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Engaging Students Through Project-Based Learning

What Is Project-Based Learning?

Project-based learning (PBL) is one of the most effective ways available to engage students with their learning content, and for that reason, PBL is now recommended by many educational leaders as a best instructional practice (Barell, 2010; Baron, 2011; Cole & Wasburn-Moses, 2010; Larmer & Mergendoller, 2010). PBL is an exciting, innovative instructional format in which students select many aspects of their assignment and are motivated by real-world problems that can, and in many cases will, contribute to their community.

PBL may be defined as using authentic, real-world projects, based on a highly motivating and engaging question, task, or problem, to teach students academic content in the context of working cooperatively to solve the problem (Barell, 2007, 2010; Baron, 2011; Grant, 2010). Student inquiry is heavily integrated into project-based learning, and because students typically have some choice in selecting their group's project, and the methods they would use to solve that

project, they tend to be more highly motivated to work diligently toward a solution to the problem (Drake & Long, 2009; Maloney, 2010). This typically results in high levels of engagement with the academic content involved in solving the problem or completing the project, as well as higher levels of academic achievement (Grant, 2010; Larner & Mergendoller, 2010; Marzano, 2007).

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PBL has been used in virtually every subject area and grade level, up through adult learning situations (Levstik & Barton, 2001; Marx, Blumenfeld, Krajcik, & Soloway, 1997; Scott, 1994). However, overall, PBL has been implemented more often in science and mathematics, and many of the instructional examples one finds involve one or both of those curricular areas (Fortus, Krajcik, Dersheimer, Marx, & Mamlok-Naamand, 2005; Satchwell & Loepp, 2003).

Because PBL increases motivation to learn, teamwork, and collaborative skills, it is now recommended as a 21st-century teaching technique (Cole & Wasburn-Moses, 2010; Partnership for 21st Century Skills, 2004, 2009). In fact, some proponents of project-based learning view modern instructional technologies and communications/networking technologies as essential in project-based learning (Boss & Krauss, 2007). An excellent pair of brief introductory videos on PBL is available at the website www.edutopia.org/project-based-learning, and the first of those videos is strongly recommended as a quick introduction to PBL.

Of course, through the years, many other terms have been used for this instructional approach, including *problem-based learning*, *inquiry learning*, *authentic learning*, and *discovery learning*. However, the general instructional approach remains the same: students identifying and seeking to solve real-world problems that they consider important and developing various projects (sometimes called “artifacts”) that may be used to demonstrate their knowledge and communicate their problem solution to others (Bender & Crane, 2011; Fleischner & Manheimer, 1997; Knowlton, 2003; Marzano, 2007).

As various proponents of PBL have described different types of projects for different grade levels, a PBL language has arisen within the educational literature. While different proponents of PBL use these terms in slightly different ways, an understanding of this terminology will help teachers understand the basis of PBL as an instructional approach. Box 1.1 presents several of these commonly used terms and their definitions, and as teachers move into PBL applications, they will need to understand these terms.

Box 1.1 The Lingo of PBL

Anchor. This is the basis for posing a question. An anchor serves to ground the instruction in a real-world scenario, and it might be a newspaper article, an interesting video, a problem posed by a political or advocacy group, or a multimedia presentation designed to “set the stage” for the project (Cognition and Technology Group at Vanderbilt, 1992a, 1992b; Grant, 2010).

Artifacts. Items created within the course of a project that represent possible solutions to the problem or aspects of the solution to the problem. The term *artifact* is used in order to emphasize that not all projects result in a written report or a presentation. Artifacts might include these, but they might also include digital videos, portfolios, podcasts, websites, poems, songs, or chants that illustrate content; art projects resulting from the project; role-play scenarios or one-act plays that represent problem solutions; newspaper articles for school or local newspapers; reports presented orally to various government bodies or other organizations; and recommendations or guidelines for actions on certain issues. In short, an artifact may be virtually anything that the project requires, given the overall expectation that the artifacts represent things required by and used in the real world (Grant, 2010). Also, in most PBL instruction, there is a heavy emphasis on 21st-century skills, so many artifacts do involve development or creation using modern digital technologies.

