Developing a problem-based learning simulation: An economics unit on trade

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This article argues that the merger of simulations and problem-based learning (PBL) can enhance both active-learning strategies. Simulations benefit by using a PBL framework to promote student-directed learning and problem-solving skills to explain a simulated dilemma with multiple solutions. PBL benefits because simulations structure the information students receive to focus learning on the intended curriculum and increase the strategy's effectiveness in a wider variety of venues. A combined strategy—a PBL simulation—places its simulation at the forefront of learning and helps students and teachers sift through the overwhelming complexity that can arise in a more pure PBL. The authors illustrate the strength of a PBL simulation with an economics unit on trade, titled THE GREAT AWAKENING.

KEYWORDS: *contextualized learning; economics simulation; problem-based learning; student-directed learning*

Active-learning strategies can often increase student interest in a subject when content is difficult to comprehend or perceived as dry (Keys & Wolfe, 1990; Wolfe, 1985). In such circumstances, simulations, experiments, and games can produce learning gains and increase applied research skills and retention of knowledge.[1] We argue that the merger of two such active-learning strategies—problem-based learning (PBL) and simulations—enhances the pedagogical advantages of both strategies.

PBL can enhance effective simulations by placing them at the forefront of student learning (and not as an enhancement). PBL helps students frame the simulation in a self-directed learning environment and builds students' problem-solving skills as they solve a realistic dilemma with multiple solutions. Unfortunately, the realistic situation posed by PBL can allow students to pursue interests outside curriculum goals. Students lacking motivation to learn the content, teachers without sufficient classroom management skills or content knowledge, and materials not sufficiently grounded in curriculum goals can move learning away from intended curriculum. In such cases, students can research areas of interest and ignore the more challenging pursuit of

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building curriculum-driven knowledge. A simulation can alleviate these potential difficulties with PBL by placing boundaries and structure on its problem by guiding students and teachers through the overwhelming complexity that can accompany a purer PBL strategy.

We illustrate the strength of a PBL simulation with an economics unit on trade, titled THE GREAT AWAKENING. The first section of the article develops the PBL model. The second section develops a PBL simulation and applies the PBL simulation to an economics unit on trade. The final section provides a summary and conclusion.

The PBL model

Like virtually all active-learning pedagogies, PBL is grounded in the belief that learning is enhanced when placed in context. For PBL, the context is a real-world problem. In its purest form, students are placed in an authentic problem before they have developed the knowledge needed to solve the problem posed. The problem presented contains multiple solutions, and students construct the knowledge they need to develop what they consider to be the appropriate solution. The teacher (or tutor) serves as a “guide on the side” and uses questions to coach students toward appropriate resources or tools that can help solve the dilemma (Birch, 1986; Duffy & Savery, 1994; Stepien, Gallagher, & Workman, 1993; Torp & Sage, 1998).

The general PBL model was developed and refined in medical schools (Boud & Feletti, 1997; Schmidt, Lipkin, de Vries, & Greep, 1989). Medical schools are rich with authentic problems and with students and tutors prepared to tackle the challenge of sifting through the overabundance of real-world information that could potentially be used to solve a problem. Although PBL implementation varies even within that context, a generic model can be described as follows:[2]

1. A problem situation, which provides the basis for study, is encountered before any preparation or study has occurred.
2. The problem situation is presented to students in the same manner it would be in the real world. Often students encounter the problem-solving situation within a small group that is guided by a tutor.
3. Students work through the problem in a manner that challenges their ability. The tutor facilitates learning by asking questions and monitoring the learning process.
4. Students continually identify needed areas of learning, which prompts and guides individualized study.
5. Students apply the knowledge and skills learned in Steps 3 and 4 to the problem, evaluate the effectiveness of learning, and reinforce and contextualize their learning.
6. The learning produced during this process is integrated into the student’s existing knowledge base.

