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Using Embedded Quality Managers in Peer Teaching Groups in a Construction Management Classroom

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In this study, a Quality Manager (QM) was embedded within a peer-teaching group. A QM is a student who is enrolled in a course and serves as an instructional and supportive extensions of their professor. The individual QM then worked with three other students to act as a peer-teaching group, with the objective of teaching one lesson at the end of the semester. The lesson topic was on using scheduling software. The QM had previous knowledge of the software and the goal was to have the remaining three students learn and prepare their lesson plan, strictly learning from the embedded QM. Then at the end of the semester, the group of four, taught the lesson to the remaining students. This methodology allowed for two layers of peer-teaching; one within the peer-teaching group, and the other from the peer-teaching group to the remaining students. The embedded peer-teaching implementation was validated through in-course surveys, and grade comparison from the student-led lecture versus an instructor-led lecture teaching a similar scheduling program. This methodology was implemented six times, using two different scheduling programs. The surveys indicated a preference to student-led learning, over instructor-led learning. The grade comparison demonstrated an average 12 percentage point improvement.

Keywords: peer-teaching, quality managers, construction scheduling, assessment, active learning

INTRODUCTION

The concept of peers teaching peers has dated back centuries, but has only recently been used as an active learning strategy in college classrooms since the mid-90s (Whitman, 1998). This concept involves one or more students enrolled in the same course teaching amongst each other. This can occur in a variety of ways, from simply helping each other outside of the classroom to a formal in-class project. Peer teaching has many benefits and is typically seen as a less stressful way of learning, as a learner is less averse to

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making mistakes in front of their peers (while learning) than they are with their professor/instructor (Whitman, 1998). In this study, a unique peer-teaching methodology was used within a construction project management course. The study used an embedded Quality Manager (QM) within a peer-teaching group. As outlined by Jaeger et al. (2013) a Quality Manager (QM) is a student or students who are enrolled in a course of interest and serve as instructional and supportive extensions of their professor in lab and class settings. In this instance one student per implementation was recruited and guided by the course instructor to serve as a QM for one lecture. The individual QM then worked with three other students from the same classroom to act as a peer-teaching group. The peer-teaching group was formed at the start of the semester, with the objective of teaching one lesson at the end of the semester. The specific lesson topic was on using a construction project management scheduling software program. The selected QM had previous training and knowledge of the specific software program and the goal was to have the remaining three students learn and prepare their lesson plan, strictly learning from the embedded QM. Then at the end of the semester, the group of four (including the QM) taught the lesson to the remaining students enrolled in the same classroom. This methodology allows for two levels of peer-teaching, one within the teaching group and one between the teaching group and the remaining students enrolled in the course. In a general sense, requiring students to teach and become the expert of a topic reinforces the student's understanding and absorption of a topic (Topping & Ehly, 1998).

However, through this structured teaching and peer teaching group, the learning and comprehension of not only the QM, but also the three other students can be bolstered. Previous studies that require students to first learn then teach a topic generally require the students to prep and learn the material from scratch with minimal assistance from the professor. This study aims to strengthen that experience by adding a QM to the teaching group such that there is someone with experience to teach the specific scheduling software program within the teaching group. This procedure exemplifies the construct of a QM, in which a QM is an extension of the professor's knowledge and tutelage. The course was a master's level construction project management course in a two-year Master's of Science degree in Engineering Management at Texas State University. Overall, six iterations of this implementation took place, which originally began in Spring 2015. The specific scheduling software programs used were Microsoft Project for three semesters and Primavera P6 for three semesters. Two different scheduling software programs were used to allow for a comparison to student-led lecture teaching one software to that of an instructor-led lecture teaching the other. For the first three semesters Microsoft Project was taught by the student peer-teaching group and results were compared to an instructor-led lecture teaching Primavera P6. In order to eliminate the specific software variable, the specific software programs were switched after the first three iterations. Such that, for the next three semesters, the peer-teaching group taught Primavera P6, which was compared to a professor taught lecture on Microsoft Project. Additional assessment was completed through a questionnaire between the peer-teaching group and another between the remaining students enrolled in the class.