Authentic achievement. Represents the emphasis that the learning stemming from these projects should stem from real-world scenarios and represent the types of things adults might be expected to do in the real world (Barell, 2007).

Brainstorming. The brainstorming process students undergo to formulate a plan for project tasks is similar to other brainstorming activities, in that the goal is to get down as many ideas for possible task solution as possible, without ruling out any ideas initially. In many cases, this process needs to be directly taught to students, since some students will immediately find problems in the ideas of others, unless specifically instructed in the brainstorming process (Grant, 2010).

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Box 1.1 (Continued)

Driving question. The primary question that provides the overall task or stated goal for the PBL project. This should be specifically stated to be highly motivational; something that the students might find meaningful and feel passionately about (Grant, 2010; Larmer & Mergendoller, 2010).

Expeditionary learning. Expeditionary learning is one form of project-based learning that involves taking actual trips or expeditions to various locations in the community related to the project itself. In the sample project presented later in this chapter, an expedition might be taken to the actual plantation, the setting for the cedar tree harvest, in order to actually obtain a count of cedar trees that will allow completion of the project. Alternatively, the sample project could be accomplished without such an expedition, which would represent a more typical PBL experience. In fact, teachers should note that the vast majority of PBL examples are not expeditionary learning projects.

Student voice and choice. This phrase is used to represent the fact that students should have some say (some proponents of PBL would say exclusive say) in project selection and statement of the essential question (Larmer & Mergendoller, 2010).

Web 2.0. The term *web 2.0* has recently been used to represent the fact that technology-based instruction has moved far beyond merely accessing information using the Internet (Ferriter & Garry, 2010). Rather, web 2.0 tools stress the fact that students, working collaboratively in modern instructional technology environments, are actually creating knowledge rather than merely using technology to passively gain knowledge. Thus, web 2.0 is not a collection of new technology applications but, rather, a way of using current applications to help students solve problems and become contributors to knowledge.

As this PBL language suggests, there are many common elements to PBL projects. First, while the project assignments themselves vary considerably, nearly all PBL projects are focused on authentic problems or issues from the real world (Larmer & Mergendoller, 2010). This focus on authentic learning experiences that students might well be required to accomplish in the real world is a hallmark of virtually all PBL experiences and typically increases students' motivations to actively participate in the projects.

Next, most PBL assignments require extensive collaborative work (Grant, 2010). Students have to collaboratively plan their team's actions as they move toward problem solution, by developing a plan of action and beginning to develop a description or guidelines for development of their products or artifacts (Larmer & Mergendoller, 2010). Research and development of those products or artifacts may take many days and typically involves the creation of multimedia presentations, hands-on demonstrations, perhaps a working model, a portfolio, a podcast, digital videos, or a test model for the project or problem (Cote, 2007; Land & Green, 2000; Partnership for 21st Century Skills, 2004, 2009). PBL projects might be focused toward only one subject, or they might be interdisciplinary. The sample PBL project that follows illustrates these aspects of PBL.

PBL projects might be focused toward only one subject, or they might be interdisciplinary.

A Sample PBL Project

A PBL project dealing with harvesting a specific type of wood for furniture production is presented in Box 1.2. This project is a relatively simple one that would be appropriate for a variety of upper elementary and middle school classes, including science, ecology, and perhaps mathematics, or in a combination of those classes, as an interdisciplinary project facilitated by several teachers. This example is very basic in the sense that much more technology can be, and typically is, incorporated into most PBL projects. Also, most projects involve longer time frames than does this example. Still, this does demonstrate many aspects of what any simple PBL project might involve, and it serves to illustrate that, even in educational environments that are not rich in technology, PBL provides a viable, dynamic instructional option.

Box 1.2 PBL Project Example: Cedar Tree Harvest

Anchor: How Many Cedar Trees Can We Harvest?

A plantation home in Virginia, the Cedar Plantation, is owned by the descendents of the family that originally owned the plantation home but is operated as a state historic site in conjunction with the State of Virginia. The family wants to allow a family-owned furniture company to harvest a selected allotment of white and red cedar trees each year for furniture

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Box 1.2 (Continued)

production. On this plantation property, cedar trees occupy all of the 49 acres of woods, but the family is not sure how many trees are on the property, and they want to be assured that selected harvesting does not deplete their entire supply of cedar trees. Of the 49-acre property, approximately 12 acres, give or take, are visible from the plantation. Also, approximately 21 acres are believed to be swampland, but all of the low-lying land is on the distant side of the woods that is not visible from the house.

