EFFECTS AND CHALLENGES OF PROJECT-BASED LEARNING: A REVIEW

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Abstract

Parents, politicians, business leaders, and educators are in agreement that change is needed in the American public school system, but what and how to change is not easily resolved (Albion & Gibson, 2000; Elam, Rose, & Gallup, 1994; Sage, 2000; Smith, 1995). Instructional methods have been of interest to educators for years. The system continues to look for ways to improve education and develop students with higher-order thinking skills. Advocates of the project approach to education suggest that project-based learning has the potential to build intrinsic motivation and provide opportunities to apply skills. Project-based learning can also increase self-esteem, enhance social skills and provide an environment for all children to experience success at some level (Katz, 1994; Wolk, 1994).

Although researchers suggest that PBL enhances the curriculum and enriches the students educational experience this inquiry learning approach failed to reach widespread acceptance. This paper describes the effect project-based learning has on student learning and provides recommendation of implementing this instructional approach.

Introduction and Statement of the Problem

Grant (2002) states as far back as the early 1900s, John Dewey supported “learning by doing”. He emphasized hands-on learning, and opposed authoritarian methods in teaching. His ideas prompted a drastic change in United States education beginning in the 20th century. This sentiment is also reflected in constructivism and constructionism. Jean Piaget, constructivism theorist, suggests that learners construct knowledge and in fact, describes how learning happens. Constructivism (Perkins, 1991; Piaget, 1969; Vygotsky, 1978) explains that individuals construct knowledge through interactions with their environment, and each individual's knowledge construction is different. By conducting investigations, conversations or activities, an individual is learning by constructing new knowledge by building on their current knowledge.

Thomas (2000) conducted a comprehensive review of PBL research and found that there is some evidence that PBL, in comparison to other instructional methods, has value for enhancing the quality of students' learning in subject matter areas, leading to the tentative claim that learning higher-level cognitive skills via PBL is associated with increased capability on the part of students for applying those learning’s in novel, problem-solving contexts. Researchers have largely supported the impact Project-Based Instruction has on engaging students in an enriching educational experience that allows the students to have ownership over their learning. Researchers claim that studies using PBL instructional techniques boost student motivation to learn and retain knowledge. There is also ample evidence that PBL is an effective method for teaching students complex processes and procedures such as planning, communicating, problem solving, and decision making, although the studies that demonstrate these findings do not include

comparison groups taught by competing methods. Even though the research claims are overwhelming supportive of its effects on student learning, PBL has not been widely implemented. This paper examines PBL, its effects on student learning and the reasons why it has not been widely implemented.

Research Question(s):

The purpose of this paper is to describe the effects of PBL on student learning and make recommendations regarding implementing PBL. Two key questions emerge. What effect does project-based learning have on student learning? What are the challenges of implementation?

Chapter II: Review of Literature

Defining Project-Based Instruction

Research on Project-Based Learning (PBL) continues to develop further as more researchers study PBL the definition is also somewhat emergent. Recent definitions of PBL include that projects are complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations (Jones, Rasmussen, & Moffitt, 1997; Thomas, Mergendoller, & Michaelson,1999).

Thomas (2000, p.1) suggests five criteria for characterizing PBL which he used to choose the literature he reviewed:

1) Centrality: PBL projects are central to the curriculum.
2) Driving Question: PBL focuses on questions centered on a theme.
3) Constructive Investigations: Central activities involve construction of knowledge by students.
4) Autonomy: Projects are student driven to a significant degree.
5) Realism: Projects are authentic, not school-like.

Thomas states that there are at least three traditions from which PBL research and practice seem to emerge: (1) Outward Bound wilderness expeditions, (2) postsecondary models of "problem based" learning, and (3) university-based research in cognition and cognitive science applications. Thomas suggested that the findings that may be of interest to practitioners are those reported by Boaler (1997) on the effects of PBL on the quality of students' subject matter knowledge, by University of Michigan researchers and others (e.g., Marx et al., 1997) on the

challenges faced by teachers and students during PBL implementation, and by the Cognitive and Technology Group of Vanderbilt and others (e.g., Barron et al., 1998) on the effects of "procedural facilitation" interventions on students' skill acquisition in PBL.