This general PBL approach seems to work well in medical schools. In this environment, students are highly motivated to learn both problem solving (the process) and content material delivered by PBL, teachers are knowledgeable about both the subject and practice (i.e., are familiar with the world of medicine), and limits to inquiry are well established by a knowledge base in both students and tutors. For example, medical students may be given basic statistics on a patient complaining of dizziness. Because students are interested in pursuing medicine after school, they will not investigate herbal remedies or psychological explanations of dizziness. More likely, the students' background and interest will keep them focused on medically grounded explanations of dizziness. If students pursue avenues of inquiry astray from a medical diagnosis, the tutor would coach them back on course with questioning (e.g., "What information would you gain from knowing the patient's bone marrow count?"). With PBL, medical students use dizziness to refine their diagnostic abilities through problem solving and to enhance their medical knowledge through research. The tutor's knowledge keeps students on track by coaching them toward medical solutions and problem solving in an authentic environment.

It is less clear that PBL in its purest form is effective in situations in which students and/or teachers are less motivated or knowledgeable about their subject (Maxwell, Bellisimo, & Mergendoller, 2001). For example, an introductory class of economics students led by a 1st-year graduate student teaching assistant may stray far from the economics curriculum using the PBL approach. Neither the student nor the teacher may have the knowledge or interest to sift through the overabundance of information produced in an authentic environment to form a line of inquiry consistent with an economics curriculum. In such cases, PBL's effectiveness may be reduced (Atkinson, Derry, Renkl, & Wortham, 2000), and a simulation can provide boundaries to focus the line of inquiry and maintain PBL's effectiveness.

Structuring a PBL simulation

Economics may typify a subject area in which a simulation can enhance PBL's effectiveness. Because realistic economic phenomena are often complex and may be explained with insights from other disciplines, students and teachers can easily stray from the curriculum's goals. For example, economic forces can explain housing prices, as can social (e.g., racial discrimination) and psychological forces (e.g., sentimental attachment to homes). If students are placed in a real estate market and left to develop a line of inquiry to discover the primary factors underlying a price increase, they may research the neighborhood's demographics (for example). Although a sociology department might be delighted at this line of inquiry, the economics department might look aghast as students ignore economic factors and conclude that prices increased with ethnocentricity and discrimination. Although these areas may be of great interest to novice economics students and social science teachers, they are of less concern to economists.

A PBL simulation can structure the students' inquiry to create critical awareness in a subject and keep students focused on the intended curriculum. In our housing example, a simulation might be constructed to highlight the economic factors that could increase housing prices. Even a teacher whose background and beliefs were grounded in sociological methods or students who were interested in discrimination issues would be hard pressed to stray from economic explanations if the simulation eliminated preferred lines of inquiry (e.g., the community contained only middle-class Latinos).

We use a simulation to structure the PBL approach (Bellisimo & Maxwell, 1998) and increase its applicability in a wider variety of venues. As a summary, Table 1 explicitly links the PBL model with a simulation's structure (columns 1 and 2), simulation guidelines, and curriculum focus. The simulation's structure provides both teachers and students with a more steplike approach to PBL so curriculum goals are met by focusing the line of inquiry.

A simulation can be created that adheres to the PBL model. Within the PBL structure, the simulation is not a pedagogical supplement to a traditional lecture-discussion unit but the primary instructional strategy. Lecture-discussion becomes the supplement. Learning becomes student driven as the simulation creates a "need to know" content knowledge for its execution. PBL's framework, focus on problem solving, and debate of multiple solutions enhance the simulation's pedagogy by placing it at the forefront of constructing knowledge.

Structuring PBL

Using a simulation to structure PBL produces a steplike approach to its problem solving with students and teachers working through the PBL simulation in a systematic manner.

Entry point. Students receive a simulated correspondence or experience (entry document) that grabs their attention and introduces them to the PBL simulation and their role. For example, students in a marketing course might receive a memo from a (fictitious) organization asking them to develop a marketing plan for a proposed child care center, or students in a water resources and management course might receive a phone call asking for assistance in identifying a strange odor emitting from a local stream.

The entry document is tightly seeded with appropriate concepts to focus a student's inquiry on curriculum goals and is presented before introducing new content to the curriculum. In the marketing class, students may be grounded in the principles of marketing but know nothing about developing a marketing plan. The PBL simulation emphasizes the need to know this new material to solve the puzzle, in true PBL fashion.

