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Problem-Based Learning

What and Why

You can memorize your way through a labyrinth if it is simple enough and you have the time and urge to escape.

But the learning is of no use for the next time when the exit will be differently placed.

—Unknown

Knowing What

Getting started in any conversation about problem-based learning (PBL) requires knowing exactly what is being called PBL. There are many interpretations of the methodology and just as many descriptions of what it is. For the purposes here, the following working definition is provided to support a framework for better understanding what PBL is and why it enhances traditional teaching approaches.

PBL is a teaching method based on the principle of using problems as the starting point for the acquisition of new knowledge.

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Pivotal to its effectiveness is the use of problems that create learning through new experience, new content acquisition, and the reinforcement of existing knowledge. Situations that are in the students' real world or that they can recognize as part of their relevant future are presented as problems and stimulate the need to seek out new information and synthesize it in the context of the problem scenario. To underscore the real-world nature of the problem, students are given a specific role in the problem scenario that enhances their ownership with working toward its resolution.

Here is a simple and familiar real-world illustration of PBL. Consider the last time you required driving directions to somewhere you had never been. You begin the process with what you already know, or your existing knowledge: where you will start driving and where you intend to arrive. You then identify what you need to know to effectively and efficiently reach your destination: names of streets and highways, distinguishing landmarks to look for, and perhaps the mileage you should anticipate. You then integrate this information with your existing knowledge; for example, the amount of time it typically takes you to travel the number of miles and the type of road conditions you can expect. Often, after creating the experience of using the new information to travel a new route and successful arrival at the appointed destination, you can later retrieve this new information and apply it to similar situations. It is also likely that you will retain much of the new information and be able to successfully travel the same route again when the need arises.

The real-world frame of reference for you in the example above is that it is likely you have had to acquire and follow driving directions unfamiliar to you before. Each learner has his or her own real-world frame of reference that should be attended to when PBL problem scenarios are developed and used in the classroom. That frame of reference for a 12-year-old is obviously quite different from that of a 17-year-old, but it is just as significant for the effective use of PBL. It is helpful to understand the learner's real-world frame of reference when determining the role the student will assume within the problem scenario. For example, 12-year-olds still enjoy fantasy as part of their entertainment, and a PBL problem scenario might give

them a futuristic or fantastical role. They might be assigned a role in the problem as a future space explorer or as a member of an undersea research community. Seventeen-year-olds, on the other hand, are beginning to see themselves as adults and are more attracted to realistic roles. They may be assigned the role of engineer or landscape architect. It is important to remember that for PBL problems to be most effective, students should be able to engage or identify with the role they have been assigned.

There are further characteristics that define and determine the quality of how PBL shows up in classroom instruction. It is essential that the learners determine their own learning needs, or learning issues, based on the problem they encounter. This is the student-centered element of PBL. In the earlier driving example, imagine that someone else determined the directions you needed without taking into account your own existing knowledge. The information they decided to provide you could discount your starting point, your familiarity with some of the route, or your own travel preferences. In essence, they would be telling you what they think you need to know, with little regard for what you think you need to know. To get excellent information, you must get answers to the questions that will help you. As the learner, you are the one who should frame these questions and then seek out the information. It is this part of the process that creates higher retention of new content and better recall at a later date.

Effective PBL lessons are facilitated for learners to determine what they need to know in order to proceed with resolving the problem. The new content that is intended for learners to pursue is embedded in how students will get to problem resolution. Curriculum standards and content objectives are linked to the problem-resolution component of this process. So, if the content standard in the driving example is “Students will know where Maple Avenue is located,” then finding Maple Avenue will be an integral component of resolving the problem students are given, perhaps as a cab driver who must get from point A to point B in the shortest distance. This allows learners to frame the question, “Where is Maple Avenue?” so it is meaningful to them in relation to what they already know about the location of point A and point B. Now it becomes important to them to

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know where Maple Avenue is because they have decided they need this information to fill out their knowledge base regarding this problem.

Unfortunately, as educators we typically spend quite a lot of time telling our learners what they need to know without first determining what they already know or what they think they need to know. Rarely do we ask students to frame the questions that align with the type of information we think is important for them to have. Rather, we provide students with information we have already deemed relevant through lectures, handouts, worksheets, or assigned readings. In PBL, the process is somewhat reversed. Through the problem, students determine what is relevant, make that declaration, and then seek out the information they need. As the teacher using PBL problems, you will be able to accurately anticipate the students' learning needs based on the problem you have selected.

