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Bridging Classroom and Lab Teaching in Audiology Using Problem Based Learning

Sriram Boothalingam
Western University, sboothal@uwo.ca

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Summary
In traditional classroom settings, disciplinary content is generally presented first and students' abilities to acquire this knowledge are then assessed through assignments and exams. Problem based learning (PBL), on the other hand, works in reverse: students learn in the context of the problem to be solved (Ram, 1999). PBL is based on both learning theories and constructivist principles.

In Audiology, students' learning is divided: they study theory in classrooms and the use of sophisticated equipment, and instruments, in lab practicum, separately. In clinical placements, however, student audiologists encounter diverse patients and, consequently, are expected to draw from their theoretical knowledge as well as from their technical know-how (of instruments and skills for operating equipment) at the same time.The problem in Audiology studies is that theoretical and practical skills are treated as separate entities in traditional teaching, despite the fact that both components must be applied together in real-life practice. PBL offers instructors a framework through which to assist students in learning and developing theoretical and practical skills simultaneously. This workshop will focus on preparing instructors to implement PBL and devise efficient assessment strategies to bridge classroom and lab-based learning. Since some basic understanding of core Audiology concepts is necessary to solve topic-specific problems, this workshop will focus on the use of PBL instruction in upper-year Audiology courses. Employing a meta-approach (using PBL to learn about PBL), participants will gain a first-hand experience of PBL while also learning about the research and principles underpinning this model.

Keywords
Problem Based Learning, Audiology, laboratory, classroom, PBL assessment

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LEARNING OBJECTIVES:

By the end of this workshop, participants will be able to:

- recognize and discuss the advantages of employing PBL for both classroom and lab teaching over using traditional pedagogical methods;
- evaluate their current teaching methods and devise a PBL plan for bridging lab and classroom teaching, using PBL; and
- develop custom assessment strategies for their respective audiology courses.

REFERENCE SUMMARIES:

Belland, B. R., French, B. F., and Ertmer, P. (2009). Validity and Problem-Based Learning Research: A Review of Instruments Used to Assess Intended Learning Outcomes. *Interdisciplinary Journal of Problem-Based Learning*, 3(1), 59-89.

This article is a meta-analysis of studies that evaluate various assessment strategies that assess the three learning outcomes stemming from PBL, namely: deep content learning, problem solving and self-directed learning. The main aim of this study is to further

determine the real benefit of PBL by considering the results of students who are tested according to PBL methods in comparison to those who undergo conventional teaching practices. In describing, and analyzing, this process, the authors have provided a wealth of information about different strategies that are employed by various authors to assess learning outcomes in PBL. Selected information from this article has been presented in Appendix C in order to give workshop attendees a guide for how to assess students (using PBL methods) and to cultivate their particular sense of what to look for in assessment processes. This article is also a fruitful resource, and is referred to during the workshop session in which attendees are asked to select their own assessment strategy or build one based upon existing strategies that resonate with their aims and methods.

Domin, D. S. (1999). A Review of Laboratory Instruction Styles. *Chemical Education Research*, 76(4), 543-547.

This article is a good starting point for those seeking to understand the different approaches one can take to laboratory teaching. Using Bloom's Taxonomy of educational objectives, Domin analyzes the various levels of learning that different laboratory teaching approaches provide. Domin reviews the extant literature that examines the four, main different teaching approaches one can take to laboratory pedagogical practices and, in so doing, also discusses their respective advantages and disadvantages. Although Domin does not offer a clear view on which teaching approach is best for laboratory teaching, it is apparent, in this study, that the conventional or expository approach (in which students simply follow a laboratory guide to perform experiments) does not fully prepare a student to independently think about planning and organizing an experiment.

This article will be used to introduce Bloom's Taxonomy to workshop participants and will also be used to point out the differences between the four teaching approaches and the ways in which each one contributes to the development of cognitive processes in students.

Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review*, 16(3), 235-266.