Project-Based vs. Traditional Instruction

Both traditional and project-based instruction may have the same course goals, objective, and outcomes. Both have the same dilemma of getting students to learn the "need to know material" in a restricted time frame. Yet, there are several ways to distinguish between the difference between Traditional Instruction and PBL.

(Chart information by Ziegenfuss, D.)

Traditional	PBL
Teacher-Centered and teacher responsible for the learning	**Student-centered, students help each other and teacher just facilitates the learning**
Transmitting knowledge to a group	**Constructing of individual knowledge**
Focuses on memorization of material	**Focuses on understanding of content**
Surface learning (a little about a lot of concepts)	**Deep Learning (through understanding of main concepts)**
Learning out of context	**Authentic learning in context**
Individual learning	**Group Learning**
Traditional Assessment	**Performance-based assessment**

PBL is generally less structured than traditional, teacher-led classroom activities; in a project-based class, students often must organize their own work and manage their own time. Within the project based learning framework students collaborate, working together to make sense of what is going on. Project-based instruction differs from inquiry-based activity by its emphasis on collaborative learning. Additionally, project-based instruction differs from traditional inquiry by its emphasis on students' own artifact construction to represent what is being learned.

What role do teachers play in creating barriers to project-based instruction? Teachers are central to education reform and in a position to directly impact student learning (Johnson 2000, Johnson 2006; Snow-Geronon, 2005). Teachers tend to drift toward passive instructional methods due to pressure to cover increased amounts of content minimizing students' opportunities to critically think. Education is in a state of accountability, with the passing of the No Child Left Behind Act in 2002. Teachers spend a great deal of time focusing on preparing students to pass the state standardized tests. Schools that don't are subject to a loss of federal funding, sanctions and other methods of accountability. The problem with teaching to the test is that the standardized tests do not measure meaningful learning and this instructional method fills students with information full of standards instead of rationale creating students that learn for the test. When students engage in PBL they are learning less information yet more meaningful information that they will retain longer and will help students construct knowledge.

Theoretical Foundation

Project-based learning is based on the constructivist learning theory, which finds that learning is deeper and more meaningful when students are involved in constructing their own knowledge.

Constructivism is a theory based on observation and scientific study about how people learn. People construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences (Perkins, 1991; Piaget, 1969; Vygotsky, 1978). When we encounter something new, we have to connect it with our previous ideas and experiences, it may change what we currently know and believe. As we acquire new information we need to continue to ask questions, explore, and assess what we currently know.

Dewey rejected schools that focused on repetitive, rote memorization. He believed education was based in real experience. He wrote, "If you have doubts about how learning happens, engage in sustained inquiry: study, ponder, consider alternative possibilities and arrive at your belief grounded in evidence." Inquiry is an essential element of constructivist learning. Inquiry finds it roots in the writing of John Dewey who portrayed education as a social process integrating student's interests with societal interests. Rodgers (2002) analyzed Dewey's educational writings in which he defined education in terms of how one thinks and wrote extensively about reflection. Reflection helps create meaning between knowledge and experience. According to Dewey, reflection requires meticulous thinking that helps move students past curiosity and confusion. This process takes time and develops with the interactions and experiences of the learner. To broaden the scope of understanding the learner must look within their own knowledge, connect to the new knowledge and the resources that are available

to them to create meaning. According to Dewey, reflection does not end in deep understand yet it brings a testing of ideas and an avenue to new experiences, making experiment and experience synonymous (Rodgers 2002).

Inquiry Dewey believes is also a social process requiring constant collaboration between students and teacher. This is necessary to keep student to keep students engaged and active in their search for knowledge. When students take ownership over their learning by collecting and interpreting information this moves from a teacher-directed to a collaborative learning environment (Crawford, 2000; Haury, 1993). When students work cooperatively with each other they urge each other to look deeper into the topic of interest by questioning and challenging (Nowell, 1992). Therefore, inquiry is constructivist as it requires students to construct and reconstruct meaning between their own ideas and beliefs and that of which was observed. Philosopher D.C. Phillips was cited by Perkins(1999) when he summarized the link between inquiry and constructivism when he defined constructivism through the learner in three ways. The active learner discusses, debates, and takes viewpoints. The social learner builds knowledge and understanding with others. The creative learner creates and/or recreates personal knowledge with the teacher guiding in the discovery of theories and perspectives.