Teachers are often nervous about this notion of allowing students to determine what they need to know or which learning areas they will pursue. These questions are often posed by the inexperienced PBL teacher: How do you know that students will come up with appropriate learning issues, or how can a teacher be certain that the intended content areas will be included? PBL problem scenarios do not stand alone but are designed and facilitated by the teacher. Well-constructed problems coupled with effective facilitation will prompt students into the intended learning areas. In this book you will find examples of effective PBL problem scenarios and instructional units by grade level, the qualities and characteristics of effective PBL problem scenarios and their development, and strategies to ensure effective facilitation of PBL problems.

Collaboration and Differentiation

The PBL approach requires that students work in small groups to attain their learning objectives. Teachers will be further reassured about how learning issues are identified when they observe that within groups, the learning needs tend to be somewhat diversified. The learning needs of one

student complement the learning needs of another as the group works together to address all the learning issues. A host of noncognitive skill development opportunities occur within the context of the small group. Students learn the skills of negotiation, mediation, and cooperation. They learn to organize themselves and their work, to self-direct in their learning, and to determine which resources are credible and reliable. Interpersonal skills in the areas of communication, mutual respect, and mutual consideration are developed in the cooperative nature of the groups. Students learn the art of contribution, they learn how to assist others in contributing, and they learn to distinguish valuable contributions and to acknowledge others for making them.

As these small groups become the focus of the learning situation in classrooms, teachers must assume a different and sometimes unfamiliar role. Rather than being the sole content authority in directing the learning process, the teacher now becomes the facilitator or coach of each small group. Suggestions for effective facilitation skills are offered throughout the book.

Collaboration within the group is an element of PBL that is necessary to accomplish problem resolution. This is a lifelong skill that makes sense to begin developing and practicing as early as kindergarten and certainly needs to be sponsored in the classroom by the middle and high school grade levels. The type of intended collaboration in the small group includes resource identification, peer support, acknowledgment and continued reinforcement of existing knowledge, and assistance and assurance in integrating and synthesizing new information. The formation of small groups, their dynamics, and how well they function are all important considerations in the PBL process. Because these elements are dependent on the learner's developmental stage, the principles to consider are presented in later chapters as they relate to grade level.

The last essential element of PBL is that in the process, students must take responsibility and be held accountable for their own learning. Once the students have identified their own learning issues, it is fundamental to the success of PBL to make them accountable for that learning in meaningful ways. Students must be able to demonstrate that within the process, they have acquired new content and that they can apply that new information

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toward problem resolution. Creating the situations that allow students to acquire new content and demonstrate application constitutes an entire chapter dedicated to authentic assessment strategies.

PBL Provides Relevance to Learners

There are philosophical underpinnings to the PBL process that explain why one would choose to make a shift to PBL in the classroom. In *How to Use Problem-Based Learning in the Classroom* (1997), Delisle gives a thorough and informative description of PBL. He describes its historical development and medical school origins. Consideration of learning theories and their alignment with PBL is provided. His book is rich with background that helps anchor the philosophies behind PBL. In this book, however, the focus is a more practical overview of why shifting to PBL practices in the classroom creates advantages for both the learners and the teacher.

PBL creates opportunities in the classroom that traditional approaches simply do not. Perhaps the most significant is that the relevance of the learning is highlighted for students. Because the problem scenarios have a real-world frame of reference, they are centered on an event that the students can imagine in their own life or in their future. The students then determine their own learning needs to understand or resolve the problem. Now, because the students have determined for themselves this “need to know,” the learning that occurs is highly relevant. This contributes to holding the students’ interest, developing a deeper understanding of the content, and increasing the retention of new information. It also contributes to eliminating the ever-present question, “Why do we need to know this?”

The emphasis in PBL is on conceptual understanding rather than the memorization of facts. The intended learning is presented through the problem scenario in a way that compels students to want to know and need to know the new information, much like the driver who needs directions. The problem then requires the students to use the new information to present

resolutions to the problem. As the students work in their small groups toward solutions, they must collaborate and negotiate within the group to rule in and rule out viable solutions. They learn to be in functional relationships with each other to accomplish the group's goals. Students develop communication skills and more sophisticated interpersonal skills. They develop respect for one another's contributions and find ways to acknowledge and encourage each other.