The family invited a fifth-grade class at the local middle school to undertake a project to determine how many trees might be selectively harvested each year, on an acre-by-acre basis. The family wants to harvest no more than 50 percent of the cedar trees in any given year, and they instructed the class to use the following data in their project, based on growth norms.

The teacher and the students discussed this project and decided to undertake it using three teams of students working independently in the classroom. Together, the teacher and the students decided that each of the three teams would devote a minimum of 20 hours to this project, spending a minimum of 30 minutes on this project daily in either their science or mathematics class. Of course, on some days, the class will spend up to an hour on this work.

Information on Cedar Growth and Family Guidelines

From seedling to maturity	Takes approximately 45 years
Average number of mature red cedars per acre	53 (based on cedar count on only one acre of the higher-ground property)
Average number of mature white cedars per acre	48 (based on cedar count on only one acre of the low-lying swampland on the property)

Tasks to Be Accomplished

Students will work in groups to accomplish several tasks:

1. Classify the types of cedar trees on the plantation. For the most part, white cedars grow in the lower-land swamps on the plantation, whereas red cedars grow on the higher ground.

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Box 1.2 (Continued)

Verify the average number of trees on each acre and the total number owned by the plantation. A webquest will be completed to guide the research on cedar tree growth in various terrains, and all students are expected to complete that webquest, either working individually or in pairs. The family requested, if possible, an actual count of trees on at least four additional acres, scattered across the property in order to accurately extrapolate the number of cedar trees (completing this task will change this from a PBL example to an expeditionary-learning PBL example). These data on the extrapolated cedar tree count should be summarized on a spreadsheet.

2. Determine the life span for cedar trees in upstate Virginia to ascertain how many trees naturally expire in a given year. If possible, provide some guidance on “worst case” scenarios (e.g., a two-year drought, late snowfall that kills new-growth seedlings in a given year) that might limit the number of trees that should be harvested yearly. Determine the number of trees available for harvest each year, based on average tree count on the four acres and other guidelines.
3. Determine a reasonable plan for selective harvest of the cedar trees that will not deplete any single section of the woodlands and will not negatively impact the view of the cedar woodlands from the plantation house itself.
4. Create a multimedia presentation that will persuade all family members of the viability of cedar harvests and the negligible impact such harvests will have on the view of the plantation from the plantation home itself.

Students Will Need Access to the Following:

1. A field trip opportunity to visit the plantation and count trees for the project
2. Computers with Microsoft Office, PowerPoint, Excel or another spreadsheet, videos, and cameras
3. Websites with information on cedar trees, anticipated drought conditions in Virginia, etc.
4. Topological map of Western Virginia to accurately determine how many acres of swampland might exist on the plantation

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Box 1.2 (Continued)**Anticipated Artifacts**

1. Four brief reports addressing questions within the project
2. PowerPoint or video presentation(s) summarizing the reported information, either for each individual question or for the questions together. This must include sufficient detail to be convincing.
3. Specific guidelines for harvesting recommendations

In undertaking the PBL project, students in the class might be divided into two or three teams with each team responsible for addressing the problem overall as well as generating the required artifacts to complete the project. In this and most PBL projects, there might be a variety of acceptable solutions to the problem, and it should be expected that various teams of students will come up with different solutions. For example, because some family members in this example are clearly concerned with the woodland view from the plantation house, one group of students might recommend that the several acres of woodland that can be seen directly from the plantation house be eliminated from the cedar tree harvest, and that would be a perfectly acceptable solution. However, another group might allow harvesting of large cedar trees up to within 100 feet of the viewable tree line, while restricting the harvest of smaller trees. That would be another acceptable solution that would result in a different number of trees available for harvest as well as different guidelines on the number of trees that could be harvested annually. Also, the average count of red cedars and white cedars on the plantation might vary, depending on how one defined swampland and each group's interpretation of topological maps of the area. Again, multiple answers are not only possible but quite likely for this project.

