Teaching Innovation Projects

Volume 1 | Issue 1 Article 1

2-17-2011

Inquiry-Based Learning in Experimental Sessions: Strategies towards conducting more effective Experimental Laboratory Sessions with Engineering Undergraduate Students

Ayodeji Abiola-Ogedengbe
The University of Western Ontario, aabiolao@uwo.ca

Inquiry-Based Learning in Experimental Sessions: Strategies towards conducting more effective Experimental Laboratory Sessions with Engineering Undergraduate Students

Summary
Experimental sessions in the Laboratory are usually preceded by instructional sessions where student participants are taught about the activities they will be doing in the laboratory. Despite this activity, many times students approach the actual experimentation in the laboratory as mere routine with an expected result. Hence, they are not mentally engaged rather expecting to follow strict procedures as written in the book (manual) and deliver as expected by the book. This is a hindrance to actual learning. This seminar considers an inquiry-based learning approach as a teaching technique for pre-laboratory sessions by Graduate Teaching Assistants which will help engage the undergraduate students more in laboratory activities for productive learning.

This presentation is aimed at the Graduate Teaching Assistant (herein referred to as GTA) whose duty usually include preparing students for experimental sessions in the laboratory such as is obtained in MME 2285 (Experimental Methods), a course in Western's Department of Mechanical and Materials Engineering.

For a GTA in this course and similar courses in Engineering, the Professor expects the GTA to hold instructional (taught) sessions with the students ahead of the Laboratory session where he teaches them rudiments of the laboratory experiment and issues pertaining to the laboratory which the students might not grasp in the lecture room typically taught by the Professor. Usually, the lecture room by the professor follow the traditional teaching methods and some students when not able to understand what was taught assume they will understand once they undertake the experiment in the laboratory. However, this is not always the case, so it is important they understand it before actual experimentation commenced. For the GTA through whom students have a second chance at learning from the experimentation, it is usually better to adopt a different teaching method from that which the student earlier encountered in the lecture room. The proposed teaching method is Inquiry-Based learning (herein referred to as IBL) which deviates from the traditional method and engage the student more thereby helping them to understand while complementing what they had been taught as it engages their reasoning. Where students already understood the pre-laboratory sessions in the lecture room with the professor, further teaching through IBL by the GTA will help to engage the student more and help students to mentally adjudge the work they do in the laboratory during the actual experimentation. Ditto, in cases where student erroneously think they understood the first lecture, the IBL session with the GTA can help correct misconceptions and thus avoid/understand potential pitfalls during actual experimentations in the laboratory.

Since IBL is question driven (Queen University Centre for Teaching and Learning), the GTA will be able to assess the level of understanding of students based on the teachings they have had with the professor. This enables the GTA to understand the specific needs of students as he undertakes the teaching session. The GTA could potentially benefit immensely from this teaching method in his capacity as a Graduate experimentalist as ideas deduced from doing IBL with undergraduate students could be a valuable input in the GTA graduate studies and research.

Keywords
active learning, labortatory, innovation, engineering students

Objectives

By the end of the presentation, GTAs will have learned effective strategies for:

- Conducting IBL sessions with undergraduate students before laboratory sessions
- Ensuring students participate in these teaching sessions.

Literature and Web Resources

For this seminar, I have consulted published literatures (Perreault, Litt & Saterbak 2006, Prince, Felder 2007, Justice et al. 2009) and the Queen's University Centre for Teaching and Learning (CTL) website (Queen University Centre for Teaching and Learning).

Pursuant to the Biomedical Engineering Education Summit (BEES II) sponsored by the Whitaker Foundation, Perreault, Litt & Saterbak (2006) developed a paper based on the discussions of Engineering educators at the summit where a general consensus supported basing laboratory curriculums on the development of core competencies in students rather than on teaching specific contents. As it applies in undergraduate laboratories, the core competencies needed by students will include Engineering reasoning and problem solving, Experimental Design and Data Analysis, Measurement making and Data Interpretation, Laboratory Techniques, Communication, Maturity and Responsibilities. Of the various teaching approaches common in post-secondary education, IBL is seen to be the most effective means of teaching critical concepts of the laboratory. Queens University's CTL and McMaster University in Hamilton sees IBL as a form of self-directed learning and as such is a critical skill needed to be acquired in order to be successful in post-secondary education (Queen University Centre for Teaching and Learning). This paper from the BEES II further discussed how IBL have been successfully used in two universities; North-western University and Rice University.

