Peer-Teaching in Construction Project Management Scheduling

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Abstract

A peer-teaching method has been implemented in Construction Project Management Scheduling (CPMS) course that focuses on Project Management Software (PMS) learning. The two graduate students, who had recently graduated from our undergraduate programs and were enrolled in the CPMS course were required to learn and teach the PMS package, Primavera, (as their course project) to the remaining undergraduate students in the course. This learning method promotes topic retention, as the student is required to be the expert on the topic. The students were only required to teach this one topic, which consisted of one class period (~2hrs). The results were verified through in-course surveys, objectively comparing assignment grades from a professor taught PMS (Microsoft Project), and graduate student reflection summary. The results show that the graduate students not only enjoyed teaching the topic, but they feel that their comprehension had increased by the employed teaching method. Additionally, the results show that the undergraduates students' learning was not adversely affected by having their fellow students provide instruction on software usage. The survey also indicates that the undergraduate students preferred the peer-teaching method to standard professor lecture and demonstration. The paper concludes with recommendations for future work.

Introduction to Peer Learning and Teaching

In this section peer learning and teaching are both examined. To start with, a point of clarification is required as to who constitutes "*peers*" in peer learning and teaching. Boud defines peers as other people in a similar situation to each other who do not have a role in that situation as teacher (formal) or expert practitioner. They share status as fellow learners. Of importance is the fact that they do not have power over each other by virtue of their position or responsibilities[1].

Peer-led small group learning has been used quite extensively in the U.S. as a strategy to enhance the performance and retention of undergraduate students in science, math and engineering[2]. *Peer learning* or rather reciprocal peer learning is a two-way, reciprocal learning activity. Peer learning should be mutually beneficial and involve sharing of knowledge, ideas and experiences between participants. It can be described as a way of moving beyond independent to interdependent or mutual learning[1].

Peer teaching or tutoring on the other hand, is a far more instrumental strategy in which advanced students, or those in later years, take on a limited instructional role[1]. Literature reports several benefits for both the learner and teacher in a peer-teaching environment[3]. Learning gains from the use of peer teaching have been reported in several applied disciplines to include science and engineering education[4], clinical education[5], and in medical education[6]. In peer teaching often the peer is a student with senior or advanced standing or a graduate student. However, the peer in peer learning is a student with similar standing from the same class or cohort. Unlike peer teaching, in reciprocal peer learning there is usually no need to reward or pay the peer. This paper involves a case study of a peer-teaching situation in which graduate students who very recently received their undergraduate degrees served as peer teachers.

Introduction to PMS

The use of PMS, in the construction industry, as a tool for managing and organizing work has grown and continues to grow at a rapid pace in many other industries[7,11]. A recent study has shown that since 2000, over 95% of construction companies use PMS for control and planning of their daily activities[11]. Multiple studies show that if present companies want to compete in today's market, they must become adaptive and use information technology systems such as PMS[7-10]. There are a few PMS available for use in the construction industry and of these there exist two favored PMS packages; Primavera and Microsoft Project[7-11]. Primavera systems (http://www.oracle.com) became available in 1983 and is today's leading provider to the construction industry[7,11]. Primavera is a full-featured software package that is rather expensive, however it provides complete project control and manipulation. It is specifically designed to handle large-scale, multifaceted projects that can handle up to 100,000 individual construction activities simultaneously. Given the nature of this PMS it often requires an in-depth instruction either through multi-day seminars for construction personal or in the university classroom setting. The advantage of the classroom setting is that the fundamentals of the scheduling methods are extensively covered prior to learning the sophisticated PMS packages.

On the contrary, Microsoft Project (www.microsoft.com/project/) was released on the DOS platform in 1984 and was marketed as an easy-to-use tool[7]. Since its release, MS project has been very popular in the construction industry due to its ease of use, however it has yet to become the number one PMS[7,12-13]. MS Project also gives the user full control with the right blend of usability and flexibility. One key advantage of the MS Project PMS is its full integration with the Microsoft Office family, which makes reporting very easy. However, MS Project is still used only by about a quarter of the construction industry, as shown in Figure 1.