For that reason, rubrics are frequently used to provide some structure to the PBL instructional experience, as well as to evaluate various artifacts in the classroom. Rubrics should be comprehensive enough to suggest the level of detail desired in any possible problem solution, as well as identify specific types of issues that the teams should consider. Also, these rubrics should be shared with and

emphasized for the students as the basis for what is anticipated (Boss & Krauss, 2007). A sample rubric for use with this particular project is presented in Box 1.3.

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Box 1.3 Rubric for Evaluating the Cedar Tree Harvest Project

<i>Stated Objective</i>	1	2	3	4
Team compiled data on red and white cedar trees per acre, using a spreadsheet.	Team achieved an average tree count for each tree type but failed to compile data on a suitable spreadsheet.	Team gathered and compiled data for each type of cedar. Team compiled data in a spreadsheet with minimal organization and no recommendations on different types of cedars on different types of land.	Team gathered and compiled data for each type of cedar, included recommendations for different cedars on different land types, and created a spreadsheet.	Team gathered and compiled data for each type of cedar, including more than minimal recommendations on different cedars and land types, and created a spreadsheet that was organized, well labeled, color coded, and easy to interpret.
Team determined an average life span for red and white cedars in two types of environments.	Team did not use an appropriate procedure for calculating normal life span for red and white cedars in VA.	Team used an appropriate procedure for each type of cedar but came up with incorrect answers.	Team used an appropriate procedure and came up with accurate data on average life span for each type of cedar.	Team used an appropriate procedure for calculating normal life span for each type of cedar tree, provided accurate data on averages, and generated different recommendations for different land types.

(Continued)

BOX 1.3 (Continued)

<i>Stated Objective</i>	1	2	3	4
Team developed a recommended number of trees that might be harvested yearly.	Team's recommendation was not sufficiently detailed or justified.	Team's recommendation was adequate but was not well organized or justified.	Team had a reasonable number and an appropriately detailed justification for their recommended harvest number.	Team developed a reasonable recommendation that was detailed and well justified, with different recommendations for different cedars and land types.
Team presented multimedia presentation(s) that persuaded family members to allow the harvest.	Presentation only integrated one type of technology and was not convincing.	Presentation integrated two technologies and was persuasive but not personal enough to incite action.	Presentation included worst-case scenarios with a minimum of two technologies but was not completely convincing.	Presentation integrated three or more technologies, including different recommendations for different land types and different cedar trees.

Evaluation Procedure: Student scores may range from four to sixteen. Either the teacher or a group of students working collaboratively with the teacher awards points to groups of students for each of the objectives listed and then totals those points. Point totals of 15–16 equate to an A on the project. A total of 13–14 equals a B; 10–12 equates to a C, and less than 10 indicates a need to redo the project.

In this rubric, the teacher or teachers have clearly established some indicators about the level of detail necessary for the project solution. In the rubric itself, indicators suggest that students should consider average life spans for different types of cedar trees and document their deliberations relative to that question. Different assumptions made by different student teams will impact the ultimate recommendations for the tree harvest. Of course, information on these issues must be researched by the students, and such research for many PBL projects involves an active and informed use of the Internet.

With this noted, rubrics should certainly not be the only type of instructional or evaluation guidance that teachers will provide. In fact, a wide variety of instructional practices may be built into a PBL project, depending on the depth, level, and time limitations of the project. For example, one or more webquests are frequently incorporated into PBL projects in order to provide some structure for the assignment and assist students in researching the information they will need to solve their problem. An example of a webquest that would assist in this particular PBL assignment is presented in Box 1.4. Some proponents of PBL have suggested that a webquest itself is an example of PBL instruction (Grant, 2010). In most cases, however, webquests are considered a means of assisting in research or perhaps as one artifact resulting from the project.

Box 1.4 Webquest on Expected Tree Life Span

Objectives

1. Identify the expected life span for cedar trees to use in calculations on cedar tree harvest
2. Find out the prevalence of the most common diseases of cedar trees and determine if those data need to be included in the estimate for the cedar tree harvest

Activities

1. Obtain information on life span of red and white cedars. Write a two-paragraph summary on the life span of cedar trees on the plantation. Of course, many times several different answers can be found using different information sources. Try the following URLs and see if they agree. For each website, make a note of the answer and note whether it represents average life span or maximum life span.