Literature Review

Student success within and after completing a degree program is important to the mission of emerging and established research universities. Peer-teaching, also known as peer-to-peer teaching, and QMs are two effective active learning pedagogies that researchers find helpful to bridge learning gaps between complex, technology-based curricula and engineering technology students. Initially described by Jaeger et al. (2013) QMs are peers that support the instructor during courses and serve as a bridge for gaps that are often created due to higher-level classroom and lab experiences where students need additional attention. Existing studies have indicated that when peer-teaching methods are used, such as QMs, the QM students accept and process the presented curricula better and the students demonstrate metacognition gains and deeper understanding aspects of learning (Jaeger, 2013). As Teacher-Student ratios (TSR) decline, resulting in less direct interaction during classroom time, Jaeger et al. (2013) hypothesize that QMs are an answer to this challenge. Despite the decreasing TSR, all students enrolled in the course are still expected to grasp difficult concepts, understand, and use the advanced technologies. Additionally, with the use of more online learning, the value of smaller learning groups with more flexibility for collaboration becomes more beneficial. In higher education, facilities space and instructional resources are not being made available to reduce the classroom size and increase the TSR, therefore QMs can provide an educational and individual student comprehension solution, which is attractive to the system. QMs are not only shown as beneficial to the teacher-student gap, but there are findings showing that the QMs are experiencing valuable individual personal and educational growth (Jaeger, 2013).

Jaeger et al (2013) demonstrated their QM model can be adopted and applied throughout many undergraduate and master's level disciplines, but has particular effectiveness in technical STEM courses. Data collection for their study was taken from a mixed-format survey given to Industrial Engineering students who participated as QMs in their third, fourth and fifth years of an undergraduate classroom. Additionally, the survey was designed for two tracks: one-time QMs and multiple time QMs. The survey questions were aimed at understanding how the QM became a "more able" peer to be able to provide peer scaffolding. Peer scaffolding is a term used to describe a skilled peer supporting the instructional gap between the educator and student during class or lab experience. Jaeger et al. (2013) organizes the QM position into four stages: 1) Sign-Up and Selection, 2) Orientation and Preparation, 3) Lab/class Time and 4) After-class Time and Reflection. The authors then provided survey questionnaires about each stage. The result analysis from these questionnaires provided substantial support for the value of the QM. The work presented by Jaeger et al. (2013) ultimately demonstrated that when QMs are used properly, and in the right environment, it is a "win-win" situation for all. Their results indicated that implemented a QM can help create more opportunities for activities or lessons that originally could not make the standard schedule due to time and resource constraints. This suggests that instructors can be relieved of the challenge of mass managing their students and focus on overall comprehension. This allows for more attention on the overall goal for each student to learn, teach, guide, motivate, and remain motivated and engaged with the subject. Jaeger

et al (2013) describe potential future improvements to the QM protocol, which include: decreasing implied peer pressure among groups to become a QM, additional course material experience opportunities, providing QMs with more challenging opportunities, increasing QM usefulness and interaction with the instructor and more transparency with QM evaluations from the students and the instructor.

Existing active teaching studies conducted in the past 15 years indicate more and more benefits to peer teaching, peer scaffolding, and other active teaching techniques. The work by Velez et al. (2011) discussed the impact of peer teaching and peer-to-peer learning, and the effects on the students in a classroom environment. The authors used a qualitative study to explore student perceptions on peer teaching using three aspects of peer teaching. The study was separated into three specific research outcomes (RO), RO 1: Described the psychological aspects of peer teaching, RO 2: Described the power relationships and classroom roles of students engaged in peer teaching course, and RO 3: Described changes to the students' sense of belonging or engagement as a result of peer teaching. The participant demographics included students enrolled in a single course offered at two different college campuses. The content, material and planning were controlled, but each course had a different instructor. The participants were paired in groups of two to three students and they were asked to take on the role as the leader in preparing and conducting one 50-minute class session. This occurred in the middle of a 10-week semester. The peer teachers taught their class the material and then the course instructor concluded with content overview and clarity, conclusions, thoughts, question and answers. The peer teachers were asked to remain in the classroom to reflect on their experience and the effectiveness of the peer teaching method. To analyze the data, the authors of this study used data triangulation, discourse analysis, textual analysis, individual interviews and focus group interviews. Students mentioned that it was an important discovery to get "a feel" for the field of study early on. Supplementary data from interviews displayed that the participants felt that the dynamic involvement encouraged engagement and interest due to the hands-on teaching approach versus a conventional lecture style where students only received information from the professor. The authors then concluded that peer teaching was enjoyed by students as compared to a conventional lecture style classroom learning process. The data showed that it promoted increased metacognition and career formation, coursework engagement, class participation and a sense of belonging.