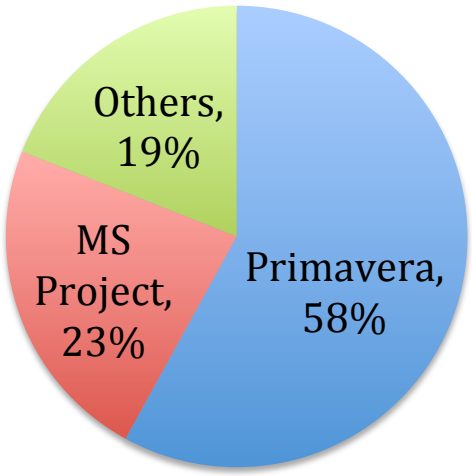

Figure 1: Distribution of PMS in construction[7,11].

As shown in Figure 1, the most widely used PMS is Primavera, which stimulates a demand for construction managers to know how to use and operate. Many companies that are hiring newly graduated students are relying on some training past college coursework on Primavera or MS Project depending upon the industry[11]. Thus, it is essential that this topic be taught in the CPMS course.

Evolution of the Course and Details of Peer-Teaching Implementation

Construction Project Management and Scheduling (CPMS) is a required course in the Construction Science Management (CSM) degree plan in the Engineering Technology Department at Texas State University and is a required course for the American Council for Construction Education (ACCE) accreditation. Additionally, the ACCE accreditation requires a specific course outcome related to using modern technology to solve construction related problems through the use of computers in the scheduling of construction projects. It has become increasingly essential for students pursuing a career in the construction industry to have an understanding of Project Management Software (PMS)[7-10]. Therefore, it is required and vital to the students' education to learn how to use modern PMS.

The CPMS course at Texas State University has been taught since 1984 and PMS has been integrated into the curriculum since approximately 2000. Two PMS packages are taught in the course, Primavera and Microsoft Project, both of which are the most frequently used PMS in the construction industry[7,11,13]. Since 2002 the CPMS course has been a 'stacked' class in which both undergraduate and graduate students can take the class for credit towards their respective degrees. During the Spring 2014 semester a self-teaching active learning method was employed with the graduate students, in regards to learning the Primavera PMS. The two graduate students enrolled in the course were required to teach the undergraduate students (29 undergraduates) how to develop a construction schedule in Primavera. This was the only topic that the students were required to teach in the course and it only comprised of one course period (~2hrs). On the first day of the course the graduate students were presented with their project guidelines. The graduate students were presented with a list of topics to be covered during their lecture and were also required to develop a homework assignment related to the PMS. Since the graduate students are required to teach the topic, it follows that they must prepare their lecture and become the expert on the topic, thus increasing their learning retention of the topic. The objective of this research is twofold; the first objective is to determine if the self-teaching method increases student-learning retention and the second objective is to determine if the undergraduates learning is affected by the student-lead instruction as opposed to faculty lead instruction. The objectives were verified through subjective surveys as well as objectively through student homework and exam grades. The objective comparison was completed by comparing the undergraduate student homework grades from the Professor lead PMS lecture (Microsoft Project) versus the graduate student lead PMS lecture (Primavera). Additionally, the two graduate students have provided a brief reflection on their learning experiences.

The overall goal of the graduate students project is to, lead one class lecture on learning Primavera (P6) scheduling software. Their requirements were to, as a group, to come up with the lecture (power point/handouts/etc.) that will effectively teach the class how to develop a schedule in Primavera (P6). The students were left up to their own means of presentation format, such as present simultaneously or separately on the same lecture date, which was specified on the first

day of class. The students were assigned the project on the first day of class and were provided access to the software and documentation available on the software. Additionally, approximately one month prior to their scheduled lecture, the students met with the professor and were then provided a preliminary presentation with preliminary handouts as well. This was for both the graduate students benefit and the undergraduate students, as it was important that adequate information was conveyed during the lecture and to ensure it was delivered effectively. This gave the graduate students an opportunity to ask specific questions and ask for assistance on troublesome problems. The graduate students were provided with a general list of topics that were necessary to be covered. The graduate students were also graded on their treatment of these topics. The topics that were required are as follows:

- How to open/create a blank project
- Describe all pertinent display elements/windows/actions/mouse clicks
- How to input information
- How to open/manipulate an existing project
- How to use database information
- How to create a Work Breakdown Structure (WBS) and work from one
- How to show progress and critical path
- How to adjust schedule due to delays
- How to change font (type and size)
- How to print the schedule
- Be able to answer questions that students ask during the lecture

The students were encouraged to read the designated chapter from the textbook that covered Primavera, review the notes discussed in lecture for hand scheduling, consult the users manual for Primavera, Primavera tech support, and use the internet, such as youtube.com for training videos. In addition to the above listed topics, the graduate students were required to assign a homework assignment as well as produce the solutions to the homework assignment to be delivered to the professor separately. The solutions to the homework were necessary so that the students knew that the homework they developed was solvable and that they knew how to solve it.

