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Problem Based Learning

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Abstract

The No Child Left Behind legislation brought about a flurry of conversations regarding student achievement (McElroy, 2006). Increased use of standardized testing to measure student achievement has resulted in a discussion of teaching models. Is the transmission teaching model with its expository style the only mode to insure student success? Or is the constructivist teaching model with its inquiry style a mode that better leads to student success? This review of literature examines the instructional practices involved in problem based learning, a constructivist approach. The paper focuses on the components of problem-based learning, the benefits and challenges of using this.approach, and whether problem-based learning is an appropriate educational method for adolescents. The literature review is based on the following research questions: 1. What is problem-based learning? 2. What are the benefits of problem-based learning? 3. What are the challenges of problem-based learning? 4. How does problem-based learning meet the developmental needs of adolescents? Based on the literature review, the author found that positive results, namely, improved academic achievement and social interactions, indicate that problem-based learning is an effective instructional model.

PROBLEM BASED LEARNING

A Graduate Literature Review

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by

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ABSTRACT

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The No Child Left Behind legislation brought about a flurry of conversations regarding student achievement (McElroy, 2006). Increased use of standardized testing to measure student achievement has resulted in a discussion of teaching models. Is the transmission teaching model with its expository style the only mode to insure student success? Or is the constructivist teaching model with its inquiry style a mode that better leads to student success?

This review of literature examines the instructional practices involved in problem-based learning, a constructivist approach. The paper focuses on the components of problem-based learning, the benefits and challenges of using this approach, and whether problem-based learning is an appropriate educational method for adolescents.

The literature review is based on the following research questions:

1. What is problem-based learning?
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4. How does problem-based learning meet the developmental needs of adolescents?

Based on the literature review, the author found that positive results, namely, improved academic achievement and social interactions, indicate that problem-based learning is an effective instructional model.

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ACKNOWLEDGEMENTS

"In every child's life there is one great teacher, why can't it be you?" This quote by Chaim Potok has been a motivating factor throughout my teaching career. I remember and appreciate the elementary, secondary, and undergraduate teachers who went beyond teaching a subject. They encouraged students to remain open minded about issues and to strive to become critical thinkers, not just for a grade but to gain a wider world view with the goal to become productive, compassionate world citizens. My goal is to be one of those teachers.

I am grateful to the dedicated educators in my school system who inspire me and provide me with challenges and opportunities leading to continued professional growth, specifically, Cherie Casey, Steve Cornelius, Kim Hermsen, and Jim Osterberger.

I appreciate the guidance and support that the faculty at the University of Northern Iowa has given me as I worked through the masters program. I want to thank Dr. Donna Schumacher-Douglas, my advisor, and express my gratitude to Dr. Jean Schneider, Dr. Rick Traw, and Dr. Tim Weih for encouraging my efforts during the process of writing this paper.

Chapter 1

Introduction

Problem-based learning (PBL) is an instructional approach where students participate in collaborative problem solving (Kain, 2003). According to Norman and Schmidt (as cited in Harwell & McCampbell, 2002), problem-based learning has three roles: "acquiring factual information, mastery of general principles or concepts that can be transferred to solve similar problems, acquisition of prior examples that can be used in future problem-solving situations of a similar nature"(p.63). In a study of problem-based learning in the middle school, Cerezo (n.d.) interviewed participants about their PBL experience. A sixth grader named Tony said, "It's fun to do and you're like, using your brain" (p.7). Another student, Anne, had this response, "We just come up with all these ideas. It's given us a chance to say [those ideas]" (p.7).

Description of Problem-Based Learning

In my career as a middle school teacher, I have seen the need for adolescents to be active participants in the educational process. In 1988, I was given the opportunity to participate in the Iowa Chautauqua Program, taught by professors from the University of Iowa. I was introduced to STS, the Science-Technology-Society Problem-Based Learning (PBL) approach. The beginning of the process starts with a question that stems from the relationships between science, technology, and society. Teachers work with students to develop open-ended questions on a specific topic from the regular curriculum. The teacher and students decide on one research question that defines the lessons and activities that will lead to multiple solutions. Small groups of students research the question and decide how to present their findings to the class.

Over the years, I have developed some problem-based units that have been an effective way for students to achieve the defined curriculum goals. There have also been times when the problem-based learning approach was not as successful as I had anticipated. Through the process of this literature review, I hope to reaffirm my belief in problem-based learning and present information that will provide teachers with the knowledge to effectively implement problem-based learning in their classrooms.

Rationale

Returning from a professional day in April of 2005, I was eager to read the notes left by the substitute teacher, a person new to our building. After reading the comments, most of them glowing, I came across one that said, "Your students need to be reminded of how to walk in a straight line." A chuckle rose swiftly, along with the thought that it is not normal for eighth graders to walk in lines like younger children. So often, people misunderstand the needs of young adolescents. Young adolescents have the need to collaborate with peers while learning concepts and skills, the need for movement to be built into their day, and the need to be challenged at their own levels of development.

I teach young adolescents who have diverse physical, cognitive, and psychosocial needs that are not met with the expository teaching model. With the expository teaching model, also known as the traditional method, the teacher dispenses information to students in a direct manner (Manning & Bucher, 2001). Let's first look at Bob, an eighth grade student who is a 6'2" thirteen year old and is still growing. Sitting for long periods of time is physically difficult for him because the desks and chairs are uncomfortable and not the correct size for him. Developmentally appropriate movement needs to be part of the curriculum for Bob and for students his age.

Another consideration is the cognitive development of adolescents. Adolescents develop cognitive skills at different rates. Every student should be challenged at his or her readiness stage. Teaching to the student in the middle ability range does not challenge all students. It is necessary to employ a teaching method that addresses the needs of all students. Lastly, social interactions gain importance during the adolescent years. The expository instructional model offers few opportunities to work collaboratively with classmates to analyze and solve real life problems, a practice that fits adolescents' psychosocial developmental needs. Collaboration is an essential component of problem-based learning. According to Knowlton (2003), when students collaborate, they gain a better understanding of the subject.

