The Problem with Problems: Helping Students Ask the RIGHT Questions

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The Problem with Problems: Helping Students Ask the RIGHT Questions

Summary
Students often approach their Engineering professors and teaching assistants for help with their assignments during office hours. This practice can be a vital part of the student learning process, yet busy Professors and TAs too often simply provide students with the solution (or steps to the solution) instead of working with the student to ensure that they understand the material. Furthermore, Boyer et al (2010) have found that Professors and TAs often ask their students very few questions, especially when they have not been trained to do so. When Professors and TAs do ask students questions, they rarely ask the most beneficial types.

This workshop provides Engineering professors and teaching assistants with information, tools, and guidance to help students solve numerical problems without simply providing them with the entire solution. The focus here is on engaging students in the learning process by helping them ask questions that facilitate active learning. This workshop gives special consideration to creating questions that can be adjusted to accommodate students’ differing learning styles.

Keywords
Engineering, questioning methods, active learning

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The Problem with Problems: Helping Students Ask the RIGHT Questions
Katie Lutz, Carlton University

SUMMARY
Students often approach their Engineering professors and teaching assistants for help with their assignments during office hours. This practice can be a vital part of the student learning process, yet busy Professors and TAs too often simply provide students with the solution (or steps to the solution) instead of working with the student to ensure that they understand the material. Furthermore, Boyer et al (2010) have found that Professors and TAs often ask their students very few questions, especially when they have not been trained to do so. When Professors and TAs do ask students questions, they rarely ask the most beneficial types.

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LEARNING OBJECTIVES
By the end of this workshop, participants will be able to:
• develop questions to aid in student learning and understanding;
• identify and differentiate between basic learning styles; and
• adapt different approaches for teaching a diverse student body.

REFERENCE SUMMARIES

Boyer et al. considers transcripts from text-based tutoring sessions between seventy-eight introductory computer science students and seventeen graduate and upper-year student tutors. Based on twenty-three possible question types, the authors categorize and evaluate the type and the frequency of the questions asked by the tutors. Boyer et al. then categorize common errors and suggest ways of rectifying them. They conclude that by frequently asking targeted questions that prompt self-explanation, tutors can facilitate deeper student comprehension of the material. This workshop will outline the classification of these questions and discuss Boyer et al.’s suggestions for improvement.

This paper describes different learning styles and discusses how to address them in the context of engineering education. Specifically, I consider Felder’s approaches for engaging “Sensing and Intuitive Learners”, “Visual and Auditory (Verbal) Learners”, “Inductive and Deductive Learners”, “Active and Reflective Learners”, and “Sequential and Global Learners”. In the 2002 preface, Felder recommends focusing specifically on inductive teaching for undergraduates. While these are not the only possible methods for describing learning approaches, this article provides a suitable background for considering the various learning styles that professors and teaching assistants may encounter in their university students. Although this article specifically addresses learning diversity in engineering students, this article is also valuable in conceptualizing individual approaches to student learning more generally.


McComas and Abraham outline a classification system for questions by categorizing them into one of the following categories: high or low order and convergent or divergent. The order of the question refers to the level of thought or reasoning required by the student to answer. Thus, low order questions are recall-based, while high order questions require students to demonstrate some level of comprehension. Similarly, convergent questions have an expected response while divergent questions are more open-ended in nature and often require students to apply their knowledge. Beyond the theoretical classification of question types, McComas and Abraham outline eight techniques for improving questions: phrasing, adapting, sequencing, balancing, participating, probing, waiting, and allowing student questions. The authors specifically focus on the need to include wait-time in order to allow students to respond to questions. These techniques, with the exception of participation, are readily applicable for tutoring students with numerical problems and are included in my lecture on how to ask the right questions.


Moreno, Reisslein and Ozogul conduct an experiment in which two hundred and thirty-two students in an introductory engineering design course are asked to solve electrical circuit problems under different set-ups after being presented with a “worked-out” example. The different scenarios include variation in the feedback students received in addition to how many steps each student had to complete in each problem. Most students received feedback that was explanatory in nature and included the correct solution. One group of students received what the researchers call “meta-feedback” which “encouraged students to compare their solutions to those of a worked-out problem” (p. 83) while the other group was given explanatory feedback. After completing this practice work, students were then tested on their ability to transfer the skills they had learned to similar (near-transfer) and novel (far-transfer) problems. The study found that students who received the meta-feedback performed better for both the near and far transfer of skills. These results support
the need for this workshop to promote the use of meta-feedback over explanatory feedback. I include the results of this study, as well as its applicability, in the workshop section on how to ask the right questions.