Data Collection and Analysis

Graduate Student Impact

The two graduate students were provided a post questionnaire that gauged their learning and comprehension of the topic. The questionnaire also included questions regarding their feelings towards teaching the topic. The questionnaire utilized a five level Likert scale (1=strongly disagree, 2=disagree, 3=natural, 4=agree, and 5=strongly agree). The questions and results can be seen in Table 1 with each question using a “G” signifier for graduate student questions.

Table 1: Post-analysis graduate student questionnaire and results.

	Results	
	Average	**Percentage In Favor**
G1. I feel that I had a more in-depth learning experience having to learn and teach the scheduling software, Primavera.	5	100%
G2. I feel that my retention of the topic has increased beyond other topics in the class (Ex: Microsoft Project)?	4.5	90%
G3. I enjoyed teaching the topic	4.5	90%
G4. I would have preferred the topic be professor taught?	2	40%
G5. I feel as though I can properly execute a basic (single family home) construction schedule in Primavera (P6)	5	100%

As we see from Table 1, the graduate students enjoyed teaching the PMS without any negative impact on their learning comprehension. The graduate students felt that they had a more in-depth learning experience by having to learn and teach Primavera. A reflection on these matters by the graduate students reads;

"I feel that in having to teach [Primavera] forced me to learn the program in more detail. Instead of just having to repeat a taught process, I actually had to learn how the program worked to be able to teach the program effectively. I also felt like I had to truly understand the program to avoid an embarrassing or awkward lecture."

"Having to learn the topic and then teach it to the other students resulted in being able to anticipate the problems and questions that the other students would ask. The material was fresh in my mind, and having experienced many of the same problems they did so recently, I could easily guide them through troubleshooting exercises."

"I would agree that I enjoyed teaching the topic and its related material. It is enjoyable and fulfilling when I can see that I have assisted in helping someone not only learn, but also understand something they were previously unfamiliar with."

The questionnaire also revealed a 90% in favor of topic retention over learning Microsoft Project, which was professor taught. Question G4 gauged their preference of having the topic professor taught. The results show that they did not prefer the topic to be professor taught with a 40% in favor result. A graduate student's reflection revealed,

"*I would not have preferred the professor teach the material, as it allowed me to really get into it and "get my hands dirty", rather than simply hearing it explained and watching it be done*

before trying to do it myself. Having practiced [Primavera] so many times prior to teaching the topic, I am definitely confident I could execute a basic schedule in Primavera P6."

Additionally, the students felt that the can confidently produce a single-family home construction schedule using Primavera.

"The program was very difficult to navigate and understand at first but in preparing for the lecture, I gained a true understanding of how the program worked at a core level and would be able to pick it up at any moment and create a basic schedule."

"Having practiced it so many times prior to teaching the topic, I am definitely confident I could execute a basic schedule in Primavera P6."

Undergraduate Student Impact

Following the graduate student peer teaching lecture and homework assignment the undergraduate students were asked to fill in a provided questionnaire. The questionnaire is the primary investigation technique used to determine the adequacy of the implemented teaching method. The questionnaire included three broad categories, learning, presentation, and organization. Each category had a specific question related to their respective category, which the students were asked to evaluate using a five level Likert scale (1=strongly disagree, 2=disagree, 3=natural, 4=agree, and 5=strongly agree). The itemized questions are displayed in Table 2. The letter "U" was used prior to the question number, to signify a question used to gauge the undergraduates learning.

Table 2: Post-analysis undergraduate student questionnaire and results.