Purpose

The purpose of this review is to examine the literature to determine whether the problem-based learning approach meets the physical, cognitive, and psychosocial needs of adolescents. Through the research process, I intend to develop a summary of the literature on problem-based learning that will support the implementation of PBL in the middle school classroom and serve as a starting point for teachers who are interested in learning about PBL.

Terminology

To aid the reader's understanding of the terminology used in this literature review, the following definitions are provided:

1. *Authentic assessment*: Authentic assessment is "the direct examination of students' ability to use knowledge to perform a real-life task (i.e., students plan, construct, and deliver a project or other form of evidence that demonstrates their

learning" (Manning & Bucher, 2001).

2. *Constructivism*: Constructivism is "an approach to teaching based on research about how people learn. Many researchers say that each individual constructs knowledge rather than receiving it from others. People disagree about how to achieve constructive learning, but many educators believe that students come to understand abstract concepts best through exploration, reasoning, and discussion" (ASCD, 2005, ¶ 30).
3. *Expository teaching*: "In this traditional method of teaching, the teacher acts as a director of instruction. The teacher conveys content information to learners in a direct, concise, and time-efficient and predetermined sequence and on predetermined schedules "(Manning & Bucher, 2001, p.303).
4. *Inquiry learning*: "The young adolescent designs the processes to be used in solving a problem of learning a particular assignment" (Manning & Bucher, 2001, p. 304).
5. *Problem-based learning* (PBL): Problem-based learning is "an approach to curriculum and teaching that involves students in solution of real-life problems rather than conventional study of terms and information. Developed in leading medical schools, problem-based learning begins with a real problem that connects to the students' world, such as how to upgrade a local waste treatment plant. Student teams organize their methods and procedures around specifics of the problem, not around subject matter. Students explore various avenues before arriving at a solution to present to the class. Teachers report that students using problem-based learning become more interested in their studies, more motivated

to explore in-depth, and more likely to see the value of the lesson" (ASCD, 2005, ¶ 13).

"Problems are chosen for their appropriateness and power to illuminate core concepts in the curriculum. They must be carefully selected to ensure that students learn the intended content" (ASCD, 2005, ¶ 14).

6. *Project-based learning*: Project-based learning is a way of "teaching by engaging students in a long-term activity in which they gather information and develop a product of some kind, such as a written report, oral presentation, or a model. Some educators believe that students learn more, understand the content more thoroughly, and remember information and skills longer when they work on a project" (ASCD, 2005, ¶ 15).
7. *Young adolescents*: Young adolescents are "students between the ages of 10 and 14, sometimes including the ages of 9 and 15, who are progressing through the early adolescence developmental period and its accompanying physical, psychosocial, and cognitive developmental changes" (Manning & Bucher, 2001, p. 307).

Research Questions

The focus of this paper stems from four questions:

1. What is problem-based learning?
2. What are the benefits of problem-based learning?
3. What are the challenges of problem-based learning?
4. How does problem-based learning meet the developmental needs of adolescents?

These questions guide my search for background information on problem-based learning. Additionally, they will provide me with information for teachers who are interested in implementing PBL in their classrooms.

Chapter 2

Methodology

The purpose of this review is to examine the literature to determine whether problem-based learning (PBL) meets the physical, cognitive, and psychosocial needs of adolescents. I believe that problem-based learning can play a key role in meeting the developmental needs of adolescents. Because of personal, previous, problem-based learning experiences, some more successful than others, I wanted to review the literature to verify my understanding of problem-based learning. By doing so, I hoped to affirm my belief in the problem-based learning approach and learn how to become a more effective facilitator. Four questions provide the focus for this literature review:

1. What is problem-based learning?
2. What are the benefits of problem-based learning?
3. What are the challenges of problem-based learning?
4. How does problem-based learning meet the developmental needs of adolescents?

Method to Locate Sources

To locate sources on problem-based learning, my first choice was to access the Rod Library online and then log onto the Full-Text Database on the Wilson Web. A second option was the Elton B. Stephens Company database (EBSCO) located on the Keystone Area Education Agency website. I learned about EBSCO from an e-mail sent to me by Keystone Area Education Agency. Dr. Jean Schneider introduced me to the Rod Library site during one of the early classes in my master's program. I followed the directions that Dr. Schneider gave me to log onto the Wilson Web.

The search words for the first two options included the following terms: *problem-based learning*, *constructivism*, *inquiry learning* and, *project-based learning*. I selected these terms because they were found in most of the literature that I read. After reading and analyzing the information gathered from the research articles that I found online, I looked at the reference list in each journal to find new sources to investigate. That search provided me with sources for additional searches on the Wilson Web. Next, I sent a request to the Keystone Area Education Agency for a list of books that I found listed in the references previously discussed. That search was followed by a request for books from the Area Education Agency and Rod Library. A Google search produced a list of possible websites. My search words included the following key words: *problem-based learning*, *constructivism*, *inquiry learning*, and *collaborative learning*.

Method to Select Sources

I chose sources for the literature review based on the information they provided for developing the chosen topic. I searched for articles and books that would extend my knowledge of the identified topics. Another criterion for inclusion was whether the selections answered one or more of the research questions. When sources did not meet these criteria, I eliminated them from the review. I read sources that provided qualitative or quantitative information first. The date of publication was considered. In most cases, the acceptable date of a publication was within six years of this paper. Two of the middle level cadre instructors suggested this time span. Near the end of my search, I extended the time span to twelve years, because I found important sources in one or more reference lists.

Method to Analyze Source

I noted topics as I read the articles. Articles were categorized by topics. Each topic had a designated colored tab. As I read the literature, I placed the appropriate colored tab to mark each topic. The topics included the history of problem-based learning, the elements, benefits and challenges of problem-based learning, and implications for future research. I rejected some articles due to an inadequate amount of information about the identified topics.