Hmelo-Silver offers an extensive review of PBL and the different stages of cognitive processing within it. Hmelo-Silver also explains every aspect of the entire PBL process, in great detail, especially focusing on: PBL's goals, its tutorial process, how it views the role of the problem in student development and the role of the facilitator in this learning process, while also examining the other skills that are promoted and developed by using PBL. Throughout this article, Hmelo-Silver also stresses that the skills and knowledge acquired through PBL are flexible and easily transferable to other problems because, through PBL, student learning is based around the framework of solving problems (a fact that sets PBL apart from conventional teaching methods). This study also provides a literary review of research that has looked at the effectiveness of PBL in comparison to other teaching methods—while also, of course, keeping in minds the advantages, as well as the shortcomings, of PBL.

Hmelo-Silver's work will provide novices in PBL the essential starting point to

understand PBL and its advantages over conventional teaching methods. It also offers students a good sense of how other research has evaluated the effectiveness of PBL. The stages involved in learning, through PBL, as depicted in this article, are provided in Appendix A for workshop attendees.

Kelly, O. C., and Finlayson, O. E. (2007). Providing Solutions Through Problem-Based Learning for the Undergraduate 1st Year Chemistry Laboratory. *Chemistry Education Research and Practice*, 8(3), 347-361.

This article examines successful implementations of PBL-based lab learning in Chemistry. Kelly and Finlayson examine the aspects of several PBL-based labs, framing the problems that emerge in assessment strategies. To further illustrate their study, they also provide example labs and problems. A key concept introduced in the article is the use of "pre-lab" work. Since labs require certain pre-learnt skills to solve problems and understand experiments, the authors have developed the idea of pre-lab learning, and promote discussing this aspect of education in Chemistry, in order that instructors help students cultivate the required skills and approaches so that they can learn independently through PBL.

Although this article has specific examples for chemistry labs, the ideas that have been introduced here, such as pre-lab learning and assessment strategies, can be applied, and extended, to the Audiology realm. This article will be of prime focus in this seminar as pre-labs are important, even in Audiology, for learning some of the more mundane—yet important—skills, like operating an instrument(s). Such activities do not require much thought; however, they are essential skills that must be learnt in order to facilitate the problem-solving process.

Tharpe, A. M., Rassi, J. A., and Biswas, G. (1995). Problem-Based Learning: An Innovative Approach to Audiology Education. *American Journal of Audiology*, 4(1), 19-25.

This is one of the very first articles that introduced PBL to the Audiology realm. The authors start by describing issues in teaching methods in Audiology that are similar to the concerns of this article. Tharpe et al. compare Audiology education to the medical education model, noting the similarities between the types of learning required for both streams. They also acknowledge that PBL alone cannot offer all the theoretical and practical knowledge methodologies required to successfully teach, and learn, Audiology. As a result, they recommend that, in addition to employing the PBL model, instructors should also hold regular classroom and lab-based educational sessions as these have clear benefits for students as well. However, the main issue that the authors identify in current audiology and medical programs is that there often exists the problem of 'Fragmentation.' In Audiology, 'Fragmentation' occurs when instructors separate the teaching of necessary skills for becoming an audiologist into several different topics. Such compartmentalization obscures the big picture (namely, providing reparative intervention practices for patients with hearing disorders) for audiology students, often severing theoretical knowledge from their fundamental practical contexts. To address, and resolve these tendencies towards 'Fragmentation' in Audiology pedagogical practices, the authors offer some guidelines that outline ways to develop PBL units for specific, Audiology topics. They also introduce the

use of computer-based assessment methods as an effective strategy for using PBL in classroom contexts.

This article provides an essential introduction of PBL to instructors in Audiology, while also providing insights into how one can possibly incorporate PBL into their respective courses. Since the article is field specific, it will be useful during the workshop for helping participants see the various benefits of using PBL teaching methodologies in Audiology.