In addition to these benefits, students report that they become excited about resolving the math or science or political problems and about discovering new information that helps in figuring out what is going on in the problem. Discovery, fun, and excitement are all elements that most learners prefer to have as part of instruction. We tend to work harder and longer on the endeavors that we enjoy. When students work longer and harder, they learn more and are more likely to be able to use the new information in similar contexts and situations at a later time. Also, teachers are assured that students have learned when they can apply new content.

Another outcome for students is the development of a process for lifelong learning. Students become aware that they are able to figure out what they need to know, find what they need to know, and use this new information to create solutions in situations that have no obvious answer. They grow more confident in their abilities in these areas and soon are engaging the process even outside the classroom.

A high school student recently shared the story of how she used the process for beginning a search for colleges that would best suit her. She first made a list of what she knew: the major curriculum she intended to study, the size of the college she thought she would enjoy most, the geography/climate that most appealed to her, and the greatest distance from home she wanted to be. She then made a list of what she needed to know: which colleges offered the major she wanted to pursue, which colleges had a strong reputation in that major, what was the tuition, where was the college located, and what were the admissions standards compared to other colleges of similar profile. She used a variety of resources, including her guidance counselor and printed information she obtained from the counselor. She used Internet searches and her local public library.

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This young lady was using the process of determining what was known, what additional information was needed, and what resources were available. The significance of this example is that the student applied the process she had become familiar with in her classroom to an issue in her everyday, real-world life.

PBL Teaches Lifelong Problem-Solving Skills

This leads us to yet another significant benefit of using PBL. In this student's example, she was not focused as much on coming up with one right answer or solution to the dilemma of college choice as she was on obtaining the most useful information to expand her consideration of choices. PBL is specifically designed for students to focus on coming up with multiple solutions rather than one "correct" answer. The value of right or correct information as it contributes to problem solving is not negated. The intention here is not to detract from the use of accurate information such as $2 + 2 = 4$. But the value of knowing that $2 + 2 = 4$ is in how that information can be used toward problem resolution rather than in just knowing it to be so.

Focusing on multiple solutions rather than on correct answers allows students to be successful in ways that have not been available to them in traditional approaches. There are limited opportunities to be considered successful in most classrooms. Success tends to be defined by the highest scores, the most right answers, the neatest work, and, often, the most conventional work. While there is value in high scores, correct answers, and neatness, there is also value in creativity, discovery, contribution to a process, and contribution to the development of other people. Students not only are afforded these opportunities in the PBL process but are positively acknowledged as they engage the opportunities. We all have the tendency to return to and continue the things that make us feel successful. Students return to PBL each time feeling more confident, motivated, and excited about what they are able to accomplish.

The PBL Process in Action

When observing a PBL lesson, it is sometimes difficult for the novice to discern the underlying structure. Often what makes a newcomer to PBL slightly nervous is that there appears to be a very loose strategy at work. The reality is quite different, and knowing what to look for assists in providing assurance that there is a specific framework supporting the process. There are actually very specific components to the process that are there to ensure that the principles underlying PBL remain intact.

A typical PBL session begins in this fashion: The students, either as a large group or in small groups of four to six each, encounter the PBL problem scenario. The delivery of the scenario may vary from projecting the problem using an overhead projector, to a PowerPoint projection, to providing a hard copy of the problem scenario to each student or student group. For a middle school class, the problem might be as modest as this:

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.

One student reads the problem aloud. This accomplishes several things. First, students need practice reading aloud. Eventually, they will find a comfort zone with reading aloud and will recognize that not all students know all words and their pronunciation. The idea is for them to help each other when there is an unknown or unfamiliar word. The other students in the group follow along as the problem is read aloud so there is confidence that all have heard and read the same problem without omitting key words or skipping sentences. PBL is a student-centered method, so it is always a student who reads the problem aloud.

Once the students have encountered the problem, they proceed to create a series of lists. One list is called Facts and should itemize all the facts they have been given in the problem. This helps them begin to identify what they know. In the above

