

Student Perceptions of Reflective Learning Activities

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Abstract

It is widely accepted that reflective activities such as recitation discussions, computer simulations and journaling are supportive to the natural learning cycle. The natural learning cycle is based on the established theory of the *Kolb's Experiential Learning Cycle* that links the learning process to brain structure. This conference presentation examines the perceived benefits of such activities by the student. Traditional teaching methods and unconventional reflection techniques were employed in a mathematically rigorous engineering course. Survey results indicating which reflective and/or traditional learning activities were most helpful to the learning process from the perspective of the student will be presented. The featured student group was enrolled in a required engineering course that addressed modern physics concepts and semiconductor material topics.

Examples of journaling exercises that required students to re-work any exam problems that the student incorrectly answered and to provide a brief statement that explains the thought process of the student that led to the incorrect solution in the preliminary computational answers to the exam will be provided. Although direct assessment of the reflective learning activities in the form of exam grade trends indicated that student understanding of the course material improved significantly, students did not attribute their progress to the journaling activities adopted in the course. Only activities such as simulations and traditional homework assignments were considered by the student to be influential in assisting in the learning process. Journaling techniques are often limited to design-courses that develop "soft-skills" in engineers and are usually not considered to be helpful to mastering analytical problem sets. This talk will identify the conflicting educational paradigms that cause students to not value reflective activities and analytical exercises equally. Methods for creating a paradigm shift towards a natural learning cycle with emphasis on reflective learning activities such as establishing student 'buy-in' will be presented.

1 Introduction

Reflective learning activities can help engineering students practice newly acquired analysis tools as well as assist them in learning from their mistakes.^{1,2} The study presented in this article will provide the results of using reflective activities important to the learning process of engineering students in an advanced technical and mathematically rigorous course. A brief course description is given to establish course expectations placed on the student as well as the practical relevancy of the class. The teaching and learning model presented by *Kolb's Experiential Learning Cycle*³ and its adaptation in the *Natural Learning Cycle*⁴ was employed in this course. This work contains an overview of the teaching and learning objectives of this course as well as the reflective journal activities. The benefits of such reflective activities as perceived

by the student and its contribution to the learning process will be discussed.

2 Course Description

Reflective journaling activities in a technically rigorous course at the undergraduate level were performed. The course was a requirement for the electrical and computer engineering curriculum that is taken during the third year (junior level) of the student matriculation process. The course focuses on topics related to electronic materials and devices such as semiconductor materials, pn junction diodes and transistors. These topics are essential to the design and operation of lasers, liquid crystal display (LCD) panels, solar cells and charge coupled display (CCD) cameras, most of which can be found in common items such as cell phones and cameras to more complex systems such as personal computers. The student assessment results from an end-of-course exit survey highlighted in this study are from a recent installation of this 13-week course in the Fall 2009 academic semester. The class was composed of 26 traditional students (21 male and 5 female). The class met for lecture twice a week in 75-minute sessions.

The nature of the material covered in the course is interdisciplinary with components that are based on chemistry, semiconductor physics and electro-dynamics principles. Many of the topics presented concepts that challenge the common thought process of the undergraduate engineering student. At this point of their academic career, the students have not been exposed to concepts that are contradictory to engineering tenants such as Ohm's Law. The dynamic systems that are explored are also very abstract and are not readily observed in the physical realm. For example, the concept of an electron is familiar, yet the concept of a hole is very unclear to the student. Most of the mental hurdles that the students encounter are related to reconciling such contradictory concepts. However, initially, it is unclear to the student how to achieve this understanding. Unlike previous course experiences where the electro-dynamic equations were limited to conditions such that only linear equations were required to analyze a system, the course in question presents the Schrodinger equation and Fermi-Dirac statistics. Simple problems and equations that can be generally applied are replaced by equations with system dependent boundary conditions and material specific terms.

3 Teaching Methodology

The teaching strategy was revised to include more reflective observation components to support the natural learning cycle.⁴ The reflective observation components consisted of homework exercises, in-class exercises and exam journals.⁵ The class performance was assessed via homework grades and exam grades. Several schemes were used to support brain physiology and assess student-learning needs such as 1) concrete experiences, 2) reflective observation, 3) abstract hypothesis, and 4) active testing.