IBL is part of a teaching strategy known as inductive learning while the traditional lecture approach is termed deductive learning according to Prince and Felder (Prince, Felder 2007). They discussed several inductive teaching approaches along with IBL which include Problem-based learning, Project-based learning, case-based learning, discovery learning and just-in-time teaching. While IBL is the focal method for this seminar, we can examine how other forms of inductive learning could be applied for students in certain circumstances and when IBL could be applied together with these other methods. They showed that for the instructor (GTA in this case), student's resistance to teaching method is minimal compared to case-based and project-based which showed considerable level of student resistance. From the aforementioned, one might deduce that the GTA is better off doing IBL with undergraduate students rather than other inductive techniques. However, it might not be out-of-place to try or combine some of these techniques to aid learning.

For interview findings at McMaster University in Hamilton, the paper by Justice, Rice, Roy, Hudspith and Jenkins (Justice et al. 2009) discussed the barriers often encountered with IBL and how these barriers were practically overcome by instructors. McMaster University is a leader in inductive learning (Queen University Centre for Teaching and Learning, Justice et al. 2009) in Canada and hence was suitably fit for the study and the educators selected for the research included Deans, Administrators and Faculty Members. So, the paper looked much at administrative barriers faced by the University in adopting IBL.

For the literature and web references, I have been able to acquire considerable information on what IBL is and how it can be fostered and administered and challenges inherent in the method. This makes useful content for the seminar.

Content and Organisation

The seminar content will be centred on several aspects of IBL and other forms of inductive learning will be introduced. Selected participants to the seminar will comprise mainly of GTAs who have been involved with experimental laboratories in sciences and engineering. The aim of the proposed seminar will be to give GTAs near-first-hand experience of the benefits of IBL, how it works out and how it will be useful to their laboratory sessions. The activities at the seminar will include lecture, discussions and role play with 20-30 numbers of participants. Table shows the proposed 45 minute breakdown of the seminar.

Span (minutes)	**Subject**	**Activity**	**Purpose**
5	Introducing IBL	Lecture presentation with slideshow	To introduce the general concept of Inductive-Based Learning to participants
3	IBL and Experimentations	Lecture	To explain the application of IBL to experimental sessions in Sciences and Engineering by drawing from available references
7	Examples	Discussions with/among/between participants	Participants share their experiences they have in classrooms and laboratories during teaching and learning that is typical of IBL approach. This is to bring the IBL strategy closer home to participants.
18	Doing it	IBL Role play with 4 volunteers as instructors using initially prepared questions/scripts for 4 minutes each.	Give participants near-hands-on experience with doing IBL in a tutorial class or laboratory instructional sessions.
12	Appraisal and closure	Discussions on role play	Analyse how effective volunteers were in setting an IBL scenario and how their performance could be improved.

Presentation Style

The presentation of this seminar will include lectures, discussions and role playing. Facilitator will start the seminar by presenting and introducing IBL to participants drawing extensively from literature and then go on to relate it to experimentation and laboratories in the next session. These sessions will be lecture based and will emphasize the role of IBL in aiding students learning.

The first discussion session will involve a think-pair-share activity where participants discuss in pairs any IBL experiences they have had in their own learning and teaching. Some of these will then be shared with the general audience. Any participant with experience using IBL to facilitate tutorials or laboratory sessions will also be invited to share experiences with the entire audience.

The 'Doing it' session will invite four volunteers who will be given prepared scripts of initial questions to ask students to set an IBL stage. Scripts given to volunteering instructors set the stage while audience (as students) response will determine the direction of the mock sessions. When this is done, general discussions will then be made on the activity just performed. Potential pitfalls in IBL sessions will then be addressed while seminar will be closed by answering questions and encouraging participants to incorporate IBL in their next instructional session.

Concluding Remark

At the end of these activities, it is hoped that the objective of stimulating participants interest in using Inquiry-Based Learning as a means of facilitating undergraduate laboratories (and tutorial) sessions would have been met.

References

Justice, C., Rice, J., Roy, D., Hudspith, B. & Jenkins, H. 2009, "Inquiry-based learning in higher education: administrators' perspectives on integrating inquiry pedagogy into the curriculum", Higher Education, vol. 58, no. 6, pp. 841-855.

Perreault, E.J., Litt, M. & Saterbak, A. 2006, "Educational Methods and Best Practices in BME Laboratories 1", Annals of Biomedical Engineering, vol. 34, no. 2, pp. 209-216.

Prince, M. & Felder, R. 2007, "The many faces of inductive teaching and learning", Journal of College Science Teaching, vol. 36, no. 5, pp. 14.

Queen University Centre for Teaching and Learning, Good Practice: Inquiry Based Learning [Homepage of Queens University], [Online]. Available: http://www.queensu.ca/ctl/goodpractice/inquiry/index.html [2010, 12/28] .