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Incorporating Active Learning into the Graphical Communications Course

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Introduction

Active learning, is a student-centered learning strategy which has recently gained considerable attention in higher education[1-3]. The literature has shown that active learning has led to better student attitudes and improvements in their thinking, communication, leadership, and writing skills[4]. The core elements of active learning are student activities and engagement in the learning process[2]. As more faculty look for alternatives to traditional teaching methods they have strongly advocated active learning [5-10]. However, the potential challenges for faculty with such an approach cannot be ignored such as increased class preparation time, the risks of student dissatisfaction, the use of instructional technology, and increased lecture time.

The Graphical Communications course at Embry-Riddle Aeronautical University (ERAU) is a freshmen level course that is designed to familiarize the students with the basic principles of drafting and engineering drawing, to improve three dimensional (3D) visualization skills, and to teach the fundamentals of a computer aided design. The students meet the instructor twice a week in the laboratory during this three-credit-hour semester-long course with each class lasting two hours. The course is taught using traditional teaching methods with the introduction to graphics concepts and examples in the first hour, and tutoring the homework in the second hour. Students passively absorb the information and work individually to solve the problems. The limited class time means that not all students get the immediate help they need. In addition, many of them do not follow up during office or tutoring hours for additional assistance. Since it is early in their university career, they often are not mature enough to admit they are unsure of the material and need help.

Since the spring of 2011, this author has transformed guided, individual, final projects towards team-based open-ended final projects. The students now have an opportunity to apply the skills and knowledge they learned in the class to solve real-world problems, and to think as engineers. This has introduced a greater level of excitement and enthusiasm into the course by allowing students to explore the topics of personal interest and has enhanced their understanding of the concepts learned in the classroom [11]. Since the majority of the students are freshmen, they do not know each other before this course and typically do not have any social links yet. To better enhance the performance of the teamwork, there is a need to help them to connect with each other from the first day of class.

Active learning techniques were incorporated into the class to establish a positive collaborative study environment, motivate their critical thinking skills, enhance the understanding of the course material, and improve the productivity of the teamwork. This paper describes how to incorporate some core elements of active learning into the traditional lecture. The effectiveness of the active learning was assessed by mid-term survey, the end-of-semester evaluation, student comments, and changes in the final grades.

Active Learning

Active learning is generally defined as any instructional methods that engage students to learn in the classroom[3]. By doing meaningful leaning activities students can think about what they are doing and learning[1]. This author implemented core elements of active learning in the fall semester of 2013 and these include 'The Name Game', peer instruction, concept test, muddiest point, homework troubleshooting, and hands-on activities.

- The Name Game

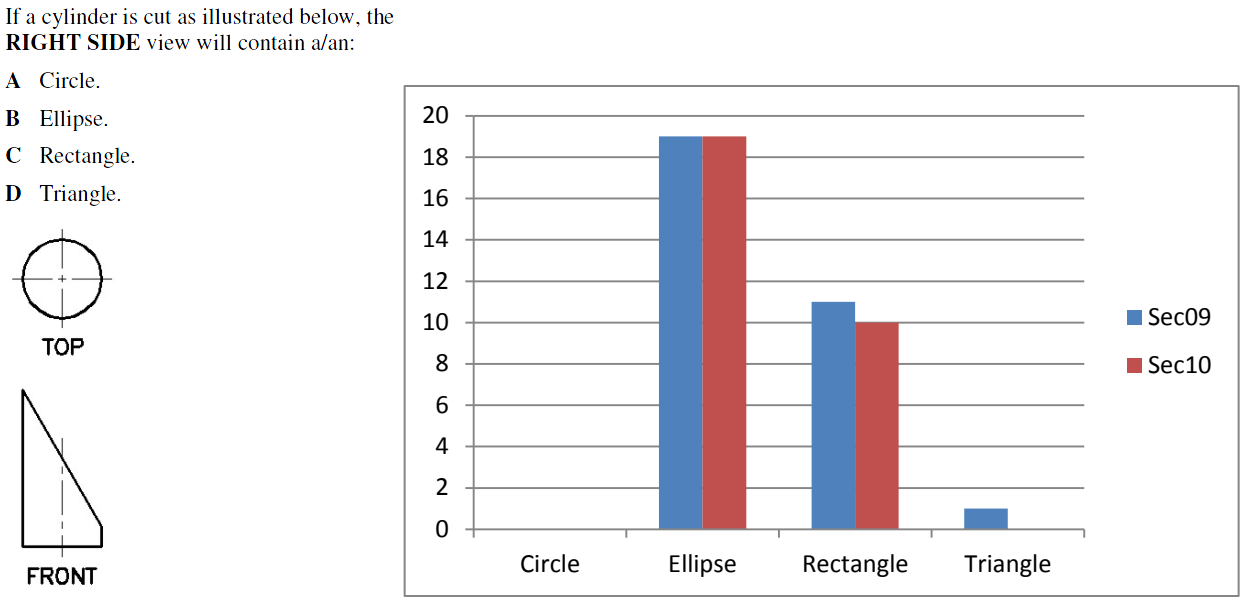
Dr. Raymond emphasizes the importance of getting to know one another by name on the first day of the class in his book[12]. He introduces 'The Name Game' which helps students to know other students in class by name and gives them an opportunity to support each other academically, socially, and psychologically. Following his insight, the author created a name card for every student which was displayed on their desk to be seen by other students. 'The Name Game' was implemented in the first few classes of the semester to help students know their classmates and make connections with each other. They worked in randomly formed groups and were required to remember the names of the other group members. The name cards were distributed to each student before the class started each time, which also helped the instructor check the student attendance. 'The Name Game' has proven to be very helpful in fostering bonding among the students and obtaining the academic support from each other.