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Box 1.4 (Continued)

- Wiki.answers.com/Q/What_is_the_lifespan_of_a_cedar_tree
 - Factoz.com/cedar-trees-lifespan
 - www.rook.org/earl/bwca/nature/trees/thujaocc.html
2. Can various types of cedar trees account for these discrepancies? You will need to determine what percentage of trees is white cedar versus red cedar on the cedar plantation.
 3. The team must devise a reasonable procedure for determining how they resolved discrepancies in life span for red and white cedar trees and explain that in detail in a two- to four-paragraph statement. This will become part of your final presentation.
 4. Are there diseases that must be factored into the question? Check on diseases for cedar trees in Virginia at the following website. Write a paragraph to explain why you did or did not include this factor in your overall recommendation for the cedar tree harvest.
 - www.gardensalive.com/article.asp?ai=879&bhcd2=1295464860
 5. The team must make a determination as to what an “adult” cedar tree is (this should be described in terms of how many feet tall the tree is). The team will also need to calculate growth rates to determine how long a cedar tree takes to reach adult status. This should be summarized in a written paragraph. The following website will help:
 - www.cedartrees.com/our_trees.asp

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In addition to this sample project, teachers should investigate other projects, and many are available on the Internet as well as throughout this text. Box 1.5 presents a list of websites that provide information or sample PBL projects that teachers might

review, as well as information on how to plan a PBL project.

Box 1.5 Websites on Project-Based Learning

Bie.org. This is the home website for the Buck Institute for Education, which is a nonprofit corporation dedicated to project-based learning. This site can offer materials for purchase in PBL as well as professional development opportunities for project-based learning.

Edutopia.org/project-based-learning. This site is provided by the George Lucas Educational Foundation and offers several short videos including a three-minute video, *Introduction to Project-Based Learning*, and a nine-minute video, *Project-Based Learning: An Overview*. These are recommended as excellent introductions to PBL. One can also join the new online magazine focusing on project-based learning.

Imet.csus.edu/imet2/stanfillj/workshops/pbl/description.htm.

This site is perhaps the single richest resource on project-based learning, in that many other sites are linked. One can find many examples of PBL projects and information on how projects may be designed and implemented.

Internet4classrooms.com/project.htm. This site provides a compendium of other links that can support project-based learning. Examples include a site of biographies of famous persons in a variety of areas (science, history, politics), as well as sites providing statistics on various countries. This site should be provided as a resource directly to students in many middle and high school PBL projects.

PBL-online.org. This is a site related to the Buck Institute that provides information on how to design PBL projects using five sequenced tasks: begin with the end in mind, craft the driving question, plan the assessment, map the project, and manage the process. Various video examples of teachers collaboratively planning to implement PBL projects are provided as a professional development source on PBL.

Superkids.com. This website identifies educational software for students, listing almost 200 examples of problem-solving software for the classroom. Ratings of this software by students, parents, and experts allow teachers to select programs that might be appropriate for their classroom.

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Box 1.5 (Continued)

ThinkQuest.org. This website provides a platform, referred to as ThinkQuest, that teachers use in constructing PBL projects for their classroom. ThinkQuest is a protected online environment that enables teachers to design and carry out learning projects within the classroom or in conjunction with other teachers worldwide in the ThinkQuest global community. On this website, teachers can find links to more than 7,000 project ideas and activities for PBL.

Components of PBL Assignments

Nearly all teachers have required students to complete a wide variety of projects over the years, but proponents of the PBL instructional approach indicate that not all projects done in classrooms should be considered examples of PBL (Grant, 2010; Larmer & Mergendoller, 2010). For example, as indicated by Larmer and Mergendoller (2010), students must perceive the PBL project as personally meaningful to them in order to realize their maximum involvement in solving the problem, and those authors consider that to be a defining characteristic of PBL versus other projects undertaken in schools. Other proponents of PBL emphasize other aspects of PBL as defining characteristics, such as specification of student roles within the context of the project (Barell, 2007) or a driving, highly motivating question that is authentic by virtue of being focused on real-world scenarios (Grant, 2010). In fact, most descriptions of PBL identify a

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variety of specific components or specific types of activities that should be included in order for a project to be considered an example of PBL (Barell, 2007; Baron, 2011; Grant, 2010; Larmer & Mergendoller, 2010).

