Investigating Inquiry-Based Learning in an Introductory Course on Semiconductor Devices

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Hypothesis

Fundamental concepts on semiconductor materials and devices can be taught in an improved manner through inquiry based learning and just-in-time teaching methods. We expect students' motivation to increase when we start with subject matter that is familiar to them; and we link new concepts to the familiar through student-led exploration. We reveal the underlying physics of devices such as transistors and diodes through inquiry. Students are expected to retain the concepts better and develop a higher level of interest in the subject matter compared to traditional lecturing methods.

Research Questions

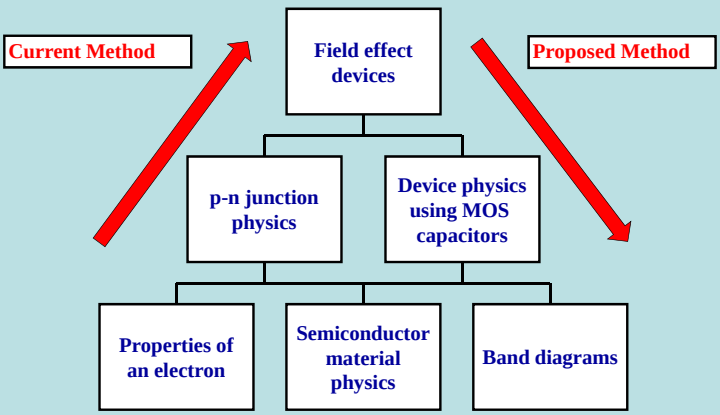
- Does inquiry-based learning improve student learning and retention?
- Do just-in-time teaching methods improve student learning and retention?
- Do inquiry-based learning and just-in-time teaching approaches increase students interest level in the subject matter?

Background

Inquiry based learning: method via which the instructor *reveals* concepts as they become necessary for the students to understand the workings of a system. A *large picture* is introduced and several questions are posed to enhance understanding. The students and the instructor together explore the underlying principles through deeper inquiry into the details of the subject. In this way, concepts are linked to knowledge already familiar to the student.

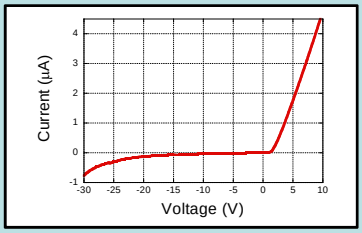
Just-in-time teaching: introducing a concept or posing a question immediately before teaching relevant details. The purpose is to get students to think about the concepts prior to the formal introduction, and to provide the instructor with information on the background knowledge of students. For example, an online quiz, reading, or survey preceding a lecture on the same topic.

EECS 320: mandatory junior-level introductory course on semiconductor devices for electrical engineering and computer engineering majors. Topics cover semiconductor physics, p-n junction diodes, and transistors.



Methodology

Inquiry based learning: We will implement an inquiry based approach to learning primarily via rearranging the order in which we introduce the major concepts in the syllabus. We will establish a top-down approach, where inquiry establishes the **need** to understand a concept.



Example: Turn-on voltage of a diode

- Show current-voltage characteristics of a diode using data from a real device
- Ask students to find out why the current begins to flow easily at a particular positive voltage.

- **Allow students to speculate and inquire.**
- *Hint #1:* Describe how an energy barrier could impede the flow of electrons, ask class how an energy barrier could be obtained in semiconductors, and how the application of a positive/negative voltage would change this.
- **Allow students to speculate and inquire. Answer questions.**
- *Hint #2:* Teach about energy band diagrams and energy barriers.
- **Follow up with a brief traditional lecture on built-in potential.**

Just-in-time teaching (JITT): We expect that getting students to think about the concepts at hand immediately before class meets will be immensely beneficial. It will allow students time to come up with questions and ideas to contribute. We will divide the class into two groups for this study:

- The class will be divided into two groups, each group will perform a different set of three web-based JITT assignments at different points in the semester.
- Both groups attend the same class/lecture.
- Student performance/interest will be tracked for the two groups at points in the course where JITT assignments were implemented

Assessment

We will design exam questions to focus on concepts addressed by different JITT assignments separately. We will compare the exam performance of the two groups of students to check for correlation to their access to relevant JITT exercises.

We will assess retention and interest level through surveys conducted on the entire class. There will be surveys in the beginning, middle and end of the semester. We will investigate retention in the second and third surveys, via questions on the confidence level of the students on earlier concepts.

Questions investigating students' interest and motivation level will be behavioral:

- What classes are you planning to take next semester?
- Are you planning to pursue an internship dealing with semiconductors?
- Will you sell your textbook back, or will you hold on to it?

Acknowledgement

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