- Peer instruction

Peer instruction used here is different from the general definition that the instructor asks students to respond to conceptual questions[13]. Students were given either an incomplete or incorrect solution, they then formed pairs, discussed their answers, and presented their understanding by using an interactive SMART Podium to the whole class. The quick feedback greatly aided the instructor in helping students address a given misconception. Peer instruction promoted the collaboration, conceptual understanding, and problem-solving skills.

- Concept test

In this method, the lectures were punctuated by multiple-choice conceptual questions to test student understanding of the material. Often the distracters (incorrect responses) reflect common student misconceptions[14]. Previous research has found that students attention spans during lectures is typically fifteen minutes long and after this time their attention begins to drop dramatically. Breaking up the lecture can refresh their mind and help to keep them engaged[3]. PollEverywhere.com, an online real time service for classroom response, was adopted due to its simple web interface and instant feedback analysis. Figure 1 (a) shows a snapshot of the concept test question on a power point slide and Figure 1 (b) demonstrates the corresponding student responses on PollEverywhere.com.



(a) (b)

Figure 1. (a) a snapshot of concept test question on powerpoint slide, and (b) student responses on PollEverywhere.com

- Muddiest point

At the end of every class, students were asked to provide their most confusing concept or other issues that arose during the class. Muddiest point responses were collected by PollEverywhere.com service. The information collected was used to address student most unclear point and their concerns in the next instructional class[15].

- Homework troubleshooting

Based on the homework collected at the beginning of the class, the author introduced a 15-minute homework troubleshooting (TRBL) section before the new concepts were delivered to students. Students were asked to study the randomly selected student homework which was projected on the screen, and correct the mistakes. By doing the homework TRBL, students should have a better understanding of the common mistakes and avoid making same mistakes next time.

- Hands-on activities

Some students struggle with visualization at the beginning of the semester, especially how to complete a missing multiple view or an isometric view of the orthographic projections. To facilitate their visualization skills, snap and build cubes were used to help students understand the formation of the isometric view and how to complete the missing multiple views. Figure 2 illustrates the relationship between the isometric view and multiple views by using the snap and build cubes. Red and white colors represent two separate surfaces at different levels.

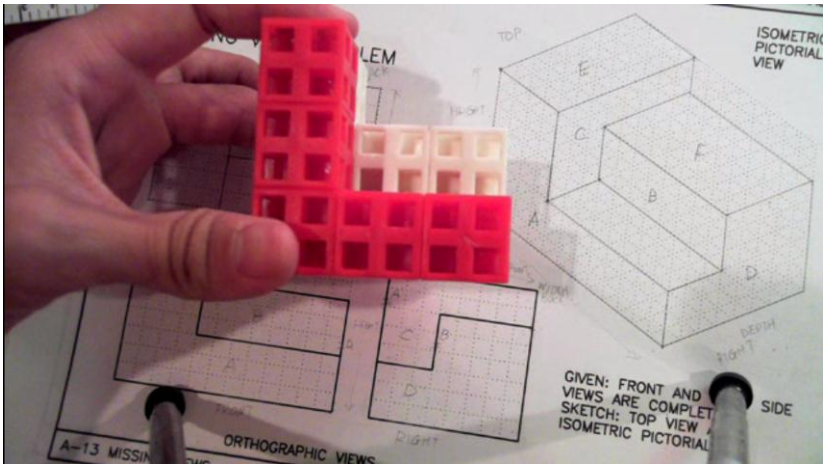


Figure 2. Illustration of the isometric view and multiple views with snap and build cubes

Assessment

In the fall of 2013, a midterm survey was given to all students who were enrolled in Section 9 and Section 10 of the course and 38 out of 56 students completed the survey on the surveymonkey.com. Figure 3 shows the students response and analysis to liking active learning. 95% of students chose either "extremely liked" or "liked" them. In order to understand the effectiveness of the each technique of the active learning, at the end of the semester students were asked to rank the different techniques as to their perceived effectiveness in helping them learn the material. Finally open-ended comments were collected.