Framing the problem. Teachers coach students through a questioning process to develop a problem statement using the following model: "How can we, as ?, do ?, so that ?" The problem statement for the marketing course might be "How can we, as marketing specialists, sell the new child care center, so that parents will take advantage of the new service?" The problem statement helps focus students' inquiry and the

TABLE 1: Using a Simulation to Structure Problem-Based Learning (PBL)

PBL Model	*PBL Simulation*	*Structure Added to PBL by Simulation*	*Curriculum Focus Provided by Simulation*
1. A problem situation, the basis for stimulating learning, is encountered before any study has occurred.	A simulated, realistic problem is presented to students to stimulate learning.	Entry point	Seeds curriculum goals with terminology, settings, and parameters. Knowledge of content is created because it is essential to undertaking the simulation.
2. The problem situation is presented to students in the same manner that it would be in the real world. Often students encounter the problem-solving situation within a small group that is guided by a tutor.	Parameters and rules of the simulation are set. Both are grounded in a simulated setting so a definitive outcome cannot be obtained once play is commenced.	Framing the problem	Students place the simulation within the
3. Students work through the problem in a manner that challenges their ability. The tutor facilitates the learning by asking questions and monitoring the learning process.	Students undertake the simulation and encounter difficulties in achieving a solution. The teacher-coach probes thinking toward creative solutions that fall within the simulation's parameters.	Knowledge inventory	Students identify the content knowledge they need to undertake the simulation.
4. Needed areas of learning are identified during the process and are used as a guide to individualized study.	Students see the need to research content related to the curriculum goals because curriculum is germane to doing the simulation.	Research and resources	Students use relevant (economic) materials as guides to successfully undertaking the simulation.
5. The knowledge learned in Steps 3 and 4 are applied to the problem to evaluate the effectiveness of learning and to reinforce and contextualize learning.	New rounds are played with each set of new information. Different and nonunique solutions ultimately are achieved.	Teachable moments, dialogues, background information, and problem logs	Traditional lectures are given and appreciated because students see the need to know the content needed to undertake the simulation.
6. The learning that has occurred through the process is integrated into the student's existing knowledge base.	Learning of subject matter that was gained through the simulation and related study is retained because of its similarity to an authentic situation.	Exit from the problem and wrap-up and debriefing	(a) A paper (for example) ensures that the simulation draws on the curriculum within the parameters outlined. (b) The debriefing corrects content errors and provides a context for the simulation (if played in isolation from curriculum).

teacher's coaching and establishes the simulations' parameters so students are led toward the curriculum goals without providing unique paths or solutions to the simulation.

Knowledge inventory. Teachers lead the class through a discussion and recording of knowledge that students already have (what they know) and information they still need (what they need to know) to solve the simulation's problem. Teachers probe with questioning so students see the relevance of the content contained in the curriculum goals. In our water resources course, the teacher might prompt student thinking with questions such as, "What chemicals might produce the odors described?"

The knowledge inventory is an iterative process that includes identifying needed learning, defining existing knowledge, and acquiring new knowledge to work through the simulation. It is this PBL process combined with the possibility of multiple solutions that moves the simulation toward the forefront of learning.

Research and resources. Tightly structured resources, such as additional correspondence, text, and tables, are provided throughout the simulation. Resources place parameters on the learning and define the rules to guide students toward the array of possible solutions, to probe their thinking, and to extend their line of inquiry as far as possible within the bounds of the curriculum goals. As new resources and information are revealed, students place them within the simulation's framework by responding to the knowledge inventory.

Teachable moments, dialogues, background information, and problem logs. As the PBL simulation unfolds, moments arise when students recognize the need to know material in the curriculum to proceed toward possible solutions to the problem. It is during these moments that more traditional instruction becomes effective and teachers can engage students in dialogues, provide background information, give lectures, or solicit written responses to specific questions in problem logs.[3] Students may be more receptive to lectures or textbook readings because the PBL simulation provides a need to use the information contained in a lecture.