CONTENT AND ORGANIZATION

Workshop Target Audience: Faculty and teaching assistants in Audiology
Workshop Size: Twenty participants (maximum)
Total Duration: Ninety minutes

Duration (min.)	Subject	Activity	Purpose
3	Introduction	The workshop facilitator should introduce the intended learning outcomes and explain how the session will be conducted, specifically noting how learning about the theory and practice of PBL governs the workshop's goals.	To discuss the purpose and goals of the workshop and to Introduce workshop participants to PBL.
7	Introduction to PBL	Activity One: • Participants will be given two minutes to write down the challenges they face when teaching in lab and classroom contexts. • Using the flowchart in Figure One of Hmelo-Silver (2004), and integrating the participants' responses into discussion, the facilitator should explain how PBL can be an option that helps address various theoretical and practical pedagogical concerns / challenges. To give further context to this session, and to develop class discussion, the facilitator should bring in evidential material from Tharpe et al. (1995) that helps concretely demonstrate the success rates involved in using PBL in Audiology teaching.	To identify issues in current teaching methods and introduce PBL as a potential solution to possible theoretical and practical pedagogical concerns.

5	Fragmentation	In this session of the workshop, the facilitator will introduce the problem of "Fragmentation" and how it, and the other challenges that participants suggested in Scenario One, may affect student outcomes in Audiology. The facilitator should base his / her introduction on the studies done by Domin (1999) and Kelly et al. (2007). Following a brief definition of "Fragmentation," the facilitator should introduce Bloom's Taxonomy and underscore the ways in which problem-based learning taps into higher cognitive levels in Bloom's. To close this portion of the workshop, the facilitator should introduce the use of 'pre-lab / classroom' work, noting how it connects to the use of PBL-based lab and classroom teaching.	To identify issues in the synchrony between lab and classroom teaching in Audiology and to discuss ways in which PBL can be incorporated into both classrooms and labs to address this issue specifically.
15	Structuring a PBL module to address Fragmentation	This portion of the workshop will focus on how participants can develop their own PBL module to better marry the lab and class contexts in audiology. After a short description of the key criteria/attributes of PBL learning generally, the facilitator will lead participants through an analysis of the 'Scenario, Requirements, and Notes' portions of Appendix A (each participant should have a copy of this handout available). In small groups (3-5), participants will be asked to consider the following questions: • What types of problems in Audiology lend themselves to the PBL format? How should such problems be structured	This session aims to lay the ground-work for outlining / approaching the construction of a PBL-based curriculum.

		to ensure the achievement of learning outcomes? • What is the role of the instructor in the PBL context? What shift will this require in the approach of audiology faculty? • How does one best achieve balance between content delivery and independent student work? What mechanisms exist to ensure that key content is being learned in the PBL framework? • What are effective and productive ways to create groups in teaching / learning contexts? How to create a group? How much should students' respective personalities shape group-formation planning? Given the time constraints, each group will be asked to focus on one question and record their thoughts on chart paper or in a shareable digital format. These can then be summarized quickly in a large group and shared in more detail after the session. Note: The Instructor should incorporate theory from Hmelo-Silver (2004) and Tharpe et al. (1995).	
15	Assessment in a PBL Module	This session seeks to examine how assessment processes work in the context of PBL. The facilitator should begin with a brief presentation on assessment methods employed in PBL—see, in particular, Belland et al. (2009).	To discuss assessment methods in PBL and to develop ideas for assessments that can be incorporated

		Referring to Appendix A, the facilitator will lead participants in a brief examination of the assessment plan. The facilitator can then ask the small groups to brainstorm their perceived challenges in evaluating PBL processes. The groups can share these concerns and the facilitator can address each briefly (where possible) with reference to Appendix B (one copy should be available for each participant).	
30 - 40	Incorporating PBL into Classroom and Lab Contexts	In this section—which comprises the longest activity—the facilitator will ask the small groups to work together to find ways to apply PBL to the following, hypothetical pedagogical scenario: An above-average student comes to your office to express concern that her learning / knowledge acquisition in the lab is not synchronous with her learning in the classroom: she finds that there is a gap between the theory she learns in class and her abilities to practically apply these theories in lab contexts. What steps can you take to make class lectures / sessions translate effectively into lab activities? Further Instructions: Each group will have to come up with a solution to the general scenario in the context of a specific course/area of audiology of their choosing (in twenty minutes) and present their solution (3 minutes per group) to their peers • Each group will generate a 'PBL plan' analogous to Appendix A (hard copy or digital). The Facilitator	To practice applying PBL to a potential pedagogical scenario that includes lab and theory components.