Vygotsky introduced the social aspect of learning into constructivism. He defined the "zone of proximal learning," according to which students solve problems beyond their actual developmental level (within their level of potential development) under adult guidance or in collaboration with more capable peers.

Constructivism takes the notion of individuals constructing knowledge one step further. Constructivism (Harel & Papert, 1991; Kafai & Resnick, 1996) posits that individuals learn best when they are constructing an artifact that can be shared with others and reflected upon, such as

plays, poems, pie charts or toothpick bridges. Another important element to constructivism is that the artifacts must be personally meaningful, where individuals are most likely to become engaged in learning. By focusing on the individual learner, project-based learning strives for "considerable individualization of curriculum, instruction and assessment-in other words, the project is learner centered"
(Moursund, 1998, p.4).

Cognitive Constructivism (Piaget)	Social Constructivism (Vygotsky)
The mind is in the head; focus on "cognitive reorganization"	The mind is in social transactions and emerges from acculturation into a community of practice
Raw Materials; uses primary data,"manipulatives," or other interactive materials	Authentic problems; learning environments reflect real-world complexities
Student Autonomy; thinking and learning responsibility in students' hands to foster ownership	Team choices and common interests; builds on common interests and experiences within a learning group, and gives some choice to that group; learning activities are "relevant, meaningful, and both product and process oriented"
Meaningful and personal motivation; learning related to personal ideas and experiences	Social dialogue and elaboration; uses activities with multiple solutions, uncertainty, novelty, etc, demanding

	dialogue, idea sharing, etc.; encourages student elaboration/justification for their responses through discussion, questioning, group presentations
Conceptual organization and concept framing; information organized around concepts, problems, questions, themes, interrelationships; activities framed within thinking-related terminology	Group processing and reflection; encourages group processing of experiences
Prior knowledge and misconceptions builds on prior knowledge and addresses misconceptions	Teacher explanations, support and demonstrations; demonstrates problem steps and provides hints, prompts, cues, and clarifications where requested
Questioning; promotes individual inquiry with open-ended questions; encourages question-asking behavior	Multiple viewpoints; fosters multiple ways of understanding A problem; builds in audiences beyond the instructor

Chart by: Parks, Jee http://ldt.stanford.edu/~jeepark/jeepark+portfolio/PBL/theory.htm

According to The National Foundation for the Improvement of Education:

Inquiry-based learning, or discovery-based learning, often calls on students to generate and test their own hypotheses. The emphasis may be on discovering specific facts or on developing a higher-order understanding of the topic and ideas being explored. Students are encouraged to develop curiosity as a habit and to approach all learning with a disposition toward questioning and systematic investigation. Project-based learning often makes use of inquiry-based teaching methods. Research indicates that hands-on, inquiry-based instruction is generally more effective than traditional didactic presentation in improving students' problem-solving abilities in particular subject domains (Helgeson 1992).

Cooperative learning and collaborative problem solving frequently engage teams of students as they work to complete a project. Cooperative learning has been shown to be effective in improving academic and social skills; however, successful cooperative learning requires teachers to organize carefully and, in some cases, to give students explicit training in collaboration and communication (Johnson 1986; Johnson and Johnson 1989). Project-based learning provides an authentic environment in which students can become more skillful at learning and solving problems through collaboration.

Effectiveness

Research on the impact and effectiveness of teaching and learning through projects has been conducted in a wide variety of contexts ranging from early childhood education to post-graduate and adult education settings. In general it can be argued that project-based learning fairs as well and often better than other methods in producing content specific skills and understandings (Boaler, 1997; Expeditionary Learning Outward Bound, 1997; Ross, 1999). When effectively implemented, PBL showed substantial gains in students' ability to use problem-solving and higher level thinking skills (Barron, Swartz, Vye, Moore, Petrosino, Zech, & Bransford, 1998; Schauble, Glaser, Duschl, Schultz, & John, 1995). There is also evidence of unintended consequences associated with PBL including, but not limited to, enhanced teacher professionalism and improved attitudes towards learning by students (Barron, et al., 1998; Buck Institute, 1999; Thomas, 2000).