Exit from the problem. Students determine which solution to the simulation they support and prepare a solution as they would for authorities in the field. For example, an individual heading a child care agency (or someone playing this role) may be asked to listen to student presentations of the marketing plan. The individual playing the role of a client in this example must confine questions to the boundaries established by the curriculum.

Wrap-up and debriefing. In a teacher-led discussion involving the whole class, students consider the thinking that went into solving the simulation's problem, including insights and analysis of both content and process. Students discuss the benefits of each competing solution or the challenge of learning content while solving problems, having to make choices, working in groups, or confronting a simulated real-world situation.

A PBL simulation

Economics is a subject ripe for developing more interactive pedagogies to enhance learning. Perhaps because it is a subject whose concepts are often perceived as difficult to grasp, economic educators have called for a more interactive curriculum to enhance learning of and enthusiasm for the subject, both in high school[4] and college. Although economic educators have begun to craft a body of experimental economics[5] for classroom use, we believe a PBL simulation provides an additional active-learning strategy to motivate learning and enhance problem-solving skills in this discipline. We illustrate its strength with a PBL simulation of trade and exchange.

Within economics, the topic of trade and voluntary exchange is often difficult for students and teachers to grasp. Although individuals trade on a daily basis (e.g., time is traded for wages, dollars are traded for food), many students have difficulty identifying their daily activities as voluntary exchanges in which both parties benefit. (Individuals are happier because they trade time for wages and wages for food, and firms make profit because they trade pay for production.)

Even if students can apply these relatively simple principles of trade and exchange to their lives, they struggle with their generalization, perhaps because newspapers often present trade between countries (for example) in a political, military, or regulatory framework. In discussing trade with Mexico, Ross Perot's "giant sucking" sound generated far more attention than did the economic benefits of specializing to reduce costs of production. Of course, it is easier to attract readers with an emotional appeal than with a discussion of such esoteric concepts as division of labor, specialization in production, and comparative and absolute advantages.

It is the difficulty of focusing inquiry on the economic aspects of trade that makes the unit ripe for using a PBL simulation to build economic knowledge. We illustrate this strength with a unit on trade, THE GREAT AWAKENING.

Entry point. The opening of THE GREAT AWAKENING presents students with a video snippet from the (fictitious) president of the Tri-Lateral Trade Consortium, Carlos Medine. The video snippet tells students that the war between the islands of Abbydale and Springfield ended and trade can be established with either island. The video explicitly tells students (a) they are the economic leaders of islands that are enemies (Hatfield or McCoy), (b) they eventually will negotiate a trade agreement with Abbydale or Springfield, and (c) the trade agreement should increase the goods and services available on their island.

This video sets the stage for the PBL simulation by providing a context (island countries), establishing an economic line of inquiry (students are economic leaders), providing a problem situation with multiple solutions (negotiate a trade agreement), and generating a need to know the economic basis for trade (how can trade increase the available goods and services?).

Framing the problem. Students are broken into two groups, the economic leaders of McCoy and the economic leaders of Hatfield. The simulation is structured to keep trading plans secret between the groups (Hatfields hate McCoys), a situation typical of political enemies. Each student group/island develops a problem statement to help focus their inquiry. Although statements differ slightly for each class, they generally resemble, “How can we, as economic leaders of our island, develop a trade agreement, so that we increase the goods available?”

Knowledge inventory. Using the problem statement as a guide, students assess what they know about trade and what they need to know to develop a trade agreement. Because the simulation was presented to students without any knowledge of the economic principles of trade, their knowledge will be largely noneconomic (e.g., we are leaders of an island), whereas the knowledge they identify as needing will be largely economic (e.g., how will we increase the amount of goods and services produced with trade?).

Research and resources. As the PBL simulation proceeds, students receive resources to guide their inquiry toward the economic basis of trade. For example, they are given numbers on the hours of work it takes to produce particular goods on their island and on the two friendly neighboring islands. Students use the numbers to show increases in production that would occur if each island produced only the goods it can make for relatively less and traded for goods that are relatively higher in cost. Students also receive a technical report, ostensibly produced by the fictitious Trade Consortium. This report describes the economic benefits of trade and its economic and noneconomic barriers (e.g., military and political concerns, quotas, and trade-offs). Although the technical report differs little from a textbook, the PBL simulation frames the material in a manner more motivating for student learning. Students need the knowledge to solve the PBL simulation.