Concrete experiences were achieved using computer simulations based on java applets that demonstrate charge carrier dynamics in semiconductor materials and devices in addition to the traditional on-the-board problem solving sessions. Opportunities for reflective observation were provided to students to discuss intuitive descriptions of the simulations. Students were then asked to extend their intuitive description to simulations with modified conditions in order to develop abstract hypotheses. Active testing was performed during lecture via simulation-based polling in

addition to traditional exams. To promote and reward reflective observation, students were allowed to continue to accumulate receive credit for keeping an exam journal. This approach addressed the dilemma regarding the value of learning versus student fixation on grades. Students were required to re-work the incorrectly answered problems on their exam and explain their initial thought process on the exam. All problems had to be answered correctly in the journal with appropriate references made to the course textbook page or homework solutions. Students were provided with the correct numerical answers for computational problems (by the instructor) and the journals were to be submitted one week after receiving the graded exam. This approach supported the student in order to address any academic weakness presented in the exam results, helped to reinforce concepts that would appear on the final exam and led to the reduction of tension in the atmosphere of the classroom. The journals also helped the instructor to determine the learning needs of the students.

4 Lessons Learned from Exam Journaling and Student Assessments

A number of observations can be made based on the exam journal feedback from students. The instructor can begin to understand why students misinterpret concepts and which concepts are generally confusing. The journals illustrate that students need help to make the connection between all exercises that they perform (e.g. homework, in-class exercises, etc.). Insight to the students' internal merit system is also obtained since students only value practice exams, false learning exercises (i.e. memorization) that they considered to be exam reviews. Additionally, exam journaling is equal to grade "redemption". The reflective journaling process allows an alternative mechanism for assessing a students' learning that does not subject the student to test anxiety. A reduction in classroom tension was observed where more students became active and vocal in class participation that had a positive affect on the learning environment.

At the beginning of the semester, learning style self-assessments were performed to identify individual student learning styles and foster "buy-in"⁶ for the unconventional learning activities from the class. The students also participated in an exit survey to assess their opinion of the various exercises to determine learning effectiveness. In figure 1, the students evaluated nine learning activity categories. The categories are as follows:

- A. In-class hands-on demonstrations such as the TV remote (IR light source) with a cell phone camera (IR detector) optical communication link demonstration
- B. In-class computer simulated activities that demonstrate key engineering concepts (e.g. pn junction, crystal lattice structures and transistors)
- C. In-class "Think-Pair-Share" activities to promote critical thinking and discussion in a group setting
- D. In-class example computational-problem solving on the board and example problems posted on on-line
- E. Exam journaling activities with pre- and post- exam materials that encouraged reflection on concepts that were not clear or misunderstood
- F. Offices hours, extra exam review sessions and email correspondence with instructor
- G. Homework, reading assignments and exam study guides
- H. Lectures and notes packets (hard copies and posted on online)
- I. Student did not participate in any of the listed activities

The chart illustrates, in learning activity G, that although students will not completely abandon memorization as a technique to learn how to solve problems they do realize the benefits of reflective learning exercises according to learning activities B and E. Such activities combined with traditional teaching techniques (e.g. learning activities A, H and F) help the students to learn and increase their comfort level with the unconventional reflection activities. However, certain socially intensive activities such as group technical discussions (i.e. C) provide little comfort for a class full of engineering students.