Nearly all descriptions of PBL suggest that teachers, working in collaboration with students, develop a highly motivating, guiding question that the students will relate to (Barell, 2007; Grant, 2010). This is sometimes referred to as the “driving question” for the PBL experience. In PBL, students are given or develop a challenging, complex task that resembles tasks adults might face in the real world. In most projects, such a driving question will not have a simple solution

(Grant, 2010), and various acceptable solutions are likely to be generated by the different groups working on the project. Next, students might be provided with an “anchor” that may be an introductory video, narrative, or presentation that indicates the importance of the driving question and suggests why and how the problem might be addressed.

Once an anchor is provided, and a guiding question, problem, or project is determined, students working together will engage in a complex series of tasks to plan and organize their activities in order to move toward a solution to the problem (Grant, 2010; Larmer & Mergendoller, 2010). These tasks vary from one proponent of PBL to another, but they generally include the following:

- Brainstorming possible problem solutions,
- Identifying a specific series of topics to help collect information,
- Dividing up responsibilities for information gathering,
- Developing a time line for information gathering,
- Searching for information on the problem or question,
- Synthesizing the data collected,
- Collaborative decision making on how to move forward from that point,
- Determination of what additional information might be essential, and
- Developing a product, or multiple products or artifacts, that allows students to communicate the results of their work.

As this list of tasks indicates, PBL projects can be quite extensive and may involve a variety of time frames (Fleischner & Manheimer, 1997; Knowlton, 2003). Given the wide variation of descriptions of PBL instructional experiences, Chapter 3 of this text will describe the various components of PBL more comprehensively, as well as provide guidance for development and design of PBL projects.

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Rationale for a PBL Instructional Approach

In the same way that various proponents of PBL emphasize different components of this instructional approach, various advocates identify different reasons for employing this teaching using this framework. Some advocates have focused on increased levels of student engagement with the subject matter or higher levels of

motivation to complete assignments that are personally meaningful to the students (Drake & Long, 2009; Fleischner & Manheimer, 1997; Grant, 2010).

In contrast, others suggest that PBL instruction is more likely to prepare students with 21st-century technology and problem-solving skills (Bender & Crane, 2011; Partnership for 21st Century Skills, 2007, 2009). Finally, the social learning basis for this instructional approach is cited as an advantage by virtually all proponents of PBL (Barell, 2007; Drake & Long, 2009; Grant, 2010). As one example, the Project on the Effectiveness of Project-Based Learning identified three criteria that summarize these aspects of PBL:

1. Curriculum that is built around problems with an emphasis on cognitive skills and knowledge;
2. A student-centered learning environment that utilizes small groups and active learning where teachers serve as facilitators, and
3. Student outcomes focused on the development of skills, motivation, and a love for life-long learning (Drake & Long, 2009).

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The PBL approach encourages students to participate in project planning, research, investigation, and the application of new knowledge in order to reach a solution to their problem (Rule & Barrera, 2008). In that sense, PBL is rather like problems confronted in life in that frequently there is no apparent organized structure that allows one to reach a solution, and that structure must be created and imposed by the students themselves in PBL. This type of learning forces students, working in collaborative teams, to create meaning from the chaos of a plethora of information, in order to articulate and effectively present a solution to the problem (Rhem, 1998).

In an age of instant communication with today's digital media, and availability of nearly unlimited information on the Internet, advocates of PBL suggest that making sense of the virtual mountain of chaotic information is exactly the type of knowledge construction that every student in today's world needs to master.

Of course, in an age of instant communication with today's digital media, and availability of nearly unlimited information on the Internet, advocates of PBL suggest that making sense of the virtual mountain of chaotic information is exactly the type of knowledge construction that every student in today's

world needs to master (Barell, 2010; Partnership for 21st Century Skills, 2007, 2009). Further, the integration of assorted subject areas with various thinking skills in PBL helps teachers work through extensive content standards by teaching students to see the connectedness of the big ideas within the various curriculum areas (Rule & Barrera, 2008).

