

# **Delivering Constructivism through Project Based Learning (PBL)**

James Pelech, Benedictine College

## **Abstract**

An approach to Problem Based Learning (PBL) is analyzed in relationship to constructivism. Because similarities between PBL and constructivism are found consistently, the author suggests that PBL provides an ideal vehicle to apply constructivist theory in classroom practice.

## **Introduction and overview**

For five years I attempted to translate Constructivism into pedagogy. I was somewhat successful, but something was missing. My classes were engaging and followed Constructivist principles, but we were doing so in order to prove an abstract theorem that the students would never apply outside the classroom. If we did an application problem, it did not have the effect that I wanted. The students seemed to be mindlessly applying the principles we learned to a pre-fabricated problem. It was as if they were just applying an algorithm to yet another abstract problem and checking with the teacher to see whether the answer was right. I started to think of what I was required to do when, as a reserve officer, I was activated for eight months.

This reflection led to the following revelation: In real life your boss does not hand you a well-defined problem for which you can easily and directly apply an already established algorithm. In real life you are handed (usually at 4:00 on a Friday before a vacation) a messy, confusing, loosely defined situation, for which you must define the problem and structure the thinking processes in order to create the best possible solution (as opposed to a clear-cut right answer as is presented in academic situations). In the real

world, successful people must use higher order-thinking skills in order take a messy situation and define the problem, construct questions to be answered in order to solve the problem, rank these questions, define the resources to be used, construct possible solutions, debrief the problem, and then start this cycle over again. My previous attempts to implement Constructivism were stifled because they did not represent what really happens in the real world. My implementation of Constructivism was centered on understanding a predetermined, well-defined principle and then applying it to a predetermined, clearly stated problem. This scenario did not empower the students to develop the higher-order thinking skills of defining problems, solutions, and creating a solution for a messy situation. When I read about problem- based learning (PBL), I felt that I found the instrument for translating my Constructivist philosophy into a pedagogy that would result in students demonstrating authentic problem solving skills.

In order to examine and explain how to implement the Constructivist philosophy, we will look at the following:

1. Characteristics of Constructivist Teaching
2. Characteristics and components of PBL
3. An examination of how PBL can deliver Constructivist thinking

### **Characteristics of constructivist teaching**

While there are many versions of the Constructivist framework, I have centered my philosophy and Constructivist teaching practices on the ideas of Brooks & Brooks (199 ) and Vermette (2001). The guidelines for my Constructivist practice follow:

1. Students take initiative and autonomy in the classroom. It is the ideas, hypotheses, and questions of students that drive the classroom.
2. Class curriculum and class activities revolve around the concept of solving an authentic, messy, and ill-defined problem that is not easily solved, and that may have more than one solution.
3. Students not only interact with textbooks, they interact with raw data, primary resources, the teacher, and with each other. Students are often working in teams. This is the norm, not the rule.
4. Communication in the classroom is characterized by discourse. There is constant give and take where phrases such as “What is your take on this?”, “What is your conclusion?”, “What is your prediction?”, “Will you break down what you have just said into smaller pieces?”, “Explain to your partner”. Why don’t you ask your partner?”, and “I want you to create a document that ....”
5. Much of student work is done in pairs.
6. Student thoughts initiate, sustain, and conclude all classes.
7. The role of the teacher and of teacher questions is to guide and coach. Teacher questions, in an open-ended format, are intended to provide opportunities for students to expand on their initial thoughts.
8. The class environment is structured so that they are given many opportunities to create hypotheses, encounter contradictions to these, and then re-construct their beliefs and hypotheses.
9. Student experiences and thoughts spiral through a hierarchy of knowledge. That is, they learn through their senses, create concepts, modify and

synthesize concepts, and then evaluate their learning through metacognitive processes.

### **Characteristics and components of PBL**

As with Constructivism, PBL has many versions and many educators who claim to implement it. There are many definitions and versions of PBL, but there are some features that are constant with all versions of PBL. PBL is pedagogy and a curricular organizer that uses a hands-on, minds-on, experiential approach. It is centered on a messy, ill-defined authentic problem in which the student takes on the role of a person who has ownership of or stake in the problem. Here are some examples. Students work as reporters for a new sports magazine that is lacking in female readership. The editor wants the reporter to write an article entitled, "Will Women Outperform Men in Athletics?" In my college algebra class we used data collection and linear regression to do this. In a composition class students act as a consultant to a warden who is concerned with recidivism among woman prisoners. The warden wants to know why these women do not succeed in the outside world. He wants to know what kind of communication skills these women will need. The warden has commissioned the consultant to design a program to address these needs. In each case, PBL presents the situation first, and that situation is messy, cloudy, and ill defined. The students then construct the problem definition and then construct the questions to be asked in order to solve the problem. In other words, students face the problem first, create/construct a definition of the problem, and then start the process of solving the problem.