Criteria to Include Sources

After reading a variety of articles, I analyzed the sources to determine if they provided pertinent information that related to the research questions and whether they were reliable sources. Sources that did not meet these criteria were eliminated from the review. I read sources that provided qualitative or quantitative information first. The list of sources was limited by time constraints and the number of available resources. Once the sources were chosen, I revised the outline to provide a more precise focus for writing the literature review. I organized the outline under the headings of my four research questions.

Chapter 3

Review of Literature

Problem-based learning (PBL) was developed in the late 1960s at McMaster University Medical School and at Case Western Reserve (Gijbels, Dochy, Van den Bossche, & Segers, 2005; Harwell & McCampbell, 2002; Kain, 2003) to assist in the training of medical students (Gordon, Rogers, Comfort, Gavula, & McGee, 2001). Problem-based learning has been employed to educate future "architects, social workers, managers, economists, lawyers, and educational administrators" (Kain, 2003, p.4) to develop problem solving skills in their area of expertise. Since the development of PBL in the 1960s, it has been implemented and used effectively in elementary and secondary schools (Brooks, 2004; Harwell & McCampbell, 2002). According to Harwell & McCampbell (2002), when problem-based learning is used, students become independent learners and are more motivated than students who experience expository learning in a traditional classroom.

Although problem-based learning was developed for medical education in the 1960s, it stems back to the constructivist learning theory (Gordon et al., 2001). "Constructivists see learning as a process of actively exploring new information and constructing meaning from the new information by linking it to previous knowledge and experience" (Alesandrini & Larson, 2002, p.118). Delgarno (2001) described the three principles, or beliefs, of constructivism. The first belief is that every person experiences knowledge formation in a different way, depending on a person's prior knowledge. The next belief is that knowledge acquisition is an active pursuit. The last belief is that

learning takes place in a social setting, between students and their classmates (Delgarno, 2001).

This review of literature was initiated to gain an understanding of the following questions:

1. What is problem-based learning?
2. What are the benefits of problem-based learning?
3. What are the challenges of problem-based learning?
4. How does problem-based learning meet the developmental needs of adolescents?

Lambros (2004) cites the many changes adolescents experience as a reason for implementing problem-based learning in the classroom. She believes that young adolescents are not prepared for the challenges that confront them when they move from elementary school to middle school and from middle school to high school. She believes students who are entering middle school do not have the skills that are required for a more rigorous curriculum. In addition to the cognitive demands of their courses, young adolescents are experiencing physical and social changes (Lambros, 2004; Salyers & McKee, 2005). Lambros (2004) also believes that middle school students do not have the skills that are needed to make decisions. Therefore, she proposes problem-based learning to teach the needed skills and fill in the gaps that students might have (Lambros, 2004).

What is Problem-Based Learning?

The processes and products of problem-based learning vary, but all the

experiences have students engaging in collaborative problem solving (Kain, 2003). Cerezo (n.d.) defines problem-based learning in this way:

> It is a process of learning where a case problem is presented to students who are asked to apply reasoning, questioning, researching, and critical thinking to find a solution to the problem. It is focused, experiential learning (minds-on, hands-on) organized around the investigation and resolution of messy, real-world problems. The emphasis of problem-based learning is not on the outcomes but on the process, with a focus on students learning to become self-reliant and eventually independent. Working in small groups, students collaborate on the problem, refine and sort their knowledge to find a solution, and then present their solution (or final product) to the whole group with in-depth explanations of their results (Cerezo, n.d. p. 1).

According to Norman and Schmidt (as cited by Harwell & McCampbell, 2002), problem-based learning has three roles: learning facts, acquiring problem solving skills, and gathering representative samples that can be implemented whenever problems arise. The problem becomes a device to gain and sustain students' attention. Students use their prior knowledge to analyze the problem. The data gathered from the analysis serves as the foundation for their research. The next task for students is to incorporate their research findings into their problem solving process (Gordon et al, 2001).

In the book, *Problem-Based Learning: in Middle and High School Classrooms*, Lambros (2004) provides an example of a seventh grade PBL problem that combines the three roles. In this example, students take on the role of genetic counselors to solve a mystery. First, students learn the facts. They are told that their clients are a couple who

are planning to marry. The couple is upset because they overheard relatives talking about other relatives who have a disease. The name of the disease is not disclosed. The couple does not want to confront family members about the disease but they are concerned that they might have an inherited disease that could be passed on to their offspring. In the next step of the process, students combine their knowledge of the case with their knowledge of genetics. Students create a *Need to Know* list which includes their research questions. Some teachers provide students with pictures of the family along with blood samples. Other teachers wait until students ask for more information. During the last step of the process, students use their research skills and their problem solving skills to address the couple's concerns (Lambros, 2004).

According to Knowlton (2003), the traditional, expository method of teaching does not equip students with the knowledge and skills that they will need in the future, beyond the classroom. Students need to be prepared for the problems they encounter in their lives outside of school. Memorizing facts and reflecting the opinions of teachers will not be effective preparation for students. It is the duty of teachers to expose their students to problems that they may find out in the world (Knowlton, 2003).

To gain a better understanding of problem-based learning, it is necessary to consider the following components: real-world problems, prior knowledge, motivation, research, collaboration, the teacher as facilitator, and developing a PBL unit.

Real-World Problems.

