Assessing Student Learning in PBL

By Nicholas Massa, PhD

A good problem solver is someone who can approach any problem and systematically dissect, analyze, and formulate a coherent and viable solution strategy. Good problem solvers are patient and methodical, carefully considering all options before moving forward toward a solution. They break complex problems down into smaller, more manageable steps, making reasoned decisions on how to approach each step. Good problem solvers use metacognitive strategies to manage the problem-solving process by planning, monitoring, and evaluating their progress and strategies during problem solving, and adjusting their approach when necessary.

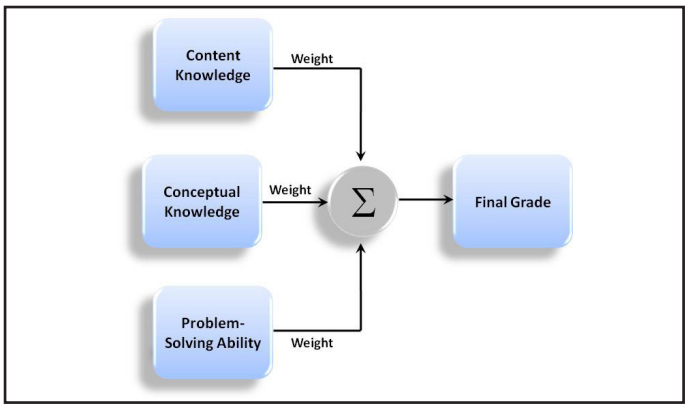
In problem-based learning (PBL), student learning is centered on solving authentic real-world problems that are inherently ill-defined with multiple possible solutions—problems that demand the use of higher order thinking skills and the ability to "think outside the box." The goal of PBL is to help learners develop the capacity to skillfully apply content and conceptual knowledge in solving complex problems in new and novel situations.

Assessing student performance in PBL, however, presents a unique challenge for educators accustomed to traditional assessment methods such as performance on homework, quizzes, exams and "cookbook" style laboratory activities. While these methods represent a convenient and effective way to measure students' content knowledge and ability to solve well-defined end of chapter problems, they do not adequately capture higher order thinking skills such as the ability to organize knowledge and understanding around key concepts and principles and synthesize knowledge in a way that creates new meaning. Assessing student learning in PBL requires authentic measures that capture not only content and conceptual knowledge, but also problem-solving ability, the process that students use in solving problems.

Based in part on the adaptive expertise model developed by the Vanderbilt-Northwestern-Texas-Harvard-MIT (VaNTH) Engineering Research Center, the STEM PBL approach for assessing student learning includes three separate measures: *content knowledge*, *conceptual knowledge*, and *problem-solving ability*. Student learning and performance on a PBL activity is determined through the summation of these three measures in which specific weights can be assigned by the instructor. This model, developed and field-tested during NEBHE's previous PHOTON PBL project, is illustrated at right.

Content knowledge refers to a student's understanding of key facts and principles within a specific domain of knowledge. To assess students' content knowledge, each PBL Challenge includes a test bank consisting of multiple-choice questions, closed-ended problems, and higher level thought-provoking questions centered on the specific technical content associated with the Challenge.

Conceptual knowledge refers to a student's understanding of the relationship between key concepts within a particular domain of knowledge and is assessed through concept mapping. Concept maps consist of groupings of circles labeled with key concepts, connected with lines and arrows labeled in a way that describes the relationship between concepts. Each pair of linked concepts produces a proposition that represents a measure of a student's understanding of the relationship between two or more concepts. Scoring is usually based on the number of connections formed and the quality and validity of the propositions generated. Each PBL Challenge contains a list of main concepts related to the Challenge topic, a "reference" concept map for instructors, detailed instructions on how to construct a concept map, and a concept map scoring rubric.



Student Assessment in PBL

Problem-solving ability is assessed through the Final Challenge Report, a reflective journal in which students reflect upon and provide a detailed summary of the problem-solving process in which they have engaged. As students work collaboratively to solve a problem, they complete four Whiteboards, a tool that guides them through the problem-solving process, helping them to reflect upon and capture their current state of understanding, thought processes, and problem-solving strategies. Research shows that verbalizing the thought process while engaging in problem-solving is essential for effective problem-solving and understanding. Upon completion of the PBL Challenge, students complete the Final Challenge Report, which represents a synthesis of the knowledge, skills, and strategies employed in solving the PBL Challenge. Researchers maintain that this final reflective exercise is essential in the development of effective problem-solving skills. A scoring rubric is used to grade the Final Challenge Report.

In short, the goal of the STEM PBL project is to produce strategic problem solvers who not only have gained content knowledge in sustainable technologies but who also have internalized skills and knowledge to apply to the process of problem-solving.

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