The model that I use comes from Torp & Sage (2002), and I learned the implementation of this model from Deb Gerdes of the Illinois Math and Science Academy. The following discussion illustrates the implementation of this model and how it delivers

Constructivism

### **1. Meet the problem**

In this phase students are presented with the problem, but are given the opportunity to take a personal stake in it. Students assume a role other than that of the student. Let's look at an example. In my College Algebra class students work as reporters for a new sports magazine that is lacking in female readership. The editor wants the reporter to write an article entitled, "Will Women Outperform Men in Athletics?'. I create an "official" letter (to include "official" letterhead) from the Editor of "*Big Time Sports Magazine*" in which I explain that our research indicates that female readership has steadily declined. A partial solution to this problem is an article that will be attractive to the female population. The reporter (the students) is to write an article entitled "Will Women Outperform Men?"

In this situation students are given the opportunity to take initiative in order to solve an ill-defined and messy problem. This is in accordance with Constructivist practices one, two, and five that were presented in previous paragraphs.

## **2. Identify what we know and what we need to know; rank our ideas**

This phase enables students to create a deeper understanding of the problem. The teacher coaches students to articulate what is know, and what knowledge must be created so the problem can be solved. In my class I use chart paper, and I divide it into columns. One column is labeled “know”, another is labeled “need to know”, and the last is labeled “ideas”.

In our example of the reporter students state that they know that they must write a magazine article on whether women will outperform. The “need to know” column presents some nice challenges. Students discuss whether women will surpass men in athletics. They also discuss how to find this out. Initially, in my class, students looked at ideas such as comparing trends of attendance at male/female sporting events, and discussions on the types of activities where women now outperform men. There was also discussion on whether there are sporting events in which women may eventually surpass men. An overriding question was “how do we know that this will actually happen or continue to happen?” With some coaching from me, students also discussed what was the reading and mathematical level of the average person who reads *Big Time Sports Magazine*. There also was discussion on where one could find the required information (this included people to interview). This was put under “ideas”.

This activity clearly drives Constructivism. Looking at our Constructivist practices, this phase of PBL fits with practices one, two, four, five, and six. The “Know, Need to Know, Ideas” phase of PBL truly is Constructivist. Students are confronted with an ill-defined problem, assume autonomy by generating the “knows” and “needs to know” through discussion and discourse. These activities drive the class, which is in contrast to many of the practices in the traditional classroom.

### **3. Define the problem statement**

This phase of the PBL process enables students to articulate through the spoken and written word the overriding issue. In our example the overriding issue was whether women will actually outperform men in athletics. In our model we use this prompt: “How can we.....in such a way that.....” So, in our example, the initial Problem Statement would be: “How can we determine whether women will be able to outperform men in athletics?” this statement makes clear the deep and overriding issue of how does one determine the improvement of women as compared to men in athletics.

In my experience with PBL and Constructivism principles five, six, and seven dominate this phase of the learning process. Students initiate and sustain discussion by discussing the overriding issue, which can be considered a hypothesis.

#### **4. Gather and share information**

In this phase our reporters (students) are now gathering data to help determine the answer to whether women will become better athletes than men. In this example I supplied students with almanacs. Why almanacs? Because almanacs contain charts and statistics on Olympics events, my class studied these statistics and charts and came to the conclusion that women may outperform men in certain events, but not all events. In this case, through much class discussion my class decided to look at the 100m dash. Through coaching we decided to graph the times for men and women in this event at the Olympics. Through more coaching and class discussion we discussed the concept of the “best-fit” line. This led to a re-defining of the Problem Statement. In this class the re-definition became: “How can we use the equation and graphs of straight lines to determine when women will be better than men in the 100m dash?”

This new Problem Statement naturally led to some class instruction of determining the equation of a straight line and determining the point of intersection of two lines. In this class there was a great deal of interest in which method would be the most accurate for finding the point of intersection. In gathering and sharing information, students engage in Constructivist practices seven and eight. By re-defining the Problem Statement they re-construct their beliefs, and create another hypothesis.

By applying the concept of the equation of a straight line to Olympic records, they are creating, modifying, and synthesizing concepts.

### **5. Generate possible solutions**

While working in teams students determine the year in which women will initially surpass men (or be equal to) in the 100 m dash. They then must determine how to write about this in a magazine article. Here the students must again re-define the Problem Statement (or some may say that they are creating another one). This statement becomes: “How can we write about using math to determine when women will surpass men in the 100 m dash so that the average magazine reader can understand it?”

Constructivist practice eight dominates this part of the process. Students are synthesizing algebraic concepts with writing about it in magazine article form. Since this is an authentic product, practice two also is prevalent.

### **6. Determine the best solution**

For our situation, I encouraged students to share their answer (the year when women will bypass men in the 100 m dash) and their magazine article. By doing this students can examine different ways of presenting and writing about their solution. In my class many student groups

revamped their articles based on what they saw other student groups do. This is in alignment with practices five, six, seven, and eight.

### **7. Present the solution**

This is usually done in front of the whole class. Student groups are given a set amount of time to present their findings and discuss the magazine format that they used. They then hand them in to me.