One of the most extensive research projects was launched by Outward Bound (OB) USA in 1992, The Expeditionary Learning Outward Bound Project (ELOB), a three-year project, funded on a grant from the New American Schools Development Corporation as part of its mission to transform American schooling. A total of 10 schools participated in the ELOB initiative for two years: four elementary; one middle; one K-8; one 6-12; one K-12; one regional vocational center; and one alternative high school. These schools were located in Boston, Denver, Dubuque, New York City, and Portland, Maine. Among these were inner-city schools with predominantly poor populations, as well as schools with more diverse racial/ethnic and socioeconomic mixes.

ELOB's major goal was to develop new schools or transform existing ones into centers of "expeditionary learning," where learning would take place through participation in expeditions. Expeditions are "journeys into the unknown," in which teachers act as expedition guides and students explore questions of importance and meaning, while developing their "curiosity, skills, knowledge, and courage." Evaluation strategies included surveys of teachers and students, interviews of school and district staff, student focus groups, site visits, and case studies of participating students. Research findings report of significant improvement in students' academic test, school climate, student motivation, attendance, standardized test scores, social and academic growth, and structured changes in schools.

In early 2008, a study was conducted by Akins, Durham, Smit, and VanDenend, at Park Elementary School of Hudsonville Public Schools, comparing the effectiveness of PBL to traditional instructional approaches in developing fourth grade students' scientific knowledge of simple machines. Two fourth grade classrooms from Hudsonville were used to perform this investigation, one classroom used PBL as their instructional method and the other fourth grade classroom was used as the control. Researchers collected summative pretest prior to starting any discussion to assess students' current knowledge of simple machines. Both qualitative and quantitative measures were used. Students were given exit cards throughout the project to monitor students' satisfaction and to learn students' understanding of concepts and vocabulary. Students were asked to answer journal questions regarding their simple machines and worked in groups on a variety of tasks working to enable them to construct a compound machine as their final project. The results supported that students learning curriculum in the PBL format demonstrated higher performance than the students taught in the traditional setting. Project Based Learning is more successful in meeting the needs of high and low ability students by

allowing children the opportunity of more hands on involvement, and to work through the project at their own pace. The PBL unit allows the students to take ownership of their work, thereby increasing the students' drive to learn. Data also supports a greater depth and breadth of knowledge as they collaborate with peers in a quest for knowledge of realistic problems. Overall, PBL was found to be a more effective instructional approach for teaching simple machines than traditional lecture/discussion. Additional analysis provided evidence that PBL was more successful in meeting the needs of high and low ability students.

In a study conducted in early 2008 conducted at Park Elementary School of Hudsonville Public Schools, compared the effectiveness of PBL to traditional instructional approaches in developing fourth grade students' scientific knowledge of simple machines. The results supported that students learning curriculum in the PBL format demonstrated higher performance than the students taught in the traditional setting. Project Based Learning is more successful in meeting the needs of high and low ability students by allowing children the opportunity of more hands on involvement, and to work through the project at their own pace. The PBL unit allows the students to take ownership of their work, thereby increasing the students' drive to learn. Data also supports a greater depth and breadth of knowledge as they collaborate with peers in a quest for knowledge of realistic problems. Recommendations after completing the PBL project would include a continuation of developing units for further study.

A recent study, conducted by SRI International, reports on a five-year evaluation of the Challenge 2000 Multimedia Project in California's Silicon Valley. Students who had taken part in the Multimedia Project outperformed comparison students on all three measures associated with the brochure task: content mastery, sensitivity to the audience, and coherent design (integrating multiple graphical and textual elements). However, students in the Multimedia

Project made the same progress as did students in the comparison classes on standardized tests of basic skills.

In 1997, Jo Boaler conducted a three year study in two British secondary schools. Boaler used one study that used open-ended projects and one that used more traditional, direct instruction. He found striking differences in understanding and standardized achievement data in mathematics. Boaler found that students at the project-based school did better than those at the more traditional school both on math problems requiring analytical or conceptual thought and on those considered rote, requiring memory of a rule or formula. Three times as many students at the project-based school received the top grade achievable on the national examination in math. This study had several features that made this study credible study of PBL. The test was over the duration of three years documenting multiple measures of growth throughout the study using a variety of instruments to assess students' attitude, capabilities, and achievement.