Project-Based Learning and Differentiated Instruction

Many proponents of PBL suggest that project-based instruction provides wonderful opportunities for differentiating instruction in most public school classes (Bender & Crane, 2011; O'Meara, 2010; Schlemmer & Schlemmer, 2008; Tomlinson, 2010; Tomlinson, Brimijoin, & Narvaez, 2008). For example, in Barell's (2007) description of PBL, he described how PBL projects can be improved by focusing on the content to be learned, the instructional/learning process, and the instructional products that demonstrate learning, and these three factors are likewise the major focal points of Tomlinson's description of differentiated instruction (Tomlinson, 1999, 2010; Tomlinson et al., 2008). In the chapters to follow, these three factors will repeatedly appear as important considerations in planning and conducting PBL projects, and this demonstrates the relationship between project-based learning and differentiated instruction, both of which are viewed today as examples of 21st-century instruction (Barell, 2010; Tomlinson, 2010).

Three factors, learning content standards, learning processes, and products of learning, are the major focal points of both PBL and of differentiated instruction.

More pointedly, in order to meet the needs of diverse learners in today's classrooms, a variety of instructional activities are needed, with some students completing some activities while other students complete others. This is both the essence of differentiated instruction as well as the overall result of PBL-based instruction. In that sense, PBL does tend to foster high levels of differentiated instruction in most instances.

A Plant Growth PBL Project for Grade 3

Of course, the level of differentiation can depend on the length of time devoted to the PBL project, and not all PBL projects are as extensive as the project presented in Box 1.2. Indeed, some projects may

be completed without leaving the classroom, and these may take only one or a few periods or portions of instructional periods to complete. Imagine, for example, a teacher in a third-grade classroom involved in a study of the life cycle of plants. That teacher might create cooperative learning groups in which each group was responsible for a presentation on one stage of that life cycle (seedling, early growth, flowering and reseeding, etc.) with the overall goal of presenting some information to the class on that particular phase of plant development (more on this type of cooperative learning is presented in Chapter 4). That type of PBL project might take only one or two periods for research, with an additional period for presentation of the information. A project description for this work is presented in Box 1.6.

Box 1.6 Plant Growth PBL Project

A Primary PBL Example

Anchor: How Do Plants Grow?

The third-grade classes in our primary school are presenting a one-hour assembly for all of the classes from kindergarten up through Grade 3 to celebrate the coming spring season. Various classes will study different aspects of the season, and our class will need to present a 15-minute demonstration on how plants grow in the spring during that assembly. A video of the entire assembly, including our presentation, will be made available on the school website for all of our parents and the community.

Driving Questions: Information We Need to Find

How can we present the life of a plant and the importance of the changes that take place in the spring?

Tasks to Be Accomplished

Students will work in groups together to accomplish several tasks:

1. Identify and describe the stages of plant life. How many are there? How are these stages of life defined?

(Continued)

Box 1.6 (Continued)

2. What do plants look like in various stages? Obtain pictures of videos showing the stages.
3. What is happening in various stages? How can we show that?

Students Will Need Access to the Following:

1. Computers with Microsoft Office, PowerPoint, Excel or another spreadsheet, videos, and cameras
2. Websites with information on plant life

Anticipated Artifacts

1. A one-page summary of each stage of the plant's life cycle, complete with pictures or video showing that stage
2. A time-lapse video of plant growth (obtain from Internet, if possible)
3. An organized presentation including PowerPoint or video presentation(s) summarizing the stages of plant life

In order to differentiate instruction within that project, the teacher might create a heterogeneous group for differentiated activities, with each group including a strong reader, a strong writer, a technology-savvy student (who could find Internet examples of plant life cycles), a weaker reader, and a fairly well organized student leader. In that manner, each member in the group would be able to use their own personal strengths to achieve the group goal while also learning from the rest of the group.

As this example illustrates, project-based learning can be considered as a vehicle for providing highly differentiated instruction in virtually any classroom. Box 1.7 presents several other examples of shorter-term and longer-term projects in which a teacher might easily develop and incorporate various differentiated activities.

