AC 2008-287: LIFE LONG LEARNING STARTS IN CLASSROOMS

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Life-long Learning Starts In Classrooms

Abstract
This paper presents the result of our experiment in a sophomore Circuit Analysis course using the learning-through-teaching method. The main goals of students teaching students are to have the student learn the material effectively and to promote life-long learning by cultivating self-learning. Details of how to make it a successful learning and teaching experience for the students are discussed. Topics discussed include: Why is self leaning important? How is a student teaching assignment organized? How are students motivated? How is the effectiveness of learning-through-teaching assessed? What are the common mistakes? Hopefully, the experience from the learning-through-teaching presented in this paper can provide useful information for others who are interested in this kind of cooperative learning practice.

1. Introduction

Life-long learning is the self-directed development and increase in knowledge performed outside of school. This growth is generally viewed by industry and accreditation agencies (e.g., ABET) as important because it prevents skill obsolescence and encourages students and alumni to be more active and capable learners. The lack of a widely recognized method for college professors to encourage life-long learning makes such encouragement a widespread challenge. Without the development of an effective approach one can expect the current status quo of very limited learning outside of classes. This paper describes an experiment in promoting life-long learning by having the students teach portions of the material covered in class. The approach is explained and critiqued with the aim of promoting the further development of instruction in life-long learning.

The recent rapid development of technology makes life-long learning more important than ever; what is taught in the classroom today may be outdated in a few years. In today's world, life-long learning is essential to be competent in a technological field. Some may think that life-long learning is mostly through on-job technical training but technical training is typically limited to 20-40 hours per year, insufficient to sustain competency. In fact, life-long learning can take many different forms other than on-the-job training, such as self-learning. Self-learning can be done everyday or whenever it is needed and can therefore keep up with the latest development in the technology world. To some extent, cultivating the self-learning ability is more important than the learning of the knowledge itself in higher education.

Self-learning is a more advanced form of learning. Typically, in elementary schools students accept everything the teacher tells them without asking why. In high school, the students are required to use more logical reasoning in addition to learning the knowledge. In college, undergraduate students are encouraged to do more independent study. In graduate school, the students are required to do more independent research work. However, many undergraduate students are still used to the learning style they use in high school and elementary school. They assume it is the teacher's responsibility to teach them everything they need to learn. These students like the traditional teaching method of

lecturing. It has been extensively studied in the literature that other learning styles such as active learning, self-learning, and cooperative learning are more effective[1]. As pointed out by Donawa et al[2], the primary purpose of all education is to teach students how to learn effectively.

Various efforts have been made to get the students actively involved in the learning/teaching process[3, 4, 5] over the last century. Extensive research on peer teaching[4] suggests that having students teach each other is an extremely effective way to increase student learning. Recently, Plett et al[6] experimented with students grading homework. Skurla[7] modified the lab class to promote student self-learning and to solve the problem of large student numbers and limited lab space. Bidanda[8] solved the problem of lab class modification using students learning-through-teaching. The availability of multimedia and web-based educational modules makes it easier for self-learning[9,10].

The practice of learning-through-teaching was discussed in detail by McIntyre[11] and Chiang et al[12]. Our experience also validates the claim made by McIntyre[11] : "Learning-Through-Teaching allows students to gain valuable experience in: teamwork, organizing and delivering presentations, critical peer evaluation, and a better overall understanding the academic process." It is commonly recognized by faculty members that teaching a course requires deeper learning of the material than learning it yourself.

Many faculty members thought about or even tried self-learning or learning-through-teaching in teaching college classes. Even though the concept of learning-through-teaching is nothing new[11, 12], it is interesting to observe that not many people are using this method. There are many reasons that can lead to an unsuccessful learning-through-teaching experience. One of the goals of this paper is to share our experience and lessons-learned with others. It is our hope that this paper will encourage more people to promote life-long learning by practicing learning-through-teaching in classrooms.