In Hong Kong, Chan (1992) and Chik (1995) examined the contributions and limitations of PBL from the teachers' perspective. PBL is considered to be an effective educational technique for enhancing the student's ability in analysis and in problem-solving (Chan, 1992). And students had a greater ownership over their own learning instead of deriving from a transmission model of teaching.

Fok and Cheung (2001) stated that the roles of PBL are to provide means for stimulating student's discovery through trial and error. It is concluded from this study that PBL seems to be equivalent or slightly better than other instructional models for increasing general academic achievements and for developing lower-level cognitive skills in traditional subject areas. PBL, in comparison to traditional instructional methods, has value for enhancing the quality of

students' learning in subject areas, improving students' abilities to become independent learners, and building problem-solving skills.

Zhou Yuxia and Lee Fong-Lok, both education faculties, at the Chinese University in Hong Kong conducted a study titled *Incorporating Project-Based Learning in Daily Instruction: Has Self-Direction Changed?* at Guangzhou University. Yuxia and Fong-Lok's study focused on one hundred sophomores majoring computer science and one teacher. The age of students ranges from 17 to 20 years old. Ten percent of the participants were female, and the mean age was 18.7 (SD = 1.1). Subjects were informed that they can choose to quit anytime. Yuxia and Fong-Lok reported that teachers at Guangzhou University have an average level of teaching experience according to peers and students evaluation.

Using a pre and post test researchers measured the gains between the 50 students in the experimental group with the 50 students in the comparison group that did not participate in PBL course along with questionnaires and a semi-conducted interview were used as tools to assess their findings. The purpose of this study was to investigate the improved self-direction readiness of both groups and factors of self-direction (SD), and the latter for deeply investigating the attitude of experimental subjects toward Project-Based Learning (PBL).

This study, integrating qualitative with quantitative methods, was conducted to explore the differences between Project-Based Learning and traditional instruction from self-direction aspect and change of the factors of self-direction after PBL. This study focused on the students' performance on a pre and post test.

Forty-nine questionnaires from the experiment group showed an improved average score of self-direction at 5.3, SD at 3.7. Oppositely, 47 students in the comparison group handed in their questionnaires and improved average score of self-direction is 4.3 and SD 2.8. The span in

SD change of the experimental group is broader than that of comparison group, because four learners' scores of SD in experimental group have declined after PBL, two more than that of comparison group, at the same time, there are approximately 65% students of the experimental group having gained progress over five scores, 19% more than the comparison one that holds only 46%. In the area of highest score there are more people in experimental group than in comparison group. So, on the part of change scope, the experimental group is larger than comparison group.

Yuxia and Fong-Lok conclude that according to the interviews with subjects, responsibility for one's own learning and self-confidence are obviously enhanced after PBL and most students are more interested in PBL than traditional instruction model. It is also concluded that from the aspect of individual communication, the subjects experienced the happiness of exchanging information with others in order to solve common problems rather than private matters. What's more, they improve the skills for deeply communicating with others. In regard to projects, there are more chances for subjects to learn to design the frame of developing a project, analyze and solve a series of problems in the context of PBL than in traditional instruction. Yuxia and Fong-Lok observed and concluded from the aspect of learning, it seems that the teachers built up self-confidence and grasped some self-learning skills, such as developing a learning plan, arranging related resources, and overcoming difficulties, etc. It was stated that half or more of the subjects had more positive attitudes to learning.

The above studies of effectiveness of PBL are mostly related with the perspective of achievements and problem-solving skills, and slightly associated with social and emotional perspective, such as attitude toward future learning, self-reliance and collaborative skills.

Challenges

The challenges associated with implementation of PBL describe the processes of planning and enacting project-based learning. The bulk of the work in this realm has come from the University of Michigan (Blumenfeld, Soloway, Marx, Krajcik, Guizdal & Palincsar 1991; Blumenfeld, Krajcik, Marx & Soloway, 1994; Krajcik, Blumenfeld, Marx & Soloway, 1994; Krajcik, Blumenfeld, Marx, Bass, Fredricks & Soloway, 1998; Marx, Blumenfeld, Krajcik, Blunk, Crawford, Kelley & Meyer 1994; Marx, Blumenfeld, Krajcik & Soloway, 1997). In general, these studies conclude that both students and teachers face a much more complex set of challenges in PBL experiences not associated with the application of more prescriptive lessons.