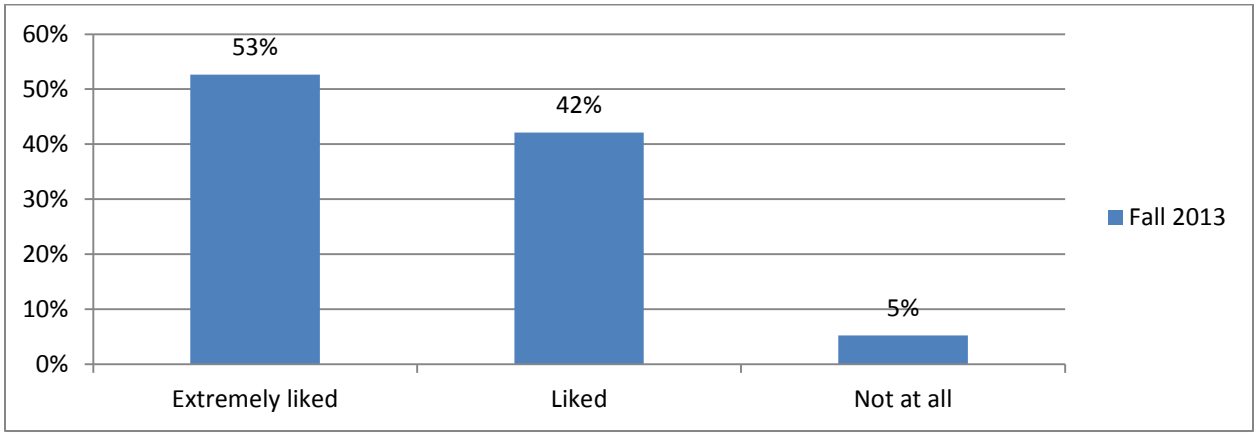


Figure 3. Student's response and analysis to active learning in the fall of 2013

The question given on the end-of-semester course evaluation which was designed to collect student feedback on active learning is as follows: *'In this semester, we have applied active learning in the class. We used name games, blocks, homework troubleshooting, concept test, muddiest points, and peer instruction on the smart podium. The purpose is to engage you to be more active in class, and to help you understand the concepts in a better way. Please share your thoughts with me and let me know if you like the active learning pedagogy'.* A list of the teaching and learning strategies followed the question, and students were required to rate each as "Extremely likely", "Very likely", "Moderately likely", "Slightly likely", or "Not at all likely".

On average 70% students completed the questions from two the class sections (N=60). Figure 4 shows the student responses to the questions which were collected at the end of semester. Among the traditional teaching methods, students rated in-class examples very high, with 100% of student liking it in various degrees from both sections. They believed that the clear, step-by-step, illustrations helped them understand how to solve the problem. One student commented that "it helped to understand the content more by showing me the way you would do it". Among the active learning techniques, students rated the concept test highly, with more than 80% of students rating them as either "Extremely likely" or "Very likely". Students commented that "the concept test not only lets students see if they know the content but gives the instructor a chance to see if ***all*** students understand the concept". The muddiest point is the next favorable active learning technique. Even though there were only 45% of students rated it as either "Extremely likely" or "Very likely", only less than 5% did not like it at all. Some of the comments are "I felt I was forced to come up with something when we did the poll." and "It helped me understand the upside to CATIA, since all I have ever used before was AUTOCAD". Students also preferred peer instruction with only 7% of students from both sections describing it as "Not at all likely". Students commented that the discussion and the collaboration with their peers promoted concept understanding and increased their problem solving skills. Homework TRBL was preferred by some students since it helped them see their mistakes and understood the instructor's expectation; however, others complained that too much class time was wasted in this area. Name card and the cubes/blocks activities were the two least popular active learning methods. Around 22% of students did not believe that the name card could help them know more classmates and 23% of students did not think the cubes/blocks could help them enhance their visualization skills. Students also mentioned that the lecture time was too long which did not leave them much time as they would have liked to work independently.