Real-world problems are an essential component of problem-based learning (Chin & Chia, 2004; Krajcik, Soloway, Blumenfeld, & Marx, 1998). The problems are

selected and developed carefully (Krajcik et al., 1998) to provide the structure for the delivery of the curriculum (Gordon et al., 2001). The realistic content in the problems motivates students (Lambros, 2004; Miao, Holst, Haake, and Steinmetz, 2000) to access their prior knowledge and challenges the students to achieve the curriculum objectives (Lambros, 2004). The problems are sometimes referred to as ill-structured or messy, (Chia & Chin, 2004; Kain, 2003; Miao et al. 2000). This description sounds like the problem was not developed properly, but instead, the creator structures the problem to have more than one solution (Kain, 2003). Lotan (2003) and Chin and Chia (2004) explain the function of the open-ended problem as one that calls for multiple research approaches that lead students to a solution of the problem.

Prior Knowledge.

In a discussion regarding pre-existing knowledge in the book, *How People Learn*, Bradford, Brown, and Cocking (2000) note that "students come to formal education with a range of prior knowledge, skills, beliefs, and concepts that significantly influence what they notice about the environment and how they organize and interpret it" (p.10). Prior knowledge impacts students' aptitude to learn new information.

Researchers found that learning increases when teachers acknowledge the prior knowledge of their students (Harwell & McCampbell, 2002). To increase student learning, teachers need to remember that "each learner brings a distinct background of experience" (Alesandrini & Larson, 2002, p.119), that should be used "as a starting point for new instruction" (Harwell & McCampbell, 2002, p. 63).

In the book, *How People Learn*, Bransford et al. (2000) explain the importance of the nature of previous knowledge. They suggest that teachers should be alert to students'

misconceptions, to underdeveloped information, and to simplistic understanding of the concepts. Teachers must take a look at students' prior knowledge and develop a comprehensive understanding of the topic. "If students' initial ideas and beliefs are ignored, the understandings that they develop can be very different from what the teacher intends" (Bransford et al., p.10).

Bransford et al. (2000) continue the discussion of preexisting knowledge by dispelling the false idea that people hold about *constructivist theories* (p.11) regarding the issue of new information building on preexisting knowledge. The false idea is that teachers cannot use direct instruction. Instead, they should let students construct their own knowledge. "This perspective confuses a theory of pedagogy (teaching) with a theory of knowing" (p.11). Constructivists believe that all new understandings are built on prior knowledge, regardless of the instructional method (Bradford et al., 2000).

Motivation.

Manning and Bucher (2001) note that middle school students seem to lack motivation to learn. They attribute the lack of motivation to the increasing difficulty of the academic content and to adolescents' attention, which focuses more on their social lives. While there are many factors involved in motivation, changing traditional instructional methods to those that call for active student participation could be an effective way to increase motivation. As Kain (2003) states, "Given that PBL has a record of success in sparking such curiosity and motivation; it is well worth considering as another tool to engage students" (p. 6).

Research.

Harwell & McCampbell (2002), describe problem-based learning as "a forum for collaborative research" (p. 63) among students. In problem-based learning, students work in groups on real-world problems (Harwell & McCampbell, 2002) to achieve shared goals (Alesandrini & Larson, 2002). Through collaboration, students "see problems from multiple perspectives or different points of view" (Alesandrini & Larson, 2002, p. 118).

Adolescents need the experience of working with a variety of "information sources" (Lambros, 2004, p.25) to conduct "in-depth research" (p.25). Students also need to learn skills that will help them identify reputable sources (Lambros, 2004).

Technology should be used to assist students in their search for sources of information to solve real-life problems (Harwell & McCampbell, 2002; Krajcik et al., 1998). Miao et al. (2000) suggest that teachers should use a protocol for "guiding and controlling problem-based learning processes in virtual learning environments" (p.232). The six-phase protocol example (Miao, et al., 2000) illustrates the structure of the problem-based learning process. The six phases of the example are the following: identifying the problem, identifying learning issues, setting goals and making plans, learning knowledge, applying knowledge, and assessing and reflecting. Miao et al. (2000) continue the discussion by explaining the CROCODILE Virtual Learning Environment, a computerized protocol program that students use to work through the problem solving process. The protocol provides a framework for students' research. Students follow a prescribed method to solve the PBL real-world problems. The "learning process" (p.232) is divided into phases. When a phase is completed the learner can move on to "those phases that are successor phases to the current phase in the learning protocol" (233).

Promoting the teaching and learning of science, Krajcik et al. (1998) suggest using technology that scaffolds the teaching and learning process. They present two software programs: Project Integration Visualization Tool, (PIVIT) and Model-It.

The research program, (PIVIT), is for developing science projects. Teachers develop projects based on questions that deal with subjects such as the following: weather, biology, and physics. Teachers can develop the following components: *project map*, *concept map*, a *calendar*, and *mini-databases* to support their instructional design (Krajcik et al., 1998). A project map is a graphic organizer that connects the parts of the instructional design. Concept maps are designed to show what students will be expected to research. The calendar component is used by teachers to plan scheduling of activities with the flexibility to be changed as needed. With PIVIT, teachers can create mini-databases that students can access for their research (Krajcik et al., 1998).

Model-It is a program designed for middle school and high school students to provide simulations and model building capabilities (Krajcik et al., 1998). An example of a model building project took place in Ann Arbor, Michigan at Community High School. Students were studying water quality. Using the software, they created a model of the creek, located behind their school. The software is compatible with the National Research Council recommendations, stating, "that science should be taught in a way that is authentic and engages students in inquiry and collaboration around real-life problems to help build a rich understanding" (Krajcik et al., 1998, p. 31). In this article, the authors apply the use of PIVIT and Model-It to learning science.

Collaboration.

Collaboration is a key component of problem-based learning (Chin & Chia, 2004; Kain, 2003; Knowlton, 2003). Students collaborate with classmates and teachers as they work through an investigation. Collaboration between students may also occur with members of the community and through the use of the Internet (Marx, et al., 1997). When students collaborate to learn the course content, they gain a better understanding of the material (Knowlton, 2003). "Through collaborative learning and social interaction, students can help shape each other's ideas by providing feedback to each other" (Knowlton, 2003, p.6 Miao et al., 2000)).