Several other resources are sprinkled throughout the simulation to help guide and deepen the students’ understanding of trade and to illustrate its complexities. For example, students watch an infomercial by Ellis McClure, who speaks for the employed workers of the islands and presents students with arguments against trade. Students also see a second video from Carlos Medine, who tells them that Abbydale and Springfield have gone back to war and trade must occur with their political enemy. Through several iterations of the simulation, students learn economics principles of trade and the process of negotiating (a trade agreement).

Teachable moments, dialogues, background information, and problem logs. The principles of trade (comparative and absolute advantage) lie at the heart of a free market economy and are the essential features of negotiating a trade agreement grounded in economics. Although the resources in THE GREAT AWAKENING illustrate these concepts, students still have difficulty mastering their application. Drawing on the PBL pedagogy, simulations frequently are interrupted with more traditional lectures or with independent student research, which helps students internalize the economic background needed to negotiate a trade agreement. In this PBL simulation, much of this material is provided in a technical report that can be augmented with a lecture. Because students must draw on this knowledge to negotiate a trade agreement, the simulation provides students with the motivation for mastering the economic material, which makes them more receptive to a traditional lecture at teachable moments.

Exit from the problem. Once the trade agreement is negotiated, Carlos Medine announces that environmental groups and unions are protesting trade with their political enemy. Students prepare an informational flyer justifying the economic basis of trade as the outcome of THE GREAT AWAKENING. By developing this flyer, students learn how to structure economic arguments to counteract criticisms, an activity that helps solidify their economic knowledge of trade.

Conclusion

The merger of simulations and PBL benefits both active-learning strategies. PBL enhances simulations by placing them at the center of student learning and by expanding their ability to impart problem-solving skills. A simulation enhances PBL's effectiveness in a wider variety of venues by ensuring that resources and processes lead students toward knowledge of desired concepts and principles. As a result, a PBL simulation guides students and teachers through the overwhelming complexity that can arise in a purer PBL, provides incentives to promote student-directed learning, and develops problem-solving skills with dilemmas having multiple solutions. THE GREAT AWAKENING illustrates the strengths of PBL simulations.

PBL simulations change the nature of the learning environment toward a more student-directed learning, unlike simulations developed to enhance traditional lecture-discussion pedagogies. Multiple solutions and realistic constraints on information, time, and resources challenge and frustrate the student because the "right" answer never comes. Students create knowledge as they recognize the need to know complex concepts or principles. PBL simulations also change the instructional environment. No longer is the teacher the "sage on the stage." Teachers are the guides on the side who coach students with questioning and probe them toward more in-depth learning of the curriculum.

In sum, the PBL simulation can become the vehicle that moves simulations toward becoming a complex, thought-provoking, and rich experience that sustain the learning process (Katz, 1999).

Notes

1. See Atkinson, Derry, Renkl, and Wortham (2000); Mergendoller, Maxwell, and Bellisimo (2000); or Ruben (1999).

2. See Barrows (1986a, 1986b) for implementation in medical school and Delisle (1997), Wilkerson and Gijselaers (1996), or Barrows and Tamblyn (1980) for descriptions of generic models.

3. Students record their knowledge or questions in a log as they proceed through the simulation so they can trace their line of inquiry and teachers can uncover difficulties with the process or content.

4. See www.nationalcouncil.org; www.economicsamerica.org; National Council on Economic Education (1995); Schug, Caldwell, Wentworth, Kraig, and Highsmith (1995); or Walstad (1992) for information about economics teaching in high school and Brozik and Zapalska (2000), Gold and Pray (1999), Zapalska and Brozik (1998), Motahar (1994), or Hester (1991) for information about college-level teaching.

5. We use the term *experimental economics* in the lexicography of economists not educators (e.g., Davis & Holt, 1993; Friedman & Sunder, 1994; Kagel & Roth, 1995; Walstad, 1992; Wolfe 1985).

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