		should then lead a discussion about the key merits of each solution. Again, if groups are willing, their 'plans' can be shared electronically following the session so that a database of diverse ideas can be developed.	
15	Concluding Remarks / Feedback and Question Period	Time should be provided for participants to voice their thoughts on PBL and for the facilitator to answer any questions / concerns the participants may have regarding incorporating PBL into their curricula.	This session provides an overview of the workshop and of the various objectives it has achieved / addressed.
Total Time: 90 minutes			

ADDITIONAL REFERENCES:

Aaron, S., Crocket, J., Morrish, D., Basualdo, C., Kovithavongs, T., Mielke, B., & Cook, D. (1998). Assessment of exam performance after change to problem-based learning: Differential effects by question type. *Teaching and Learning in Medicine*, 10(2), 86–91.

Evensen, D. H., Salisbury-Glennon, J. D., & Glenn, J. (2001). A qualitative study of six medical students in a problem-based curriculum: Toward a situated model of self regulation.*Journal of Educational Psychology*, 93(4), 659.

Gibbons, M. (2002). *The Self-Directed Learning Handbook*. SanFrancisco: John Wiley and Sons.

Hmelo, C. E., Gotterer, G. S., & Bransford, J. D. (1997). A theory-driven approach to assessing the cognitive effects of PBL. *Instructional Science*, 25(6), 387–408.

Ram, P. (1999). Problem-based learning in undergraduate instruction. A sophomore chemistry laboratory. *Journal of Chemical Education*, 76(8), 1122.

Segers, M. S. R. (1997, January). An alternative for assessing problem-solving skills: The overall test. *Studies in Educational Evaluation*, 23(4), 373–398.

LIST OF APPENDICES:

Appendix A: An Example Problem Linking Lab and Classroom Learning in Audiology

Appendix B: Assessing the Outcome(s) of PBL in Audiology

Appendix A: An Example Problem Linking Lab and Classroom Learning in Audiology

Scenario: A fifty-year old working woman with an active lifestyle has been using a hearing aid for her moderate sensori-neural hearing loss over the last five years. She is coming to your clinic as she is looking to upgrade her hearing aid. Your group's task is to fit this lady with a suitable hearing aid. Write a report that outlines the steps that you would take before and after the patient arrives at your clinic.

Requirements: Compare at least four hearing aids and justify the reasons your group's final choice. Perform tests that will ensure that the hearing aid you have selected works as advertised.

Note: This problem requires background knowledge learned in basic Audiology courses; hence, this activity is most suitable for second year Audiology students. The goal of this module is to learn about "Advanced hearing aid technologies." An Audiology classroom at Western University typically has twenty students so students can be made to work together in groups of four. The timeline for this report can be one or two weeks, depending on the material that needs to be covered in the remaining modules.

The first class will introduce this problem to the students and will be followed by a short lecture incorporating how active learning can help students understand new terminologies that may be required to solve the problem. This PBL will include both discussing the theoretical aspects of the advanced features of a modern hearing aid and also practically testing these features by using a hearing aid analyzer. The tutor will meet each group over the course of the module. In addition, students will be given specific times to meet with the teaching assistant to run experiments in the lab. Each group will be allotted specific times such that there will be no two groups in the lab at a given time.

Evaluation: Group Report: 50%; Case Study and "Suggest Next Steps" (following submission) component: 35%; Individual Written Reflective Account: 15%.