### **8. Debrief the problem**

This is a great exercise in metacognition (Constructivist practice 8). I have done this through a whole class discussion, reflections or a combination of both. Students think about what they learned, and how they learn best. In my experience they discuss what they are still unsure of, or what they still want to learn. This is important because students want to have a feeling of completion. In my math classes we discuss how this PBL answers the question so often heard in the classroom: “When are we going to use this stuff?”

## **Research and the effectiveness of PBL**

PBL is not only a platform for delivering the Constructivist philosophy, it is an instrument for delivering effective pedagogy. While anecdotal evidence indicates that PBL is supported by students, parents, teachers, and administrators alike, formal research also provides evidence that PBL is effective as a curricular organizer and as pedagogy.

The effectiveness of PBL at all levels of learners has been documented. A meta-analysis type review of English-language international literature from 1972-1992 indicate the effectiveness of PBL (Albanese & Mitchell, 1993). This meta analysis indicates that medical students trained by PBL do as well or better than students trained by traditional methods in the areas of faculty evaluations and on clinical examinations. In a study that attempted to synthesize all available evaluative research from 1970 through 1992, Vernon & Blake (1992) conducted five separate meta-analyses on 35 studies representing 19 institutions. This study found PBL to be significantly more effective with respect to student perspectives of program evaluation and with respect to student clinical performances.

Community college leaders, in a year-long community college leadership academy, indicate their support for PBL (Herron & Major, 2004). The respondents indicated their belief that PBL is an effective method of instruction that helps them develop in the areas of leadership, collaborative skills, and research.

PBL effectiveness as an instructional technique has been documented at the secondary level. Gallagher, Stepien, and Rosenthal (1992) conducted a study that compared high school students taught by PBL with students taught by another method. They wanted to determine changes in student use of spontaneous use of problem-solving steps. The results showed significant changes for the PBL group that were not observed in the other group. Sungur and Tekkaya (2006) examined the effects of PBL on tenth-grade

biology students. The study showed that PBL students had higher levels of intrinsic goal orientation, task value, critical thinking, and self-regulation. Dodds (1997) compared classes at the Illinois Math and Science Academy taught by lecture with classes taught by PBL. While the lecture method widened content knowledge, PBL increased understanding and retention.

Gordon, Rogers, & Comfort (2001) examined how PBL can effect middle-school students. Overall, PBL increased science learning and even improved behavior. Given the fact that PBL represented only two percent of the curriculum time, this is a surprising outcome.

Newman, Bryk, & Nagaoka conducted a study that has implications for educators looking for research on the effectiveness of PBL. Their report, published by the Consortium on Chicago School Research, looked at the effect of authentic intellectual work on standardized test scores. Their study asked the following: *What happens to students' scores on standardized tests of basic skills when urban teachers in disadvantaged schools assign work that demands complex thinking and elaborated communication about issues in students' lives?* The phrases “complex thinking” and “elaborated communication” are phrases that can be used to describe PBL activities. In the report they discuss how interactive instruction asks students to formulate problems, organize their experiences in new ways to solve problems, and to test their ideas with other students. They then summarize the characteristics of authentic intellectual work as “**construction of knowledge**, through the use of **disciplined inquiry**, to produce

discourse, products, or performances that have **value beyond school**. Again, this certainly aligns with PBL. The results convincingly show that students who were exposed to authentic intellectual activities scored higher on standardized tests than students who were exposed to low-quality assignments.

### Summary

While Constructivism is a philosophy of how one learns, it is very crucial to have a delivery instrument that consolidates many of the Constructivist practices that have been known to successfully help students create knowledge. PBL is such an instrument. Not only does PBL enable teachers to deliver the Constructivist philosophy, research has documented its effectiveness.

### References

- Albanese, M.A. & Mitchell, S. (1993). Problem-based learning. *Academic Medicine*, 68(3), 52-81.
- Brooks, J. & Brooks, M. (1993). *In search of understanding: The case for constructivist classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Dods, R.F. (1997). An action research study of the effectiveness of problem-based learning in promoting the acquisition and retention of knowledge. *Journal for the Education of the Gifted*, 20(4), 423-431.
- Gallagher, S.A., Stepien, W.J. & Rosenthal, H. (1992). The effects of problem-based learning on problem solving. *Gifted Child Quarterly*, 36(4), 195-200.
- Gordon, P.R., Rogers, A.M. & Comfort, A.M. A taste of problem-based learning increases achievement of urban minority middle-school students. *Educational Horizons*, 79(4), 171-175.

- Herron, J.F. & Major, C.H. (2004). Community college leaders' attitudes toward problem-based learning as a method for teaching leadership. *Community College Journal of Research and Practice*, 28, 805-821.
- Sungur, S. & Tekkaya, C. (2006). Effects of problem-based learning and traditional instruction on self-regulated learning. *The Journal of Educational Research*, 98(5), 307-317.
- Torp, L., & Sage, S. (2002). *Problems as possibilities: Problem-based learning for K-12 education* (2<sup>nd</sup> ed.). Alexandria, VA: Association for Supervision and Curriculum Development
- Vernon, D.T.& Blake, R.L. (1993). ). Does problem-based learning work? A meta-analysis of evaluative research. *Academic Medicine*, 68(7), 550-563.