According to Speck (2003), the size of groups for collaborative learning can vary from two to a dozen, or possibly more. The difficulty level of the assignment along with the writing and verbal skills needed to accomplish the task should be considered when assigning students to a group. Speck also noted that gender issues and cultural differences are other factors to consider when determining the makeup of collaborative groups.

Teacher as Facilitator.

In a PBL classroom, the teacher becomes a facilitator to encourage students to take responsibility for creating a problem solving plan (Harwell & McCampbell, 2002, Kain, 2003). Teachers act as metacognitive coaches (Chin & Chia, 2004) by thinking aloud with students and practicing the behavior they want their students to use (Hacker & Dunlosky, 2003). Walking around the room, the teacher monitors students and asks questions that lead students to a deeper understanding of the problem (Gordon et al, 2001; Harwell & McCampbell, 2002).

Marx et al. (1997) explains the role of teacher as a coach who teaches strategies for solving problems. The teacher also affirms students' efforts and encourages students to take responsibility for their learning (Kain, 2003; Marx et al., 1997).

Developing a Problem-Based Learning Unit.

Kain (2003) challenges teachers to develop a problem-based learning unit by outlining five specific tasks. He provides the following parameters: (a.) choose content that lends itself to the PBL process, (b.) designate a particular group of students; (c) develop a problem; (d) design an assessment and a rubric; and (e) reflect on your plans.

What are the Benefits of Problem-Based Learning?

According to Kain (2003), a growing number of teachers are noting the benefits of problem-based learning as an approach that is known for promoting active learning and problem solving skills. Researchers found the benefits to be academic achievement and a combination of academic achievement and social interactions (Kain, 2003).

Academic Achievements.

According to Lambros (2004), students' achievement scores increase when they understand the content information and can apply their knowledge to "similar situations" (p.55). In PBL, assessments should be structured to reveal the students' knowledge and their ability to use their knowledge in different settings (Lambros, 2004).

In a study by Ellsworth and Ellsworth (2001), the researchers fostered academic achievement through a problem-based program. The state of Wyoming established a Coordinated Resource Management (CRM) program that invited groups of citizens to discuss natural resource issues. The objective was to reach a group consensus about the issues at the local level. Since that time, science professors from the University of

Wyoming saw a need to develop CRM programs in elementary, middle and high schools. One such program is in place in an environmental science class at Lander Valley High School in Lander, Wyoming. The students serve as members of a CRM team. They study a specific area of land on the Red Canyon Ranch, which is owned by the Nature Conservancy. The goal of the study is to determine how the land should be used and to have students report their findings to the land manager and to governmental agencies at a CRM meeting. Students must consider how the land was used in the past. They study and make detailed records regarding the plants and animals found on the property. Soil and water tests are conducted and the results are recorded. Throughout the study, students prepare their proposal, building a case to support their recommendations. Statistical evidence found that students had a "better performance on standardized measures of academic achievement in reading, writing, math, science, and social studies" (Ellsworth & Ellsworth, 2001, p.140).

According to Gaines (2003), another CRM program was established at Clear Creek School in Buffalo, Wyoming. The seventh grade science classes contacted and met with the game and fish warden to plan their study. Students are studying the problem of overpopulation of deer on a section of land near their school. When students complete their study they will present their findings to the city council.

In a science class in Singapore, 38 young adolescent girls participated in a problem-based learning study on nutrition (Chin & Chia, 2004). The study's focal point was to find out how PBL could be infused into the classroom. In addition, the researchers noted how students reacted when they were asked to define a problem and make an inquiry plan to solve the problem. Collaborative groups read nine case studies on a

variety of nutrition topics. Then students discussed their reactions to the case studies. Each student made a mind map of an issue and kept a problem log for a week. After the week, the teacher presented examples of ill-structured problems. Students then met to form their problem statements. From there, they proceeded through the research, which sometimes took them into other disciplines. Finally, they moved on to the creation of their final projects. The researchers collected data from observations, surveys, and audio taped interviews with students. They recorded an 89.7 student achievement rate for knowledge application skills (Chin & Chia, 2004).

Academic Achievement and Social Interactions.

Problem-based learning has been used widely with gifted students but can be beneficial for a variety of students (Kain, 2003). In a study by Gordon et al. (2001), the authors report that results of problem-based learning indicate an increase in appropriate behaviors and higher achievement in science scores for low income students. At Stoddart-Fleisher Middle School in North Philadelphia, a school where all students are members of minority groups, problem-based learning was developed as an enrichment activity for 2% of the curriculum schedule. Students investigated health issues and health careers as a means of developing critical thinking skills and self reliance. The researchers found that, "even though most students were performing below grade level, they responded well to the high academic challenge of PBL" (p. 173).

Gordon et al. (2001) used a student and staff survey to quantify perceptions of problem-based learning. They also analyzed students' report cards for two years in a row. The students in the cohort group were characterized as low income urban minority students. One result of the behavior portion of the study indicated higher behavior scores

in both years for the cohort group that started in sixth grade. In terms of grades, the cohort group starting in sixth grade, had an overall higher grade point average. The sixth grade cohort group also had higher grades in math, both years, and they showed a trend toward higher grade point averages in science. The cohort group that started in seventh grade showed a trend toward better behavior but not enough to be significant. However, they achieved a significant difference in their science grades during both years of the study (Gordon et al., 2001). The researchers determined that adding PBL to the curriculum in just 2% of the school day improved academic achievement. They wondered how successful students would be if PBL was used in more subjects and for longer periods of time (Gordon et al., 2001).

What are the Challenges in Problem-Based Learning?

Along with the many benefits of problem-based learning, there are also challenges (Harwell & McCampbell, 2002; Marx et al., 1997). Marx et al. (1997) found that teachers who use problem-based learning cite some common challenges. Marx et al. (1997) lists the issue of time as a challenge to teachers who are interested in problem-based learning. Sometimes, teachers rush to implement new methods and fail to prepare thoroughly before introducing the method to their students (Kain, 2003).