Expected Stages for this PBL

Type of Work	**Stages and Learning Outcomes**	**Life Lessons**
Introductory Lecture / Presenting the Scenario	Deep Content Learning: Understanding the problem requires application of prior knowledge.	
Working within Groups	Identifying Facts: While working in their respective groups, to find a solution to the scenario, students should be applying their prior knowledge to come up with a solution.	This session fosters team work and other leadership qualities.
Working within Groups	Generate hypothesis: At this stage, students understand the problem and have generated	This session assists with the development of problem-solving

	hypotheses to answer the problem.	abilities.
Working Individually and Reporting Back to Group	Identify learning issues / knowledge deficiencies. By this stage, students should have identified areas that need to be understood before proceeding to the next step. For example, in the scenario comprising this assignment, students will have to take some time to work separately in order to learn about different, advanced signal processing in hearing aids. Each student will then take turns teaching what they have learned to their fellow group members.	This session hones collaborative skills, team work, and presentation and communication skills.
Working within Groups and in the Lab	Applying new knowledge: For this stage, students should have enough knowledge to solve the scenario's problem. They will have to start experimenting with different hearing aids so as to select one.	This session develops problem-solving and research skills, such as: experimental design, hypothesis testing, data collection, data analysis, and statistics.
Working Individually and Reporting Back to Group	All required learning processes should be completed by this stage in the assignment. Group members will individually write up different sections of the final report and then meet to work together and turn their various contributions into a complete, collaborative document.	This session cultivates report writing abilities, individual analysis skills, and collaborative group work strengths.
Working Individually	Evaluation: Students will be assessed by the tutor and write a reflective account of the process.	This session fosters problem-solving abilities and personal reflection.

Appendix B: Assessing the Outcome(s) of PBL in Audiology

Deep Content Learning:

Deep content learning is the ability to learn, understand and apply content to new situations (Gallagher, 1997). To learn contents deeply and be able to apply knowledge to / in different situations, one must be able to integrate prior knowledge into new contexts (Belland et al., 2009).

How (1): Multiple choice Questions

How (2): Case Consideration and Suggest Next Steps (Aaron et al., 1998)

This method of assessment is highly suitable for any topic in Audiology. It involves providing a case history of a simulated / real patient and framing a question about this scenario that the student should be able to solve / answer / treat by applying learnt knowledge. This method of assessment / learning can be presented in a variety of formats, including, for example, by way of essay questions.

Problem Solving

The core principle behind PBL is to help make students better at problem solving; hence, most PBL modules start by defining a problem which students must try to solve. To successfully solve a problem, students must be able to break the problem down into its smallest components and work their way from there in a step-by-step manner. To do this, one must rely on both prior knowledge and must possess deep content learning.

How (1): Case and Suggest Next Steps (Aaron et al., 1998)

How (2): Case and Think Aloud while Defining and Solving Problem (Segers, 1997)

This method is similar to the “case and suggest next steps” procedure—except that, here, the student will have to narrate the steps involved in solving the problem. This method is suitable for assessing problem solving in labs involving instruments.

Self-Directed Learning

When comparing PBL to conventional teaching methods, it is clear that PBL offers unique emphasis on the cultivation of personal development through independent student learning and self-discovery. Gibbons (2002) described this component of self-directed learning as being “any increase in knowledge, skill, accomplishment, or personal development that an individual selects and brings about by his / her own efforts using any method in any circumstances at any time”.

How (1): Case Consideration and Describe Learning Issues and Suggest Methods to Solve Them (Hmelo, Gotterer, & Bransford, 1997)

In this method, having understood the problem using the above two learning outcomes (Deep Content Learning and Problem Solving), students should try to identify learning issues that they have to work on.

How (2): Student Reflections (Evensen, Salisbury-Glennon, & Glenn, 2001)

One of the most powerful ways to know if one has learnt something during a process is to take time to reflect and ask one’s self about the learning process. In writing reflections, students will have the opportunity to honesty evaluate their learning experience(s) throughout the process of a given PBL module.