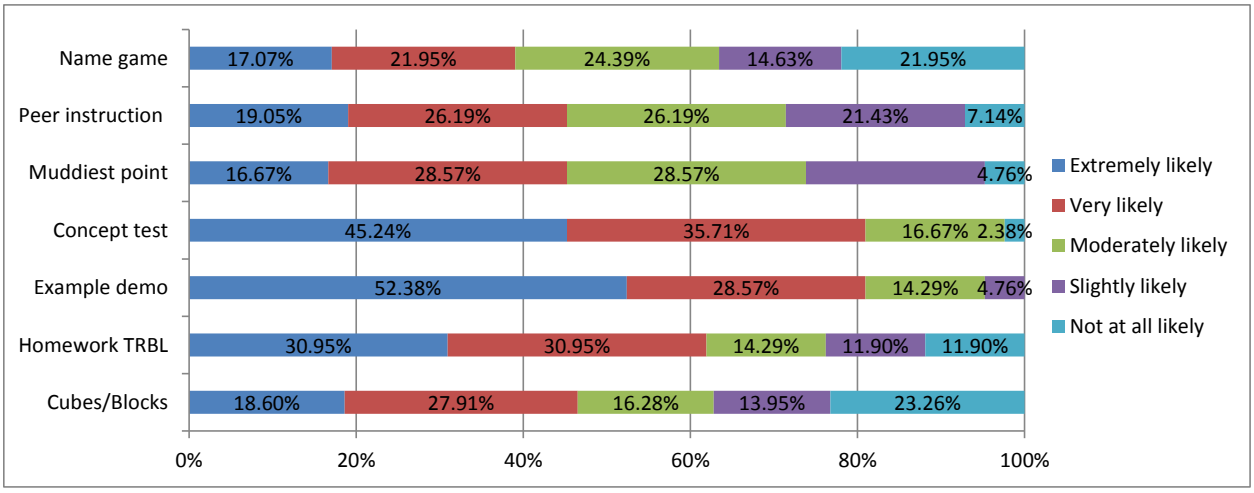


Figure 4. Student rating of various teaching and learning techniques in fall 2013. (N = 60)

Therefore, does the active learning help improve students final grades? Student final letter grades from spring 2012 to fall 2013 were collected and compared in Figure 5. Since this is a freshmen-level course, students who have a grade of D or below will fail the course. The failure rate remains less than 10% each semester. The figure only shows the student grades C and above.

Generally speaking, students in the fall of 2013 with the adoption of active learning have better grades than the students in the spring of 2013 and the year of 2012. However, more data will be collected to support the effectiveness of the active learning in the future.

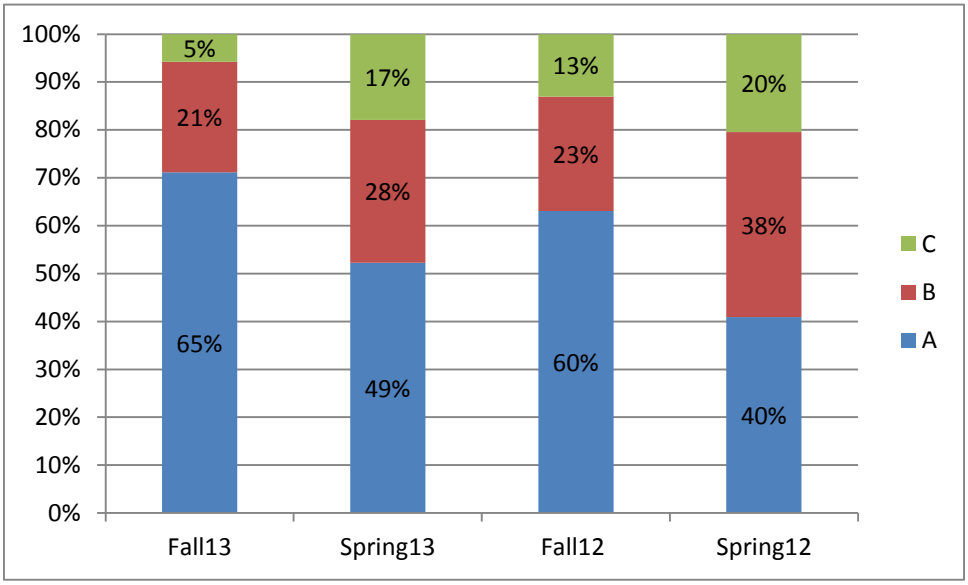


Figure 5. Students final grades (C and above) distribution in each semester

Conclusion

This paper describes the experiences of incorporating active learning elements into a Graphical Communications course at the freshmen level. Historically the course is taught through a traditional teaching with the introduction to graphics concepts and examples in the first hour, tutoring the homework in the second hour. Overall students were exceptionally positive in their assessment of the active learning elements. They felt that active learning did help them understand the course material and improved their critical thinking skills. The only complaint was the extended lecture time which left less time for them to work independently in class. Incorporating active learning into a traditional lecture is not an easy to implement due to the additional class preparation time, fear of the uncertainty that comes with the change and a potential low course evaluation from the dissatisfaction of the students due to implementing new and untried course elements. However, this author believes that with a careful strategic planning process; active learning technique can be incorporated into the traditional lecture for improving student attitude, achievement, and fostering student learning process.

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