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example, students would list things such as “We have a \$500 budget; it is cold weather; there are four family members; we want to buy as much as possible for the family.” They then make a list called Need to Know. Here they list all the information they would like to have to better understand the problem and their role in resolving the problem. In the current example, students might list things such as “Who are the family members; what are their ages, genders, clothes sizes; what are they most in need of; where can we get the most value for our money?” From this Need to Know list, students should begin to derive a Learning Issues list, comprised of the things they need to look up, research, or explore in order to move forward with problem resolution. The learning issues for the example would likely include “Understanding discounts; daily recommended nutritional requirements for food purchases; something about the children’s developmental stages for purchasing educational toys.” The Need to Know or Learning Issue list should be followed by a plan of action that will list the next steps to be taken in order to obtain new information. You will notice that a column for the plan of action is not included in Figure 1.1. This particular chart is designed to capture and blueprint the learning objectives that are pursued and how they relate to the possible solutions. The plan of action may reflect a plan for the entire group or may be individualized by each student. If you prefer to have students document their plan, then simply add a column to the format for Plan of Action. Following the exploration phase, the students should then list their possible solutions. This list will have ideas about how to resolve the problem and should require the development of a New Learning Issues list. This new list is used to gather additional information that will allow the students to rule in or rule out the possible solutions they created.

Here is a more detailed example of a seventh-grade science problem regarding weather and the process for working through it:

You are a weather forecaster in Morehead, North Carolina. You are currently concerned about a tropical storm off the coast of Africa. You must track and predict where it is going and when it will strike land. Once you have collected this information, you must give warnings to ships and military aircraft that could be affected by the storm.

Figure 1.1 PBL Process

<i>Facts</i>	<i>Need to Know</i>	<i>Learning Issues</i>

<i>Possible Solutions</i>	<i>New Learning Issues</i>

<i>Defendable Solution(s)</i>

NOTE: This or a similar form is the basic document in the PBL process. It may be structured slightly differently or it may take two or three pages, but the categories are constant. See Resource B for examples of filled-in charts.

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The students' Facts list may contain things such as "We are weather forecasters; we are in Morehead, North Carolina; there is a tropical storm, and the storm is near Africa." The Need to Know list may contain things such as "Where is Morehead, North Carolina? Where is the storm on Africa's coast? How fast is the storm moving?" There are additional facts that may be supplied to the students by providing them with maps and other information. The Learning Issues list may contain things such as "What makes a storm tropical? How are storms classified? What affects storms' movements?" From these learning issues the students might gather information about barometric pressures, ocean currents, and wind scale. They will further explore geographic issues around the landfall of the storm and where the potentially affected military bases are located. They will use mathematical equations to determine storm speed as they predict its movements. After gathering this kind of new information, students will make their list of Possible Solutions. In this case, that list might contain two or three hypotheses about where the storm will land. Then, in the context of the problem scenario, students should be provided with enough additional information about the storm's movements to eventually choose one of their hypotheses as the most viable.

Throughout this process, the teacher's role is very active as the facilitator and guide. Sometimes the teacher may take the role of "expert resource" in order to provide some of the needed information. For the most part, however, the teacher is monitoring the process and progress of the students, helping them to explore the intended learning objectives, and reassuring them or redirecting them as needed. It is important to understand that the teacher is anything but absent from the dynamics and effectiveness of this learning approach. The teacher is pivotal to the opportunities available to the students in the PBL methodology.

In a Nutshell

The intent in this book is to provide teachers with an understanding of the PBL process and with sample instructional materials

to support classroom implementation. Chapters 2 and 3 address these issues by grade level, giving special attention to the developmental characteristics of middle and high school students. The additional elements that contribute to the success of PBL instruction, such as group size, group work, supporting content learning, timing, pacing, and the teacher's role, are discussed by grade level as well.

Chapter 4 describes the process for developing instructional materials that align with PBL and for creating PBL problem scenarios. The principles of problem development, format and delivery of the problem, and flow and management of the problem are presented. Issues of classroom resources, the use of Internet technology, and external resources are considered. Multiple examples are used to demonstrate the described principles and to guide teachers in their own materials development.

Chapter 5 provides an overview of the appropriate and effective use of authentic assessment techniques and PBL. Sample evaluation tools and strategies are provided as well as assessment templates specific to evaluating the students' process skills and group function levels. Guidance for evaluating students as individuals and for evaluating a student's group performance is discussed. Also included in this chapter is information about assessing the effectiveness of PBL as an instructional approach. Many teachers are concerned about being able to determine if the methodology is working in their classroom. How does a teacher know if a student is learning more, retaining more, able to apply more, or be a better collaborator or negotiator as a result of engaging the PBL methodology? This chapter also underscores the very strong linkage between local and state standards and PBL. PBL is a powerful method that can work with almost any curriculum.

The concluding chapters describe the use of PBL beyond the high school classroom setting. There is information presented that has been gathered from postsecondary educational institutions and from potential employers that supports the use of PBL to prepare students for what awaits them following high school graduation.