2. Learning through teaching

The immediate benefit of learning-through-teaching is the effective learning of the material. What is more important is the long term benefit of an improved self-learning ability for students, which is necessary for life-long learning. These benefits were the main motivations for experimenting with learning-through-teaching in a Circuit Analysis class offered to sophomore students in the Electronic Engineering Technology program. Such an early technical class was chosen for learning-through-teaching for the following reasons: the students need to practice self-learning in an early stage because they will have more chances to practice it in later courses, this will allow them to build their confidence in self-learning; the early technical classes have easier material and usually contain many reference books with plenty of examples, this makes it easier for the student to practice self-learning for the first time. Similar results also arose from incorporating student teaching in a sophomore level class on digital electronics.

2.1. Motivating the students

The students were told in the first class that they would be teaching one chapter of the text book. McIntyre[11] intentionally made the teaching assignment for the students vague in the syllabus in order to avoid large amount of students dropping the class. This was not

a problem in our practice of learning-through-teaching in the last three semesters. It is important to motivate the students. If the students sense that the student learning-through-teaching is just a way to make the life of the faculty member easier, they will not be motivated. The students were motivated by going through the importance of self-learning and life-long learning in the first class. The teaching assignment also carried the same weight as a midterm examination. The number of midterm exams was reduced from 3 to 2 to allow students enough time to prepare for the teaching assignment. Most of the students were actually excited about the teaching assignment after the first lecture.

2.2. Providing a guideline

In the first week of the semester, students were asked to form teams, each consisting of 2, 3, or 4 students depending on the size of the class. Each team worked together in the lab classes so that they got to know each other better. The following guidelines for the teaching assignment were posted on the web:

Guidelines for ENTC 211 Teaching Assignment

1. Form 4 teams, each team consisting of 3 students;
2. Study Chapter 20 (Resonance). The chapter and sections are for the 10th edition of the text book.
3. Teams will be randomly assigned to teach Sections 1-3, Sections 4-5, Sections 6, 8, Section 9 and10 (Examples from Sections 7 and 12 can be used by any team).
4. The teaching will start around November 1st (after we finish Chapter 19).
5. Each team has 35 minutes to teach. Every team members must teach. Erasing the board does not count as teaching!
6. Each team needs to assign one homework problem that the rest of the class and the professor must complete. Each student must use separate pages for each problem so they can be submitted to different "Professors" for grading.
7. Each team must submit their lectures notes for the whole chapter, not just the sections they teach.
8. Each team will grade the homework they assigned. The scores must be reported to the professor within one week. The homework must be returned to students within one week.
9. The teaching of each team will be evaluated with the informal teaching evaluation form by the rest of the class and the professor. (Students evaluation: 35%; Professor's evaluation: 35%; attendance: 10%; grading, reporting the scores, and returning homework in time: 10%; lecture notes: 10%).
10. Enjoy teaching and have fun!

Since the learning-through-teaching was started in a sophomore class, for most students, this was their first time teaching a college level class and most did not have very much experience in public speaking. Many of them were a little bit nervous. It is extremely important to provide the students with help and guidelines to make them feel more comfortable. It also helped that the student teaching started in the second half of the semester so that the students knew their teammates well through the lab classes by that time.

2.3. Selecting the material

The selection of the material for the teaching assignment is very important. This was especially true for the first time student teaching was attempted. There were a lot of uncertainties in how effectively the students could learn the material. Therefore, extra caution was used in selecting the material for the teaching assignment. The topic of Resonance was chosen for the teaching assignment. By the time the students started teaching Chapter 20 of the text book[13], they already learned the basics of the ac circuit analysis. They were familiar with phasors, complex math, impedance, Ohm's Law, Kirchhoff's voltage law and current law, Mesh analysis, and Network Theorems such as Superposition Theorem and Thevenin's Theorem. The resonance theory is based on these fundamental ac circuit analysis theories. It also has a minimum impact on other subjects that are taught later in the semester. After several semesters of practicing and fine tuning of the learning-through–teaching experiment, with more confidence in the students' learning-through–teaching, other chapters can be used as the teaching assignment material.

