacy and evident relevance of its application. Consistent with its goal of making learning a mirror of practice, most implementations encourage collaboration and communication among learners during this process. Learners bring together their previous experiences, skills and current understandings into a negotiation process that should contribute to strengthen students' response to the learning situation. The process of consultation of sources of information, negotiation of understandings and design and refinement of the solution is backed up by continuous reflection on content and process. It is improved on an ongoing basis by input from multiple sources and perspectives of assessment. The result constitutes an informed response of students to address the situation.

Distance education is becoming a realistic alternative for many to further their academic careers. The benefits that authors have attributed to distance learning have spanned at least financial, accessibility and academic reasons (Belanger & Jordan, 2000). One of the long-standing concerns with it is whether the quality of education parallels that of traditional classroom-based education (Birnbaum, 2001). An approach to try to ensure this is to design educational experiences that benefit from the educational principles that are deemed to yield effective learning. PBL is one of the educational methodologies that have emerged from practice in traditional classroom-based environments as a successful approach to strengthen learning. Therefore, designing distance learning experiences with PBL can be one of the alternatives by which institutions provide equal quality distance education to their student populations.

Different strands in communication theory advocate the preponderance of media in the delivery of messages (Meyrowitz, 1994). Authors like Marshall McLuhan are cited for his ideas of the influence media has in the delivery of messages (Deibert, 1998). Other authors stress the inherent importance of physical immediacy in human interaction (Boden & Molotch, 1994). In light of the ideas of these currents of thinking, the intention of fostering collaborative problem-based learning environments at a distance needs the special consideration of the affordances and challenges that the medium of delivery attaches to it. Synchronous communication that could bring the benefits of copresence is technology-mediated. Asynchronous communication that brings the

advantage of reflective thinking entails delays in the exchange of ideas. These situations suggest that implementation of such distributed examples of problem-based learning need to be informed by research that considers the new factors that come to play in it.

One of the common denominators in problem-based learning models is the use of collaborative learning groups during the process. Cooperation in learning has been defined as "working together to accomplish shared goals" (Johnson & Johnson, 1996). These authors stress the importance of various aspects that characterize group work. The first aspect they mention is positive interdependence. It has to do with the idea of working towards the accomplishment of a shared goal. They also talk about the importance of both individual and group accountability. Another important aspect is the development of interpersonal skills. Yet another aspect is the ability to self monitor group work to ensure consistent progress towards the goal and to discontinue patterns of behavior that impede this progress. However, the last item that these authors mention is what constitutes one of the challenges that this kind of inquiry wishes to explore. They explicitly incorporate face-to face interaction as one of the defining aspects of group work. When learning necessarily has to occur with a separation of space and/or time, educators then need to know how to facilitate such experience with the lack of immediacy between distance learners and teachers.

# The Literature Review

Research and evaluation literature on the development of PBL in DE has already begun. Researchers and practitioners have started to help identify possible limitations and / or advantages of this combination. This section describes the findings of several research undertakings as they zoom into general or more discrete relevant portions of the PBL design and implementation process.

## Teachers and Students

Sage (2000) studied the overall PBL experience from the perspective of students and instructors involved in the process. She focused on a set of elements each with a continuum of possible values, the combination of which has an impact on the online PBL experience. Courses that attempt to implement online PBL will encounter several starting characteristics of teachers and students that will be somewhat given. These cannot necessarily be changed during a single learning experience. Teachers and students bring their assumptions, skills and preferences related to both teaching and learning. They also bring their previous experiences and abilities in teaching and learning in traditional, constructivist, PBL and online environments. The more experienced both teachers and students are in all the factors that compose the PBL experience, the more flexibility educators will have to implement experiences that are closer to the models of this methodology that view students as more self-directed.

Taplin (2000) reports on the experiences of educators who are beginners in the transition from more traditional educational methods to the implementation of online PBL. She also points out the importance of considering student characteristics in the design of the course particularly regarding their flexibility to devote time to identifying and evaluating resources by themselves, individual accountability and group work. The limited schedules of distance learners is what makes them turn to anytime anywhere flexible opportunities for learning. Their availability needs to be taken into account and balanced with provision of resources and the design of group experiences so the assumed highlights of such undertakings do not turn into deterrents of learning. Teacher experience and availability to facilitate is also deemed important by this author.