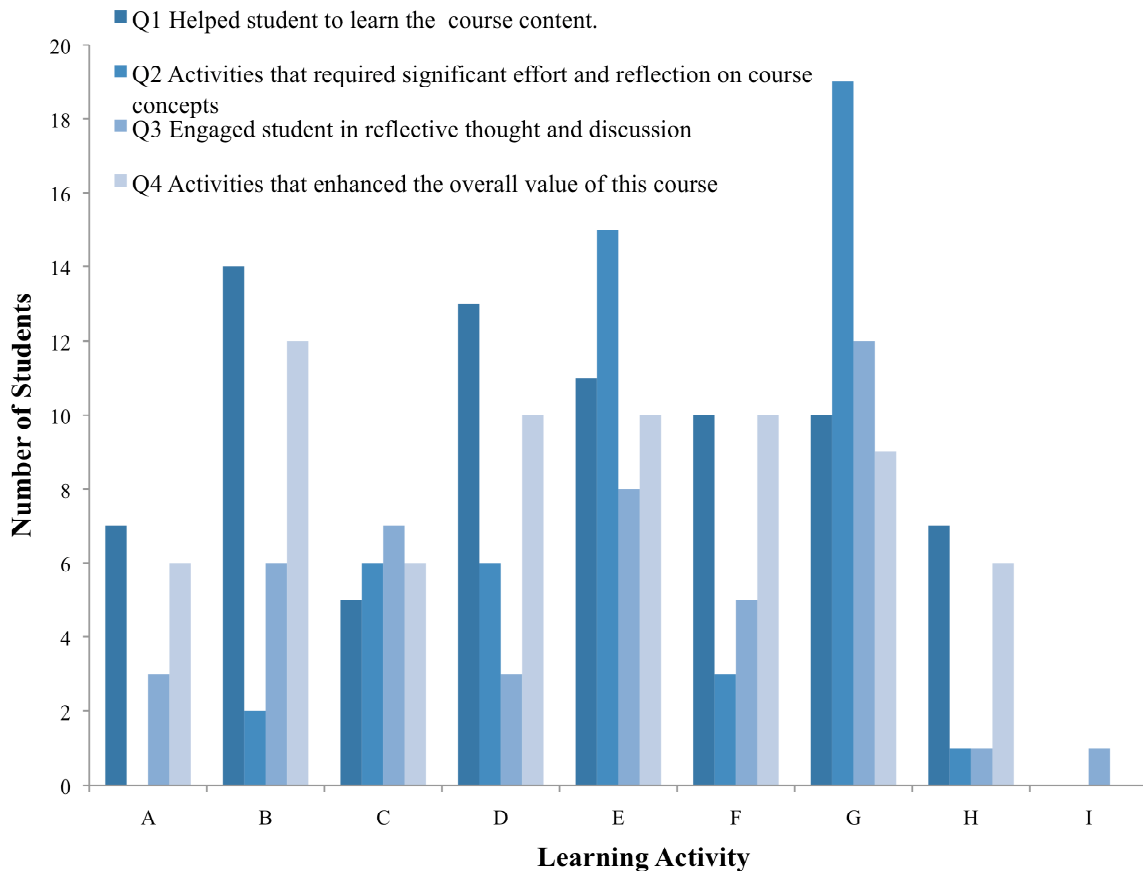


Figure 1. Exit survey results measuring the perceived usefulness of learning activities by the student.

5 Future Recommendations

Overall, journaling (in addition to the other reflective learning exercises) can be useful and effective tools that are beneficial to both the student and instructor. For example, journaling helps both parties understand learning styles and encourages students to reflect on course materials. However, instructors should be aware that introducing the concept of reflective observation is unconventional which can lead to student resistance and increases the risk of low course teaching evaluation scores.² Considering its positive benefits, journaling has been extended to other exercise materials (e.g. practice exams, etc.) in the Fall 2009 offering of the course and the results will be discussed in future articles.

Bibliography

1. Socha, D., V. Razmov and E. Davis, "Teaching Reflective Skills in an Engineering Course" Proceedings of 2003 ASEE Conference, 2003.
2. Guan, Z., S. Lappenbusch, J. Turns, and J. Yellin. "Portfolios in Engineering Education: What do they promise and how can they be used?," American Society for Engineering Education Annual Conference, Session 1858, (2006).
3. Kolb, D. A., *Experiential Learning: Experience as the source of learning and development*, Prentice Hall, Eaglewood Cliffs, NJ, 1984.
4. Zull, J., *The Art of Changing the Brain: Enriching the Practice of Teaching by Exploring the Biology of Learning*. Sterling, VA, Stylus Publishing, 2002, pp. 13-29
5. Wynne, R., "The Diary of a Mad Student: Exam Diaries and Other Evaluation Schemes," American Society for Engineering Education Annual Conference, Session 3532, (2010).
6. Smith, G. A. (2008). "First-Day Questions for the Learner-Centered Classroom," *National Teaching and Learning Forum*, Vol. 17, No. 5, September 2008.