2.4. Making the teaching experience as real as possible

In addition to motivating the student to use the teaching assignment as a way of starting their self-learning and life-long learning habits, efforts were also made to make the teaching experience as real as possible by having the faculty member doing the homework assignments and the students grading the homework. Teaching evaluation similar to the official university teaching evaluation was also conducted in class right after the students completed teaching their section. The scores were used to evaluate the performance of each student. After teaching the material, each student team assigned a homework problem to the rest of the class and the faculty member. Each team then collected the homework and graded them. Many students were amused in the beginning by the thought of getting a chance to grade their professor's homework. A seemingly minor thing like this could actually make the teaching experience more fun. Some students struggled with the grading of the homework. They complained that it took too much time and that homework by some students was too hard to read or follow. Others refused to grade any late homework. Through the grading process, the students realized that it was important to write the homework clearly and submit homework in time. After the teaching assignment, clear improvement could be seen in students' homework. They gained an appreciation for the effort faculty put into grading their homework.

Many students did not like power point presentations[14], but from their own teaching experience, they realized using power point presentations was much easier than writing on the board. Before the learning-through-teaching experiment, many of the students had a negative opinion about how teaching was conducted by faculty. The teaching assignment helped reduce the complaints from the students. The general attitudes of the students were more positive.

2.5. Learning experience for the faculty

All faculty members were students before. Sometimes one can easily forget how it was being a student. The learn-through-teaching practice allowed the faculty members to be students again. As one sat in the audience, many little things that are essential for good teaching could be noticed: it is important to keep eye contact with the audience; speaking

louder helps; use examples to illustrate ideas; ask questions; try to get the students actively involved; certain areas of the black board are hard to see for some students; moving the papers too fast in front of the Document Camera can be annoying. Once the students and the faculty member switch roles, both have better understanding of the other.

3. Assessment
   The performances of the students were evaluated according to the guideline:
- Students evaluation: 35%;
- Professor's evaluation: 35%;
- Attendance: 10%;
- Grading, reporting the scores, and returning homework in time: 10%;
- Lecture notes: 10%.

The grading rubric was designed to encourage the students to better prepare for their lecture, grade the homework, and attend the lectures of others to learn from each other. The grading rubric was modified several times based on the feedback from the students.

   Immediately after the student teaching, an informal survey was conducted in class with the following format:

<div align="center">Survey on Teaching Assignment</div>

A. Please provide specific written information, based on your experience in the Teaching Assignment:
1) What was done well (please be specific):

2) How can you be better motivated to learn the course materials?

3) How would you do the teaching assignment if you have a choice?

B. Please rate (on a scale of 1-10, with 10 = best) your perceptions of how successfully the teaching assignment was in terms of these dimensions:
1. Usefulness of the teaching assignment guideline ____
2. How do you like the format of team presentation ____
3. Learned all the materials in chapter 20____
4. Learning of chapter 20 more effective than other chapters____
5. Was the grading fair?____
6. Do you prefer a regular midterm exam rather than the teaching assignment?_____
7. Does the teaching assignment have any positive impact on your interest in life-long learning?_____
8. Does the teaching assignment have any positive impact on your interest in self-learning?_____
9. Do you recommend to continue the teaching assignment for students in next semester?____
10. What is your overall evaluation for the teaching assignment?_____

   The results of the survey are summarized in Table 1. The results clearly show the overall positive attitude toward the learning-through–teaching practice.

Table 1. Survey results

Question	1	2	3	4	5	6	7	8	9	10
Average score	9.1	7.8	8.7	8.4	7.2	3	8.2	8.2	9.4	8.7

Most students gave positive feedback:

"I enjoyed it and got a lot out of it."

"I found that I learn better by doing it on my own."

"Good practice for public speaking."

"Group selection and presentation order were very fair."

"The guideline was extremely helpful."

"The teaching assignment was a good change of pace. I definitely prefer teaching over a midterm exam."

"It is positive knowing that I can teach myself new things."

"I learned the material in Chapter 20 better because I had to look over it several times to understand it."

Some provided useful suggestions:

"The professor should review good teaching techniques such as eye contact, well-prepared lecture notes, and speak loudly."

One student commented:

"I personally discovered that your job is tough."

Each semester, the feedback from the students was carefully analyzed, and used to further improve the process for the next semester. For example, the addition of the attendance to the assessment was suggested by the students. Another suggestion by the student was also adopted: before the teaching assignment, each team had a chance to practice teaching by presenting an example to the class. The feedback mechanism is the main reason that the learning-through–teaching practice has been successful.