CONTENT AND ORGANIZATION

<table>
<thead>
<tr>
<th>Duration (min)</th>
<th>Subject</th>
<th>Activity</th>
<th>Purpose</th>
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<tbody>
<tr>
<td>5</td>
<td>Introduction</td>
<td>A brief lecture that introduces and outlines the workshop.</td>
<td>Briefly introduce the topic and explain the format of the workshop.</td>
</tr>
</tbody>
</table>
| 10            | Student Approach       | Role-play interactions between students asking for help from their professors or teaching assistants. Since the intent is to focus on environment and attitude, content is not an important focus here. Depending on group size, this activity can be completed in either large or small groups. Participants will draw primarily on their own experiences but brief outlines of generic scenarios or prompts may also be used, such as: “A student comes to your office hours asking for help because they ‘don’t get it’ but have made no attempt to complete the problem”. Potential discussion questions for wrapping up this activity include:

• What sort of environment do you want to create for the students?
• How do you respond to students when they ask a question?
• What sort of attitude do you have towards the students and the questions that they ask? | Help professors and teaching assistants consider the student-learning environment they create when students ask for assistance. This activity also serves to further introduce the topic and will act as an icebreaker for the participants as it will encourage them to interact with each other in a nonthreatening way. |
| 10            | Creating the Learning Environment | Conduct a lecture on how to create an environment that supports student learning during office hours. | Promote the idea that learning best occurs in an environment that |
Some considerations to focus on include: tone of voice, personal attitude, responses to student questions, and how to set up and position furniture in the office space. While this type of material is often included in basic teaching assistant training, a reminder of these best practices can be beneficial in ensuring that participants continue to practice them.

| 15 | Asking the RIGHT Questions | Conduct a lecture on the theory and practice of asking the RIGHT types of questions. This lecture should focus on how to improve student engagement and accommodate different learning styles when helping students solve mathematic-like problems. See Appendix A for a sample handout to distribute. | Give participants an overview of the theory and practice of asking questions so that they will be able to help their students ask more effective questions. |
| 35 | Helping Students | Divide participants into small groups and give each group a mathematical problem with an incomplete answer. In groups, participants should develop a series of questions to ask the student to help them complete the solution. Each group will present their approach to the larger group. Consult Appendix B for further information on how to select appropriate problems to solve. | Give participants the opportunity to implement previously discussed theories and by generating their own questions to incomplete solutions. |
| 10 | Assumptions About Students | Briefly discuss the assumptions that each group made about the students in the previous task. Topics of discussion may focus on assumptions about the student’s level of commitment, learning style, gender, language skills, perceived effort into solving the problem or any other assumptions that each group used to develop their | Help participants to vocalize and consider the assumptions that they make about their students. |
Potential questions to ask include:

- What assumptions did you make about the student given the work that you were shown?
- How was your response to the student affected by these assumptions?
- Are there ways in which your response would need to be changed if it was another student asking you the same question?

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<tr>
<th>10</th>
<th>Conclusion</th>
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<td></td>
<td>Highlight the key points presented during the workshop and give participants an opportunity to ask any further questions.</td>
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<td></td>
<td>If time permits, it would be valuable to have a group discussion about other possible types of questions they can ask students to help promote their learning.</td>
</tr>
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**Total Time:** 95 minutes

**PRESENTATION STRATEGIES**

This workshop employs a few different presentation strategies. The lecture is supported by PowerPoint visual aids and is the main method for conveying the necessary information for this workshop. However, there are several strategies used to actively engage participants. Participants have the opportunity to role-play near the beginning of the workshop. Small and large group discussions also provide additional ways to involve participants. Employing these differing presentation strategies will ensure that participants remain engaged with the material throughout the workshop.
APPENDIX A: Handout for “Asking the RIGHT Questions” Task

Asking students questions that follow the following RIGHT principles encourages better understanding and learning outcomes.

- **Reflect on the Problem**: Ask questions that encourage the student to reflect on the problem and promote understanding.
  - Can you explain what the question is asking in your own words?
  - What are the main (first) steps necessary to complete the problem?

- **Individualized to specific needs**: Ask questions that can be tailored to the specific needs of the student in order to accommodate variables factors such as educational backgrounds, language skills, and learning styles.
  - What previous knowledge does this question assume that you have?
  - How would you visualize this problem if you had to draw it?

- **Generate self-explanation**: Prompt students to express their understanding of a concept or problem in order to improve their learning. These types of questions encourage students to expand or support their answers.
  - Given this step, what do you think is the next step?

- **Highlight important concepts**: Ask questions that target specific areas of knowledge and specific parts of the problem. By asking specific questions (as opposed to asking more generally if the student has any questions), students will be better able to identify gaps in their understanding.
  - How did you perform that calculation?

- **Think Time**: Give students time to consider the question and provide a thoughtful response. Offer unpressured time to the student of **at least one minute**.

REFERENCES

APPENDIX B: Additional Notes for “Helping Students” Task

It is advisable to select problems in subject areas that your participants have complete mastery. The composition of your audience will determine this.

In this author’s experience, the educational background and mastery of graduate students’ skills can vary significantly even within a specialized department. If all the participants will be tutoring or instructing in the same field or course, problems that are specific to their instructional roles are most beneficial.

If your group is more diverse, it is advisable to choose generic mathematical problems so that all participants will be familiar with the material. For some sample questions and solutions, consult Ontario’s Education Quality and Accountability Office Scoring Guides for the Grade Nine Assessment of Mathematics available at the following URL: http://www.eqao.com/Educators/Secondary/09/BookletsandGuides.aspx?Lang=E&gr=09&yr=12