Brooks (2004) cites the lack of teacher training as a challenge. Teachers and students, who have been trained with the traditional instructional approach, may find it difficult to embrace problem-based learning (Marx et al., 1997). Students who are passive learners might find it difficult to change, to take on an active role in the classroom (Miao et al., 2000). Teachers who are comfortable with traditional teaching strategies may not have the skills for facilitating problem-based learning (Maio et al., 2000). Teachers need

support as they change from a role as information giver to the role of teacher as coach (Sage & Torp, 1997).

Students who are passive learners might find it difficult to change, to take on an active role in the classroom (Miao et al., 2000). A third challenge to PBL is the increased demands for standardized testing (Brooks, 2004). Federal and state legislation require testing with the goal of improving learning. Brooks calls that line of reasoning magical thinking (2004).

The Challenge of Time.

The problem solving process takes more time than traditional, expository methods of learning (Marx et al., 1997). Real-world problems, research and discussions can extend the time designated for a unit (Gordon, 1998). In the traditional method of *lecture, memorize, and test*, the time factor is more predictable ((Marx et al., 1997). According to Lambros (2004), lectures are an efficient means to deliver information. However, lectures are usually a one way conversation. Lambros also addresses traditional assessments by saying, "they often measure what students can recall on a certain day at a certain time" (p.56). The assessments used to sustain PBL happen during the entire learning experience with a concluding assessment that demonstrates student achievement (Lambros.2004).

Time also factors into another challenge (Marx et al., 1997). Teachers need to design problems that focus students' research on the curriculum content standards. Creating the appropriate problem is an important factor in problem-based learning, one that demands a time commitment (Alesandrini & Larson, 2002; Harwell & McCampbell, 2002; Marx et al., 1997; Sage & Torp, 1997). Kain (2003) suggests a way to determine

the value of problems. To measure the effectiveness of a problem he proposes six characteristics:

1. Problem has relevance (contemporary) to students, touches their interests
2. Problem is real versus contrived (students sense it could be or is an actual event)
3. Problem has significance
4. Problem has contextual details, but not enough to solve without going beyond the problem documents
5. Problem is ill-structured (messy), opening the way for multiple solutions
6. Problem has important learning targets embedded in it (216).

Kain (2003) provides this example of an effective problem.

> After completing your investigation into the issues surrounding the transportation of nuclear waste through our city, present your recommendations to the City Council. The Council allows speakers only seven minutes each, so you will need to organize your presentation carefully. You may find it helpful to reinforce your presentation with visual aids, such as charts and graphs (p.217).

There is a time constraint involved in assessing learning in PBL (Marx et al., 1997). Lambros, (2004) notes that, in a problem-based classroom, authentic assessments are used. Unlike testing in traditional classrooms, authentic assessments require more time to create and present (Lambros, 2004, p. 56). Authentic assessments are ongoing throughout the problem solving process. They take the form of writing assignments, group projects, online discussions, classroom presentations, portfolios, (Anderson & Puckett, 2003) and self or peer evaluations (Lambros, 2004).

The Challenge of Teacher Training.

According to Brooks (2004), teaching is a complex process and educators should stop portraying it as being simple. Brooks asserts that many teachers do not involve students in much "meaning making" (p.2). Instead, they should acknowledge the complexities of their work. After being introduced to the problem-based learning approach, many teachers admitted that, as students, they did not know how to identify

patterns of ideas or to find "unifying principles," (Brooks, 2004, p.9), or to compare and contrast events. Therefore, those teachers have difficulty visualizing how a problem-based classroom functions. "Clearly, many educators don't see that the curriculum can be embedded in solving complex problems, nor do they recognize the skills that problem solving develops" (Brooks, 2004, p.9).

In order to effectively implement problem-based learning, teachers need to be trained as facilitators. Facilitator training provides teachers with the tools to assist students in suggesting research questions and resources instead of providing students with the answers to problems (Kain, 2003).

Another challenge for teachers is the need for technology training. Teaching in the 21st century requires computer-based skills (Miao et al., 2000). Oberlander and Talbert-Johnson (2004) promote the use of technology to support problem-based learning for students and teachers. The training, according to the authors, needs to prepare pre-service and inservice teachers with the skills they need to integrate instructional technology. In their study, teachers encountered problem-based learning in the same manner that students do. The background for their problem stems from a national park issue, *BASE-jumping*. "BASE is an acronym for building, antennae [towers], spans [bridges], and earth [mountains, cliffs]" (p. 50). BASE-jumping is an extreme sport for people who like to jump off of tall structures. People active in this sport may suffer serious injuries or death. Despite the protests of participants in this extreme sport, BASE jumping is not permitted in government owned parks in the United States. (Oberlander & Talbert-Johnson).

Because the participating teachers had little knowledge of BASE jumping, the problem was deemed to meet the requirements for an ill-structured problem (Oberlander & Talbert-Johnson, 2004), that is, a problem structured to elicit multiple solutions (Kain, 2003). Teachers met for seven sessions throughout the year. Technology skills and problem-based methods were taught in all sessions. The final session was a Congressional hearing that was held at a law school courtroom. The results of this study found that "technology-enhanced PBL strategies" (Overlander & Talbert, 2004, p.54) can have a positive effect on the students learning experiences (Oberlander & Talbert-Johnson).

The Challenge of Testing.

Brooks (2004) points to the federal and state educational regulations as factors that can be barriers to student achievement. Brooks calls the regulations "single-event measures of accountability" (p. 9). Although there is data that shows improved test scores, Brooks questions the price that is paid for the increase. She cites two reasons for her skeptical views of standardized testing. First, she suggests that higher score results do not indicate higher learning. Instead she suggests the tests reflect extensive time spent on test preparation rather than an increase in student learning. Then Brooks asserts that the "evidence tells us that inappropriate management decisions and statistical manipulations can make negative outcomes appear positive" (p.8).