The impediments faced by students were: (a) generating meaningful questions, (b) managing complexity and time (c) transforming data, and (d) developing logical rational to support decisions. Krajcik et al. (1998) and Marx et al. (1997) describe the following difficulties encountered by teachers:

1) Time: PBL investigative projects as such require more planning time and classroom time than typical lessons on both long term and daily bases.
2) Classroom Management: Teachers must balance student autonomy with order.
3) Subject Depth: Teachers need to focus on a driving question and link concepts and diverse activities, helping the students to construct their own knowledge rather than didactically teach single subjects.
4) Assessment: PBL requires alternative forms of evaluating the student's knowledge.

In order to effectively overcome these complexities, teachers must make profound changes in the way they teach. Krajcik et al. (1994) summarize their findings this way:

> "The cognitively based approaches that project-based science represents require substantial changes in classroom practices of teachers and students that are not easy to achieve" (p. 489). Similarly, Barron et al. (1998), in studying the hurdles to implementing project-based learning, concluded that PBL curricula "require simultaneous changes in curriculum, instruction, and assessment practices, changes that are often foreign to the students as well as the teachers" (p. 271).

A primary criticism of project work is that it often leads to doing for the sake of doing. Project work is popular with both students and teachers and given that typical classroom initiatives are grass roots efforts unguided by research or theory this is a likely result (Thomas, 2000). Unless challenged to do so by the conditions of the project it is unlikely that students will learn new skills or processes. Over a several year period teachers and researchers of the Learning Technology Center at Vanderbilt University planned and evaluated project-based approaches (Barron et al., 1998). They explored "whether it is possible to deepen student's understanding without dampening their enthusiasm" (p. 273). The research team outlined four principles of design critical to successfully "achieving doing with understanding rather than doing for the sake of doing" (Barron et al., 1998, p. 273). These principles are:

1. Learning-appropriate Goals: Proposing driving questions or framing the project with criteria that foster deep understanding.
2. Scaffolds that support both student and teacher learning-preparing learners to solve a problem on their own; scaffolds include procedural skills, inquiry skills, developing mental models, and directing attention to essential aspects of the problem.

3. Frequent opportunity for formative self-assessment and revision; reflection by both students and teachers throughout the project helps monitor progress towards goals and allows one to redirect efforts if needed.
4. Social organizations that promote participation and result in a sense of agency; establishing norms of peer interaction and individual accountability; sharing efforts with audiences beyond the classroom.

According to Blumenfeld, Soloway, Marx, Krajcik, Guzdial, and Palincsar (1991), previous attempts at hands-on and discovery learning curricula failed to reach widespread acceptance because developers did not base their programs on "the complex nature of student motivation and knowledge required to engage in cognitively difficult work," nor did they give sufficient attention to students' point of view. Other authors mention authenticity, constructivism, and the importance of learning "new basic skills" in attempting to describe the difference between PBL and prior models that involved projects (Diehl et al., 1999).

Comparing a past study with, (Marx, Blumenfeld, Krajcik, Blunk, Crawford, Kelly, & Meyer, 1991), a more recent summary of their research (Marx, Blumenfeld, Krajcik, & Soloway, 1997) the University of Michigan research team describes the common problems faced by teachers as they attempt to enact Project Based Science. These problems have to do with time, classroom management, and control, support of student learning, technology use, and assessment. For example, teachers report difficulties associated with striking a balance between the need to maintain order in the classroom and the need to allow students to work on their own (Marx et. al., 1997).

Edelson et al. (1999) describe a number of practical constraints associated with the organization of schools that interfere with successful inquiry. These factors include fixed and inadequate resources, inflexible schedules, and incompatible technology. To this list, Blumenfeld, Krajcik, Marx, & Soloway (1994) add class size and composition, and district curricular policy as restrictions that interfered with enactment of Project-Based Learning. School factors were the prime impediment reported by Hertzog (1994) in a summary of how well Project-Based Learning was operationalized in an elementary school setting. According to Hertzog, the physical organization of the school, limitations on time available for learning, and the perceived need on the part of teachers to structure time in order to cover all academic subjects tend to interfere with the effectiveness of Project-Based Learning for integrating subject matter areas and providing for in-depth learning.