	Question	Results	
		Average	**Percentage in Favor**
Learning	U1. I found the lecture challenging and stimulating.	4.08	81.60%
	U2. This topic is very valuable to my career.	4.40	88.00%
	U3. I have learned and understood this topic.	3.72	74.40%
	U4. I prefer to have this topic student taught as opposed to professor taught.	3.64	72.80%
Presentation:	U5. Instructor explanations were clear, carefully explained.	4.28	85.60%
	U6. Instructor spoke at a comfortable speed.	4.20	84.00%
	U7. Instructors presentation held my attention throughout the class.	4.24	84.80%
	U8. The instructor was knowledgeable in the subject matter	4.36	87.20%
Organization	U9. The slides/handouts were easy to follow (fonts, diagrams, styles were clear and legible).	4.36	87.20%
	U10. The slides were organized in a logical manner.	4.40	88.00%
	Overall Average	4.17	83.36%

The learning category primarily reflects on the effectiveness of the graduate students' teaching and impact on the undergraduate students' learning. This category also includes a question devoted to gaging the students' preference of the teaching method (peer taught or professor taught). The second category, presentation, focuses on the students' ability to convey the knowledge, focusing on the graduate students' presentation aptitude. Lastly, the third category, organization, focuses on how well the graduate students' lectures were prepared. The results are presented as an average of the 29 students that answered the questionnaire as well as a percentage in favor, calculated as the average from the Likert scale divided by five. A bar chart comparison of the results can be seen in Figure 2.

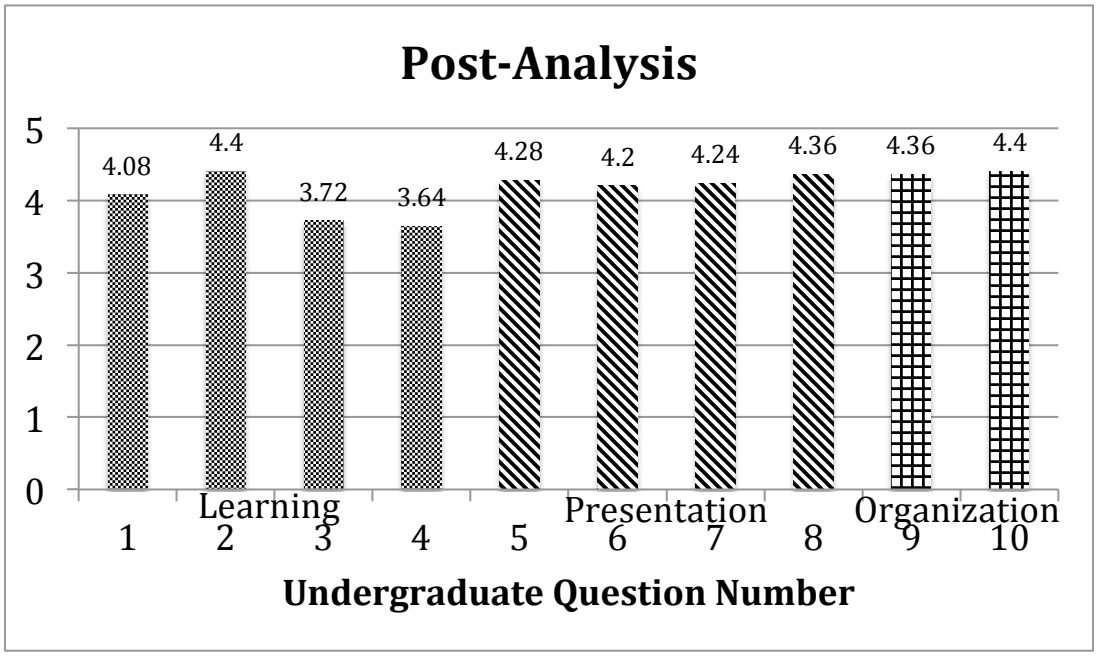

Figure 2: Post-analysis undergraduate questionnaire results.

As shown in Figure 2, the results from this study are generally positive with most results in the "agree" category. The results from the learning category produced positive results, with a local average of 3.96 and a percentage of 79.29% in favor. Question U2 probed the students' opinion on the value of learning PMS towards their future career. This question shared the highest score (4.4) with question U10. Question U10 probed the quality of the graduate students' presentation slides. From the outcome of question U2, the students primarily agree that learning to develop a construction schedule using PMS software such as Primavera is valuable to their career. It is a general consensus by the construction industry and construction faculty that learning PMS is extremely valuable to one's career in the construction industry (Galloway, 2005). Overall, the learning category did contain two of the lowest scoring questions. Question U3 and question U4 produced scores of 3.72 and 3.64, respectively, which is below the average results from this questionnaire (4.17). Question U3 gauges the students' comprehension and learning with using PMS to build a simple construction schedule. Although, these results are still positive, this outcome is interesting as it is the main focal point of this study. Secondly, question U4 also scored low, which probes the students' preference to the PMS lecture being student taught or professor taught. This item scored the overall lowest score (3.62), but is a reasonably lower score as the value of three on a five level Likert scale correlates to a neutral response. Therefore, this result shows that the students had little preference to the teaching method, but leaned slightly towards the student taught preference.