Jorgenson and Vanosdall (2002) describe the emphasis on standardized testing as "the basic skills frenzy" (p. 603). Since government officials, the media, and the

general public place so much emphasis on standardized tests as the key indicator of academic performance, schools have been "locked in a frenzied struggle" (Jorgenson and Vanosdall, p. 603) to train teachers and students how to meet the challenge of testing.

How Does Problem-Based Learning Meet the Developmental Needs of Adolescents?

Adolescents need educational programs that are based on their cognitive, physical and psychosocial needs (Salyers & McKee, n.d.). "The rapid growth spurt, the onset of puberty, and the gender-specific physical development all have the possibility of producing effects that impact adolescents' lives" (Manning and Bucher, 2001, p.30). Additionally, peers become the dominant influence on young adolescents' conduct, language, and clothing. Just as physical and psychosocial changes take place during adolescence, so does cognitive ability (Manning & Bucher, 2001). Lambros (2004) asserts that PBL presents learning experiences that stimulate cognitive, psychological, and emotional development better than traditional approaches do but PBL is not the answer to all educational issues. Lambros explains by saying that controversial issues might arise. When they do, teachers should think about the strategies they are already using to address those issues and realize that the strategies will work well with PBL teaching.

Cognitive.

Adolescents' cognitive growth includes the ability to categorize information. That skill enables students to make generalizations and adds to higher level thinking skills (Manning & Bucher, 2001). Kain (2003) asserts that problem-based learning fosters life-long learning skills in adolescents. Through PBL, adolescents work with classmates to solve problems. Collaborative learning skills are developed and increased through the

process. Critical thinking skills are learned. According to Kain (2003) adolescents learn to link new knowledge to prior knowledge. They begin to accept responsibility for their learning which helps them become self-directed learners. Manning & Bucher (2001) suggest that teachers "provide opportunities for young adolescents to engage in problem-solving activities in an attempt to influence the future" (p. 298).

Physical.

According to Manning and Bucher (2001), growth in muscles and bones can result in lethargic and impatient adolescents. Prolonged periods of sitting become uncomfortable for them (Manning & Bucher, 2001). Additionally, the size of classroom furniture does not meet the needs of all students (Manning & Bucher, 2001). Manning and Bucher suggest providing educational experiences that allow active participation rather than long periods of passive sitting (p. 291). Problem-based learning is active (Knowlton, 2003). As students work through the problem-based process, they analyze the problem, connect new information to their prior knowledge, solve the problem, and develop a presentation to explain their solution to their teacher and classmates (Knowlton, 2003). Lambros (2004) provides an example of physically active participation that takes place in North Carolina. In a three week science unit, eighth grade students work on their state competency goals regarding force, motion, and Newton's laws through a PBL problem. They are asked to be engineers who have been hired to create rides for amusement parks. One of their requirements is to build a model of a ride to demonstrate Newton's third law.

Psychosocial.

During the middle school years, the classroom environment and procedures need

to be developmentally appropriate (Manning & Bucher, 2001). Manning & Bucher (2001) suggest "providing educational experiences that boost self-esteem, emphasize trust, and help in building personal identities, and teach socialization skills. They should also provide genuine choices" (p.294). Problem-based learning provides students with opportunities to work in small collaborative groups (Kain, 2003, Knowlton, 2003), to explore real-life problems that interest them (Chin & Chia, 2004; Lambros, 2004) and to explore it in an environment that promotes understanding of the content (Lambros, 2004).

Summary of Problem-Based Learning

Problem-based learning is an instructional approach with ties to the constructivist learning theory (Gordon et al., 2001). According to Alesandrini and Larson (2002), constructivists view "learning as a process of actively exploring new information and constructing meaning from the new information by linking it to previous knowledge and experience" (p.118). The researchers also state that the teacher's role is to facilitate learning by coaching students to reach their personal goals. According to Lambros (2004), PBL begins with a real-world problem that is used as a means for students to acquire new knowledge. The process is student-centered (Lambros). The teacher's role in PBL is to develop authentic problems, present the problem to students, establish classroom management strategies, and serve as a facilitator of learning. (Gordon et al, 2001; Harwell & McCampbell, 2002).

In PBL, students work collaboratively to analyze the problem and research information that will help them define an acceptable solution (Cerezo, n.d.). Lambros (2004) provides a middle school problem for groups of 4 to 6 students to solve. The problem reads:

> Your class has decided to sponsor a family during the winter holiday season. You have raised $500 to spend for the family. Your teacher has talked with the school social worker, and together they have identified a family of four in need of assistance that has recently moved into the community. You want to provide for this family, getting the most for your money.

The groups work to understand the facts in the problem and then they continue to move through the PBL process (Lambros, 2004).

Problem-based learning is not without its challenges. Teachers and students who are accustomed to passive learning may be reluctant to try this active learning approach (Miao et al., 2000). For teachers who are interested in using the PBL approach, training as a facilitator is essential (Kain, 2003). Time is another challenging aspect of PBL. The problem-based learning process takes longer than the traditional lecture and test method (Marx et al., (1997). Time is also a factor in the development of teacher's lesson designs. Creating an open-ended problem is time consuming (Alesandrini & Larson, 2002; Harwell & McCampbell, 2002; Marx et al., 1997). Federal mandates and state regulations can be a hindrance to students (Brooks, 2004). When instructional time is used extensively to teach test taking skills, high scores become the prized goal, and students lose opportunities to discover and create (Lambros, 2004).

Middle school students are known for the range of diversity in terms of their cognitive, psychosocial, and physical needs (Manning & Bucher, 2001). Problem-based learning addresses the cognitive (Manning & Bucher, 2001; Kain, 2003) physical (Manning & Bucher, 2001; Knowlton, 2003), and psychosocial (Kain, 2003; Knowlton, 2003; Chin & Chia, 2004; Lambros, 2004) needs of adolescents. The educational needs identified by these researchers address the following developmental needs: physical activity, collaborative learning experiences, opportunities to demonstrate their

responsibility and achievement, a structured environment, and the freedom to apply their knowledge in a creative manner.