PBL is especially effective when supported by educational technology (Blumenfeld et al., 1991; Means & Olson, 1997; Coley, Cradler, & Engel, 1996). Evaluations of K-12 instructional have shown strong evidence of learning gains associated with PBL plus technology (Ryser, Beeler, McKenzie, 1995; Cognition and Technology Group at Vanderbilt, 1992; Pellegrino et al., 1992). In one of the best documented programs combining PBL and technology, eighth graders in the Union City (New Jersey) Interactive Multimedia Education Trial scored approximately 10% higher than students from other urban and special needs districts on statewide assessments of reading, mathematics, and writing achievement (Education Development Center, 1994).

Past implementation attempts suggest that without adequate attention to ways of supporting teachers and students, these innovative educational approaches will not be widely adopted. Previous attempts at reform of curriculum and instruction in the 1960s used "investigative" and discovery learning as central themes. (Bruner, 1963)

Although evidence suggests that such curricula enhanced student learning and motivation (e.g., Bredderman, 1983), their adoption and success were not as widespread as desired. According to Blumenfeld et al. (1991) the reasons for this included the fact that the projects were developed and disseminated without sufficient appreciation for the complex nature of motivation and knowledge required to engage students in difficult and reflective work.

Research shows it is difficult to change teachers' established practices and beliefs, especially if the changes are perceived as "top-down" decisions (Kennedy, Doyle and Goh, 1999). How teachers teach is largely determined by the knowledge, attitudes, values, theories and assumptions they already hold about teaching (Breen, 1991; Woods, 1996), and these are likely to be based on their own first-hand experiences and observations as classroom learners (Lortie, 1975; Richardson, 1965; Richards, 2001). For most Singaporeans these were in teacher-centered, didactic contexts, so teachers and teacher-trainees thus face a double challenge of implementing change, and adopting pedagogies they have not themselves experienced as learners.

Recommendations

Because project learning is filled with active and engaged learning, it inspires students to obtain a deeper knowledge of the subjects they're studying. Research also indicates that students are more likely to retain the knowledge gained through this approach far more readily than through traditional textbook-centered learning.

PBL is an instructional approach that provides meaning to students' learning. According to Benjamin Bloom, cognitive theorist, when learning has meaning for students they retain it longer and are better able to apply the information. Students will move through the six cognitive levels of Bloom's Taxonomy as they gain new knowledge from simple to complex and concrete to abstract. Most teachers' classroom objectives are and should be at the higher cognitive level so that students move beyond simply memorizing information. PBL requires that students be involved in the design, problem-solving, decision making or investigative activities, culminating in a project or presentation.

A classroom that practices project-based learning requires some physical features that will allow student room to work and collaborate with their teacher and peers. PBL requires materials and tables. Teachers will need to have a classroom that has appropriate storage and space to meet these requirements. These are a necessity and should be discussed with administrators prior to implementation.

Some of the more difficult requirements are needed from administration. Effective leadership and a commitment to reform are a necessary part of implementing project-based instruction. Administrators and educators must work together to formulate a vision for learning

in their school. This type of instructional method requires a vision with rigorous up-front planning that includes timelines and management strategies. Administrators must commit to training their teachers prior to implementation and again throughout the school year as well as providing the proper block of time for students to engage in this type of learning. Project-based learning works well in schools that have extended blocks of time instead of 50 minutes periods.

The transition from becoming teacher-directed to student-directed is complex. Teachers need to take on the role as the facilitator and coach while bringing the problems to the students keeping in mind that teaching is about more than content it is about your students thinking. Consider a standards-focused project as a central method of teaching and learning that replaces conventional instruction for a portion of your curriculum.

Too often it happens in the classroom that many topics are included during a year of instruction and often teachers are pressed for time. Teachers who experience this may want to think of the concept of "uncoverage." This means making a deliberate decision about the topics that you want to teach in depth versus topics that can simply be covered. What parts of the curriculum can easily be covered and handled through lectures and textbook and then what parts of require more depth. Teachers need to identify these topics that reflect the most important ideas and concept in their curriculum and incorporate these topics into projects. Doing this early in the year helps teachers find balance between both traditional instruction and project-based instruction.