In addition to the survey, the effectiveness of learning-through–teaching practice was also evaluated based on the final exam. One problem on Resonance in the final exam showed that students learning the material better: the average score of the problem was 87%; the average score for all other problems was 67%.

4. Lessons learned

Each semester, lessens were learned from the practice of students learning-through-teaching. The lessons learned made continuous improvement possible. The following list includes some observations made during the last three semesters:

◊ Some students may say: "I paid my tuition to attend a lecture given by a professor, not a student". Others may think: You got paid to teach, and you are asking us to do your job? Some may complain that the scoring rubric is not fair; or they don't have time to prepare for the lecture. It is crucial to explain everything in the first day of the semester. Once the students understand the importance of learning-through-teaching and the effort put in by the faculty, they will have fewer issues with the teaching assignment.

◊ The preparation needs to be started early so that the students have time to get to know their teammates and feel comfortable with each other. In the first semester,

the students were not required to have a team early on; as a result, one student was not able to find a team the day before the student teaching. Most people know the benefits of learning-through-teaching, but only a few who actually tried it knew that an unprepared learning-through-teaching can have undesirable outcomes.

◊ Team work is important for learning-through-teaching. With a team, the students had a chance to discuss some difficult contents they were supposed to teach and they could practice their teaching to the teammates. This helped them improve their teaching, especially for the ones with no public speaking experience.

◊ Each team was selected in a random manner to teach part of the chapter in the beginning of each lecture. This requires the students to prepare the entire chapter for presentation, but limits the amount of time spent with students lecturing. Otherwise, some students may choose to study only the part they teach the night before the lecture. That would limit the effects of self-learning. Since the groups must be prepared to teach the entire chapter, there is an opportunity for lively discussion, and each student should understand the entire chapter even if one or more presentations are poor.

◊ A grading rubric is useful. The students understood exactly what they need to do to get a good score. There was one student jokingly telling the class that they should give everyone a perfect score. It turned out this student gave low scores to everyone. The structure of the rubric should be such that this kind of trick has a minimal impact on the results.

◊ Attendance should be counted as part of the evaluation for student teaching. Some students chose to skip the classes after their own presentation since they figured they had done their part and they already learned the whole chapter by themselves. This could leave the last team with smaller audience and the evaluations might be skewed.

As one can expect, implementing learning–through-teaching is easier said than done. Any mistake can make the experiment a total failure. As teachers develop more experience in designing the learning-through-teaching practice, and as students become more accustomed to learning and working together, these problems usually disappear.

5. Conclusions

To promote self-learning and a life-long learning habit, students were assigned in a Circuit Analysis course to teach one chapter of the text book. This seemingly simple learning-through-teaching experiment requires careful planning and commitment by both the faculty and the students. Motivation for the students, early team formation, a detailed guideline, and a good scoring rubric are just some of the necessary ingredients for a successful student teaching experiment.

Based on the feedback from the students, most of them found that teaching someone else leads to their own improved understanding of the material. The students also realize that they can learn all the materials on their own. After they go through the teaching assignment, they also appreciate more the effort made by the teacher. The faculty member also has a chance to learn from the students: some of the students do extremely well, others do relatively poor. It is easy to find what works and what does not. The

teaching assignment worked well for introductory courses such as Circuit Analysis I and II, where there are many examples in the text book and the material in the text book is not very difficult. The idea is to get the students used to self-learning early on. As they move into their junior and senior years, they will start to work on course projects and senior design projects, where self-learning is critical. With the early exposure to the idea of self-learning, the students should be able to make a smooth transition from learning everything from the teacher to learning everything on their own. This way, the life-long learning habit is gradually cultivated. In addition to effective learning of the material and the life-long learning benefit, learning-through-teaching also has some positive social benefits[4]: better adjustment to the college life, heightened social membership in college, improved social skills, and a positive attitude toward college. The students thus get the best out the education program.

As one gains more experience, the learning-through-teaching practice can be extended to other chapters, more material, and other courses. This is just one of the approaches that can be applied to improve the students' learning skills. It would be interesting to compare the effectiveness of learning-through-teaching to other types of self-learning such as course projects or web-based research.

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