Poon (1997) describe a hybrid environment in which educational efforts are triggered by problems that depict what students can do within a subject domain instead of what students should know. The distance learning technologies together with face-to-face experiences help deliver the content that students will use in order to solve the problems. The face-to-face component is also the setting in which students encounter the problem and initialize the process of problem definition and process organization. Then students undergo the iterative process of consulting sources of information and devising the solution. In the final stage, students not only construct the solution, but also reflect about what they have done and relate it to future practice.

These authors focused on feedback from tutors at the end of the first stage of work. This feedback covered areas such as ability of tutors to discern the scope of content they needed to care for based on the problem, understanding of the nature and purpose of PBL, the need of both training and practice to internalize the approach, time demands imposed by new teaching skills, reinforcement of change in student roles (from passive to active), shift in the role of teachers (from providing knowledge to questioning, making resources available, and refocusing) and problem generation. This experience underscores the need for teacher development when attempting to implement PBL designs. It also highlights the usefulness of considering teacher feedback to improve the design of such environments.

**Readiness to Work in a PBL Environment**

Readiness to work in a PBL environment not only benefits performance in learning but also in professional practice (Björck, 2002). His study focused on the nature of interactions as a way to evidence the level of appropriation and mastery of the process. The researcher studied issues of participation: amount and content of messages. Findings suggested a relationship between the volume and nature of interaction and the level of mastery of online PBL. Mastery was signaled by richer communication, more and detailed, critical but respectful questioning of classmates' standpoints, openness to feedback, continuous and spontaneous discussion. A shift in the facilitator's role with progressively less intervention evidenced students' level of confidence in their skills to undergo the process.

This author concludes that multiple online behaviors exhibited by students describe their level of mastery of online PBL. Nevertheless, for students to display the highest level of those characteristics, it takes several iterations of participating in the process. Initial scaffolding may be crucial in whether mastery of online PBL may be accomplished among students but eventual fading will characterize their achievement of it. The findings of this author seem to indicate the need of finding ways for strengthening student mastery of the process in the PBL design because of the dual benefit for the process itself and for future professional performance.

**Institutional Arrangement and Support**

Sage (2000) also explored the influence of the virtual structural environment of the course. The structural environment suggests that the course will have a previously specified amount of students and length and will be backed up by certain types of support from the institution. Therefore, educators need to adjust those PBL experiences based on the combined constraints and / or particular advantages that these elements will afford. Taplin (2000) had similar findings in that the overall commitment and support of the relevant administrative and academic departments is seen as crucial for the successful online PBL experience.

**Subject Matter**

The nature of the subject matter will also impact the design of the experience (Sage, 2000). The amount and level of complexity of the information that students are expected to learn helps to define the kinds of problems that can be adopted as starting points for learning. Then the characteristics of the problem (e.g. level of definition) and the amount of resources provided by the instructor also have an impact in design decisions.

**Technology Literacy and Infrastructure**

The technology access and support that the course receives is yet the last aspect that Sage (2000) describes. The type of communication and collaboration tool that the course uses together with its advantages and disadvantages for supporting PBL contributes to strengthen or debilitate the PBL implementation.

McAlpine & Dudley (2001) studied an implementation of online PBL in a course that consisted of 5 PBL experiences two to three weeks long each. It used online communication to support the exchange of ideas towards the resolution of the problem. They found that both students and the institution lacked the appropriate technology infrastructure to support the process. Technology literacy, access and support can become important obstacles in the development of effective online PBL. Technology requirements are at the threshold of an educational experience: it is a supporting element that must be transparent to all users so it will not severely limit learning benefits. This is consistent with Sage's (2000) findings.

**Impact of the PBL Problem in Interaction**

The connection between the type of problem that underlies a PBL experience and the amount and nature of interactions that occur during its process is the area of interest of Ronteltap & Eurelings (2002). Learning issues identified by students based on the problem were classified as theoretical or practical. The authors analyzed quantitatively the amount of interactions generated by type of issues. They also focused on their level of cognitive activity (e.g. low for copy and paste and high for original contributions). The study relied on student and instructor interviews and analysis of discussion board transcripts as multiple sources of information to corroborate findings.

According to this study, practical learning issues increased the amount and quality of interaction between students. The need for continued research on this is established due to a small sample. Nevertheless, these results could be supporting the view that learning that consists of memorization of facts only yields

enough interaction to achieve their reproduction. Furthermore, educational experiences that aim at developing increased scholarly interaction in quality and quantity should utilize practical problems as their starting point. This study provides useful pointers for educators looking for ways to increase interaction especially to avoid the sense of isolation that some distance learners experience.