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Box 1.7 Examples of Differentiation in PBL Conclusions

- A. In the PBL project previously described (harvesting cedar trees in an ecologically sound fashion), students needing enrichment might be required to create and edit a podcast on various life span differences between assorted types of cedars or disease scenarios that impact tree growth and harvesting. That type of assignment would require a storyboard for the podcast, and students with strong writing skills would certainly have an opportunity to show their skills in that area. Others could participate in the podcast creation through camera work, editing, or the provision of props for the podcast's Internet-based content. Students needing intervention and remediation in various reading or research skills might be required to create or participate in a blog on forest growth as one part of their responsibilities, and the somewhat shorter format used in most blogs would provide a chance for struggling students to practice their writing skills without the intimidation factor associated with longer written projects.
- B. Many projects can be differentiated to specifically address the needs and abilities of musical learners, bodily kinesthetic learners, and learners with other strengths. If a fourth-grade teacher is undertaking a project on the types of life within the oceans of the world, that teacher might begin by summarizing the main 10 or 12 points within the project content. These may be definitions of the various types of sea creatures—crustaceans, fishes, mammals, etc.—or points that emphasize the differences and relationships among them (e.g., predators/prey, common characteristics). In fact, teachers might even form small groups and let those groups determine what those critical 10 or 12 points might be, while providing some coaching and guidance along the way. Then students with musical ability might be tasked to create some form of chant or song to teach those main concepts. Alternatively, students who learn best by bodily movement might be asked to develop a “movement model” that could show the relationships among planets, asteroids, moons, stars, galactic dust, etc. All of these could be identified as different artifacts that are required within a PBL project.

(Continued)

Box 1.7 (Continued)

- C. In a kindergarten PBL project, students might undertake the study of living and nonliving things in the schoolyard. Teams of students could be formed to collect either actual examples of various objects in the schoolyard (grass, leaves, paper, or trash) or pictures of those objects (swing sets, baseball bases, etc.). Students might then work in teams to identify and describe differences among these classes of objects. To differentiate this assignment, the linguistic learners, who are more likely to be academically accomplished writers, can write down a sentence about each object noting the differences. Subsequently, interpersonally skilled learners might be used to actually present the team results to the class, and during that presentation, bodily kinesthetic learners might participate by holding up the objects and pictures of objects being described.
- D. Biology students in high school might undertake this project: identifying infectious bacteria within our school. In developing that project idea, the use of microscopes would be essential, and bodily kinesthetic learners would benefit from the hands-on nature of the project. Brainstorming various locations for such bacteria would be useful (though the teacher might wish to disallow study of bacteria on commodes!). However, collecting bacteria samples on classroom desks, doorknobs, floors, lockers, kitchen and bathroom sinks, etc. would be acceptable. Students with linguistic skills could write summaries, and students with mathematical or classification skills might develop spreadsheets to depict bacteria in various locations.
- E. Students in middle school or high school who are involved in a mathematics class, or perhaps a consumer economics class, might undertake a project answering this question: Can our family purchase a new car for me? One can imagine how pressing that question might be! Students would then need to account for their parents' income (both Dad's and Mom's salary or some income figures created by the teacher as an example), any monthly part-time work income that the student might generate, and other family income such as child support or tax refunds.

(Continued)

Box 1.7 (Continued)

They would also need information on bills that must be paid (monthly and yearly bills, info on insurance rates for adolescents, car costs for used automobiles). By compiling all of those data, students would get a good sense of the family budgeting process. If parents are reluctant to share the actual family budget information, the teacher might create a family and provide these data in some form.

- F. An example of an upper elementary project in health might involve a survey of our food! Students could develop a presentation for the school administration on the types of breakfast and lunch meals served in the school cafeteria, as compared to the recently published “Food Groups Plate” graphic that was developed in 2011 by the Department of Health and Human Services of the federal government. In comparison with that representation of appropriate food groups, do the meals served in the cafeteria adequately represent the governmental recommended diet?

This chapter has presented a rationale for PBL in the context of 21st-century instruction. While teachers have presented various instructional project assignments to their students for many decades, the move to PBL involves much more than merely the assignment of an individual project within a given instructional unit. Rather, PBL involves a shift to student-centered learning on authentic, engaging problems and questions, and the increased use of web 2.0 tools and other instructional technologies in the teaching process. The next chapter presents a discussion of PBL in the classroom and research supportive of PBL.