There are six steps teachers should use to help plan the beginning of a project.

- Develop a project
- Decide the scope of the project

- Select standards
- Incorporate simultaneous outcomes
- Work from project design criteria
- Create the optimal learning environment

It is important that we take a look at each of these steps separately to help with the development of your projects ideas and themes:

Develop a project:

Work backwards from a topic. Project ideas come from article, real-world issues, current events, conversations, interests, and curiosity.

Use your standards. Standards are a guideline for educators outlining what students should know. They represent what is important in a discipline. They often encompass important themes that can form the basis for projects.

Find projects and ideas on the web. Many websites offer descriptions and ideas of successful projects in every discipline and at every grade level.

Map your community. Examine your local community for project ideas.

Match what people do in their daily work. Projects can be modeled on questions people face in their daily work life, technical operations defining their craft, the workplace expectations, and problems students encounter in the school lives.

Tie projects to local and national events. Use projects to focus on controversies and questions of the day.

Focus on community service. Authentic projects can be developed around community needs. Nonprofit organizations are a good place to start.

Decide the scope of the project.

Projects can range from short, one to two weeks, to a much more ambitious project that can last many weeks to an entire semester. Projects involve research, interviews, library visits, and community inquiry. You should decide the scope of your project before you begin and based on students' experiences, readiness, the school schedule, the subject, and your level of comfort and expertise.

PBL works well with authentic issues making community-based projects ideal. Having these open-ended investigations invite many different solutions to problems and the opportunity for students to work with adults outside of the classroom. If students are not able to leave the school for a project consider allowing adult from the community to come to your classroom as guests or experts to assist not only with supplying information but to work on the students projects with them.

The Audience

Vital consideration should be given to the audience that will view these projects as they play an important role raising the stakes for students to put forth their best performance and master the information necessary to prepare a culminate presentation. Having people from the community will evoke an increase in effort.

Student Autonomy

Students' experiences and capabilities will influence the scope of the project. Student autonomy is generally introduced in stages but is dependent upon students' age and experience. Teachers should plan how much they want their students involved in the projects design.

Select Standards

The process of identifying standards begins before the projects itself and often is planned before the school year even starts. Look over the state standards and identify the key standards that you believe will be best met through project-based instruction. Assessing too many standards is difficult, be careful not to try to meet too many standards in a short project, no more than three per subject is best. The important task is to be clear about what standards will be assessed in the project and how the products will give all students the opportunity to demonstrate what they have learned. What do you want your students to know and be able to do?

Literacy as Core Standard

It is recommended that you include at least one literacy outcome in your project along with a major product that can be used to assess writing, speaking, or reading strategies.

Incorporate Simultaneous Outcomes

PBL allows students to work together to gather and present information. Collaboration is essential to successful project as well as performance-based products such as exhibits and oral presentations. PBL allows teacher to incorporate more than academic outcomes into classroom

activities in the form of a specific skill and habits of mind which build students' capacity for skillful work.

Skill

As you begin to plan the project identify one or two skills that students will use in the project and decide how you will assess them. Skills are best assessed using performance-based measures aligned with a scoring guide such as a rubric.

Habits of Mind

These are the deeper qualities of learning and thinking that are vital to lifelong learning, success in the work world, and personal satisfaction. You should choose one and incorporate it as an outcome for the project. This can be difficult to measure, use journals or individual debriefings with students to collect qualitative assessment information on habits of mind.

Appendix

Blooms Taxonomy:

In 1956, Benjamin Bloom headed a group of educational psychologists who developed a classification of levels of intellectual behavior important in learning. Bloom identified six levels within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, through increasingly more complex and abstract mental levels, to the highest order which is classified as evaluation.

As described by Benjamin Bloom.

- **Knowledge:** *Remembering:* Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
- **Comprehension:** *Understanding:* Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
- **Application:** *Applying:* Carrying out or using a procedure through executing, or implementing.
- **Analysis:** *Analyzing:* Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.
- **Synthesis:** *Hypothesizing:* Making judgments based on criteria and standards through checking and critiquing.

- **Evaluation:** *Creating:* Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

(Anderson & Krathwohl, 2001, pp. 67-68)

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