**Group Development**

McConnell (2002) utilizes analysis of online discussions, products and student interviews to examine the development of PBL groups throughout the process. The course guides students to learn the design and evaluation of learning that occurs through PBL (which constitutes experiential learning). They are given ownership in determining the focus of the problem, direction of their efforts, monitoring their process, and simultaneously evaluating and redesigning the process in which they are participating. The facilitator becomes a co-participant in the process relinquishing most of its traditional authority in making decisions.

The author's findings point to the development of groups in three consecutive but overlapping stages. The first stage was characterized by negotiation of understandings and organization decisions. The second stage comprised the research related to devising the solution. The third stage corresponds to the development of the final product. This author found iterations within the first stage and simultaneous interaction among members of the group and its subgroups. This author describes implications of his research for the design of online PBL. Because of the affordances of the online environment, the development of groups' stages occurs simultaneously as the technology tools provide for accomplishing simultaneous work for different purposes. The amount of time that students take to undergo understanding, research and resolution differs and therefore designers need to account for this. It also has implications for facilitator increased or decreased intervention per stage as need.

**Cognitive Tools**

Technology tools that support PBL experiences can also be explored in a dimension that goes beyond their technological characteristics. Orrill (2002) deals with a technology-based tool to support metacognition during the collaborative inquiry during PBL. This tool used threaded discussion with message labeling to promote metacognition. The aim of the development of the tool was to support PBL thinking as opposed to mere logistics management. The focus of the course was technology integration in K-12 education. The length of the PBL portion of the course was three weeks. The analysis of interactions in the Asynchronous Conference Tool (ACT) comprised discussions that occurred during the first phase of the project (approximately 11 days). The researcher conducted an analysis of the character of interactions: whether messages focused overall on defining the problem / discussing issues (e.g. present student thinking, asked content-related questions), tasks (e.g. verify due dates, corroborate aspects of assignment, focus in course-related aspects of the problem) or other (e.g. supportive messages).

Student use of the tool as a process manager provoked less complains about it in comparison with use to directly support problem solving inquiry. The author suggests that this indicated a more limited support of the tool for the later purpose. She concluded that it was apparent that PBL can be successful and worthwhile in distributed learning environments. Nevertheless, there was an evident need for a more robust system for supporting communication, organization of resources and issue development. Recommendations for continued research spanned finding ways to support simultaneously online PBL and its process management, and design considerations on how to structure the discussion space for promoting meaningful conversation which is critical to success.

**Assessment**

Assessment is an issue that demands special consideration. Constructivist approaches to assessment suggest embedding it in the learning experience and incorporating students as designers of the assessment mechanisms as well. Sage's (2000) findings indicate that educators need to consider individual and group performance in the online environments. Taplin (2000) also brings into consideration the importance of rethinking assessment in the online problem-based learning environment. She suggests further research to investigate effective ways to evidence knowledge construction within this setting.

## Conclusions

Several authors assert that distance learning environments seem more prone to implement constructivist principles (Crumpacker, 2001; Orrill, 2002; Poon et al., 1997). Several benefits are highlighted. Learners from around the world could work together benefiting from their multiple perspectives. Continuous collaborative work could be guaranteed even if some group members are temporarily unavailable for physical

proximity due to job-related or other circumstances. Its resemblance to workplace problem-solving is highlighted by its advocates. Conversely, Taplin (2000) considers divergent opinions about its feasibility. The lack of physical proximity and challenges in student support are reasons proposed by those who do not necessarily support this approach in online learning. The transition from face-to-face to online PBL has been regarded as having "obstacles" (p. 41) that need to be addressed (Orrill, 2002).

Because of the innovation of the combination of distance learning context and problem-based approach, McConnell (2002) asserts that course designers and tutors will need to understand its implications for learning and teaching. This author claims that it is a complex and yet little understood form of distributed learning. Therefore, he makes the case for ongoing research that is "exploratory, descriptive, grounded in real learning situations and contexts, addressing both broad themes and micro issues" (p. 80) to help increase understanding. Sage (2000) briefly explores the possibility of the need for differentiated forms of online PBL tuned to the nature of their contexts. Other authors explore the idea of the need for understanding online learning as it constitutes a different enterprise than its face-to-face counterpart in its very nature (Birnbaum, 2001). A current of educational thinking maintains that not only action but also thought are reshaped by the tools that support interaction (Wertsch, 2002). Communication theory also supports that idea. Computer-mediated communication within online PBL implementations may be such an agent for that transformation. Therefore, continuous research on its relevant design components should constantly inform practice.

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