Chapter 4

Discussion and Recommendations

Problem solving is a life skill. A person who knows problem-solving strategies is more likely to have a less stressful life. Young adolescents experience many changes in their middle school years which can be stressful (Lambros, 2004). "Evidence indicates that peer support, active decision making, and planning help reduce the stress levels these students often feel [when they confront new challenges]" (Lambros, 2004, p. 15).

Discussion

The adolescent years form a unique period of life. The variety of physical, cognitive, and psychosocial needs of adolescents must be taken into consideration when teachers develop instructional practices (Manning & Bucher, 2001; Salyers & McKee, n.d.). Problem-based learning (PBL) is an approach that helps teachers adapt the curriculum to meet the needs of their students (Gordon et al., 2001).

The purpose of this literature review was to examine research on problem-based learning to determine whether this instructional approach meets the diverse needs of adolescents.

Four questions formed the basis for the research:

1. What is problem-based learning?
2. What are the benefits of problem-based learning?
3. What are the challenges of problem-based learning?
4. How does problem-based learning meet the developmental needs of adolescents?

Results of the review indicate that PBL is an instructional approach that requires students to use critical thinking skills and prior knowledge (Lambros, 2004) to solve

authentic problems (Kain, 2003). The benefits of problem-based learning include appropriate social interactions (Knowlton, 2003; Lambros, 2004) and academic achievement (Gordon et al., 2001). Problem-based learning promotes collaborative research among students (Harwell & McCampbell, 2002) as they work for common goals (Alesandrini & Larson, 2002). Knowlton (2003) found that when students collaborate to learn the curriculum, they "gain a better understanding of the material" (p.6). Academic achievement was reported for gifted students (Kain, 2003), students who live in poverty (Gordon et al., 2001), and minority students (Gordon et al., 2001), as well as mainstream students (Ellsworth & Ellsworth, 2001).

Problem-based learning is not without challenges. Teachers who do not have experience with PBL can be reluctant to learn a new instructional approach (Miao et al., 2000). The amount of time needed to plan PBL units, implement the learning experiences, and assess students is more than is needed to develop a traditional unit. Researching and implementing a new instructional tool might seem like an impossible task to accomplish without some assistance.

Another challenge is in teacher training. In problem-based learning, a teacher takes on the role of facilitator. Teachers need to be trained to take on that role. Teachers also need computer-based skills (Maio et al., 2000) to assist students with their research. Standardized testing presents an additional challenge for teachers. When standardized tests become the most important measure of student achievement, teachers might be expected to allocate more time to test taking strategies than to teaching the curriculum (Kain, 2003). Brooks (2004) maintains that putting the emphasis on test preparation and testing to increase learning is a poor substitute for learning the curriculum. Standardized

testing has a significant role to play in education. However, it should not take center stage in educating students. Kain, (2003) explains the situation well in the following passage.

> "...there can be contradictions between *standards* and *standardized tests*. It is important, therefore, to be clear about the differences. Standards focus on what students should know and be able to do. The standards can be carefully selected to produce the kinds of graduates we can be proud of. However, in most views of what it means to be well educated, not all standards are reducible to what can [sic] measured by standardized tests (p. 155).

Teacher training is vital to the success of students. Problem-based learning (PBL) is an approach that could be beneficial as they teach their students how to learn the information described in the standards.

Limitations

The literature review was limited by the types of literature found in databases and the scope of the studies described in the periodicals. The review was limited to my search words, namely, *problem-based learning, constructivism, inquiry learning* and, *project-based learning, collaborative learning.*

Recommendations

This literature review indicated that problem-based learning can be a successful learning model that meets the diverse needs of adolescents. Positive social interactions and academic achievement were reported as benefits of PBL in the literature. Problem-based learning clearly has the potential to play a key role in teaching adolescents. Teachers of young adolescents should consider problem-based learning as an instructional approach that can increase student achievement.

To implement PBL effectively, teachers may need to make changes in the way they instruct. Teachers need to receive training to learn the problem-based learning process. Teachers do not need to throw out the strategies that work for them and for their

students. Instead, PBL provides the framework to integrate their strategies in a meaningful manner. The training should be active. Sitting at an inservice meeting and passively listening to a speaker, no matter how dynamic the speaker may be, is insufficient. Instead, teachers should seek out a workshop or class on problem-based learning. During the training, teachers should work collaboratively as they go through the PBL process that starts with an ill-structured problem and continues through the research to the final project that reveals their solutions to the problem. In that way, they would understand the structure that needs to be created for their students and they could study the techniques the facilitator uses.

Teachers also need to learn how to create a classroom environment where problem-based learning is a natural part of a student's educational experience. The classroom environment needs to be structured for collaborative groups of students to meet, to move around the room, to conduct their research and prepare presentations. The teacher should create a workshop, clustering desks or tables to accommodate four to six students. Students should have access to reference books, computers, and supplies for creating charts and other documents. Establishing procedures is helpful in maintaining a productive learning experience for all students.

Problem-based learning is an instructional approach that has been used successfully in elementary, middle schools, high schools, undergraduate, graduate, and medical schools. Researchers have found that PBL improves academic achievement and social interactions. Research studies state that problem-based learning is an approach that meets the needs of adolescents.

Middle school students are in a transition stage with needs that must be met. They often feel unprepared to take on the more rigorous curriculum. In addition to the academic concerns, they are not equipped to make the decisions that result from their changing physical and social development. Problem-based learning (PBL) provides students a framework for working through problems that are developmentally appropriate. Further research is needed to provide educators with the knowledge that is essential to successfully implement problem-based learning.

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