The questions from the presentation category all resulted in an above 4 ("Agree") response. These set of questions focused on the graduate students' presentation ability. It was a class consensus that the graduate students' presentation was clear and carefully explained, the students spoke well and spoke knowledgeably on the topic. Also gaged was the undergraduate student attention. The undergraduates feel that their attention (question U7) was held throughout the lecture. The local average for the presentation section was 4.27 and a percentage of 85.40% in favor, which was above the overall average (4.17/83.36%).

The remaining questions (U9 and U10) gauge the undergraduate students' opinion on the organization of the graduate students' slides and handouts. As with the previous section, the students had high remarks on the graduate students' ability to teach the PMS lecture and their organization of the lecture. Both questions were above 4 in the "agree" category with a local average of 4.38 and 87.60% in favor. The local average was also above the overall average for this category.

The last measure of comprehension from the undergraduates was their grades. Table 3 shows their average grade from their homework related to the two PMS packages taught. The Microsoft Project lecture was professor taught and the Primavera lecture was student taught.

Table 3: Undergraduate homework averages from professor taught and student taught PMS lectures.

	Professor Taught	**Student Taught**
	Microsoft Project	Primavera
Undergraduate Homework Average	90.69	91.38

As shown in Table 3, the undergraduates' grades and conversely their learning weren't adversely affected by the student led lectures. Both homework assignments required the students to produce the same single-family home construction schedule. The homework assignments were equal in difficulty, with the major variable being the PMS package used. The results show that the students actually scored a slightly higher grade on the student taught lecture than the professor taught lecture. Overall, the students' grades reflect an equal and positive understanding of both PMS packages and were not adversely affected by the teaching method.

Conclusions and Recommendations

In this study, the two graduate students that were enrolled in the Construction Project Management and Scheduling course were required to learn and teach the Project Management Software package, Primavera, to the remaining undergraduate students in the course. The purpose and hypothesis of this learning method is to promote topic retention, as the student is required to be the expert on the topic. The results from this study were favorable as both the graduate students and undergraduate students had positive feelings towards the implemented teaching method. The post-analysis and opinions of the graduate students revealed that their retention of the topic was enhanced over the learning of the professor led PMS package. Based on their opinion, since they were required to be the expert of the topic, their understanding of the topic was increased. The post-analysis questionnaire to the undergraduate students revealed that not only was this topic important to their careers, but learning the topic was not adversely affected by the teaching method. The questionnaire also displayed that the undergraduates leaned in favor of the topic being student taught versus professor taught. This could be due to the fact that students may be more comfortable learning from their peers as opposed to learning from the professor.

After completing this implemented teaching method for the first time, the authors feel that there are some recommendations and notes for future iterations of this learning method. The authors feel that the first implementation worked well due to the enrollment of graduate students in the course. If more than two students are enrolled in the course in future implementations of the teaching method, then adjustments will need to be made. The authors feel that if three students are enrolled in the course then the workload could be distributed amongst the three of them with minimal affect on the teaching outcome. If there were four or more graduate students enrolled in the course then it would be ideal to split up the graduate students (e.g. two groups of two students, etc.) and have each group teach individualized PMS topics in Primavera. The first group could teach the same introductory lecture as outlined in this paper and the additional groups could add more advanced techniques in Primavera. That is, one group would hold an entire lecture on the introduction and set-up of construction schedules and the additional group(s) would go more in depth into the PMS package. The undergraduate students indicated in Question U2 that this topic is vital to their careers; therefore additional lectures on this topic will not adversely affect their education. If additional student led lectures on one PMS package is required, corresponding additional, professor led, PMS package lectures will also be added. Lastly, the authors feel that a pre lecture questionnaire could be added to this study so that a comparison can be made of the student response before and after the intervention.

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