Kim et al. (2014) was interested in understanding the impact of peer teaching on student learning in a theory based and laboratory Electric Circuits course. Their case study is designed to allow teams of two student Peer Assistants (PAs) to prepare and present course materials for the week they are assigned. Each week a different team presents and by the end of the course each student has become a PA. The authors start the report with introducing the concept of peer teaching, defining it and describing different ideas of thought developed by peer teaching researchers Vassay, Jaeger, Goldschmid and Goldschmid. These researchers have shown that when there are complex lesson objectives or improving technology in the classroom, peer scaffolding can be used. Like instructional scaffolding, the addition of supporting tools to help students through new use of technology or difficult concepts, peer scaffolding attempts to do the same except

from a peer to peer stand point. Jaeger et al. (2014) showed that a peer Quality Manager (QM) was effective in bridging the gap between fundamental course work from the instructor and student learning, supporting the students as the course moves along. These QMs are trained or are already knowledgeable with the technology so they can be a guide to their peers throughout the learning process. The case study presented involves peer teaching used in a laboratory section of a first-year electrical engineering course at the University Of San Diego Shiley-Marcos School Of Engineering. Students enrolled in this course were asked to act as PAs on a rotating basis taking the lead on teaching the course and lab work. A pair of PAs were assigned to each lab experiment for the electrical circuits course, meeting with the instructor prior to the experiment. The PAs were instructed on their assigned week's upcoming experiment, theoretical foundation, relevant calculations, computer simulation techniques and results and instrumentation. Due to the significance of introducing fundamental electrical theories and instruments to the class, the course instructor taught the first couple of classes. The PAs are evaluated, but by whom is not detailed in the report. Each member of the peer teaching team completes before and after surveys. The report reviews the survey data, which showed results based on questions about the students' knowledge of the material. A final survey specifically asking opinions about the peer teaching experience showed a modestly average score for those who agreed with the outcome of different peer teaching aspects. The participants were not sure about the effective use of peer teaching in this experience contradicting the overall benefit the peer teachers felt the experience provided them.

In regards to the specific course, construction project management in general is an application of project management aimed towards all types of construction. The role of a project manager is to determine and define the scope, understand and guide plans and specifications, specify goals and objectives, maximize resource efficiency, build and follow budgets and schedules such that they can safely implement all operations pertaining to the project. In this growing industry, the ever-increasing difficulty in scope and tighter budgetary and scheduling parameters has led to the majority of companies to utilize computer software to help them manage the information and data. Using scheduling software not only assists with information coming in from the project, but the schedules themselves can also serve as a valuable asset as a project deliverable. Scheduling software can optimize resources, enhance visibility due to data entry and tracking, allow forecasting, improve collaboration and other advantages. While there are many construction project management software programs available, Microsoft Project and Primavera P6 are the most used scheduling software in the construction industry. These two scheduling software programs were taught in the course used for this study.

Microsoft Project is a project management software program developed and sold by Microsoft, which is designed to assist a project manager in developing a plan, assigning resources to tasks, tracking progress, managing the budget, and analyzing workload. (Microsoft, 2016). Primavera (also known as Primavera P6, or P6) is a competitor to Microsoft Project with the same capabilities as Microsoft Project. The main difference between the two scheduling programs, other than the user interface, is that Primavera is an "enterprise" software program. An enterprise software program allows users to

access the software and files produced with the software at the same time and from any computer on the network. This feature may be useful to larger companies working on large and complex schedules in which information needs to be extracted by many personnel simultaneously. Other than the enterprise ability of Primavera, the two scheduling software programs are very similar.

Objective

There are two objectives of this study:

1) To develop and implement a unique two-level peer-teaching methodology using an embedded QM.
2) To improve student comprehension of scheduling software through peer-teaching.

The objectives of this study will be explored by answering the following hypothesis.

1) Peer-teaching is a preferred method of learning over instructor-led instruction.
2) The students perceived a deeper understanding of the content from a peer-led instruction versus a instructor-led instruction.
3) The students' assignment grades were higher from a peer-led instruction compared to a instructor-led instruction.

METHOD

The demographic breakdown for each implementation can be seen in Table 1.

Table 1
Demographics

Semester	Spring 2015	Spring 2016	Spring 2017	Spring 2018	Spring 2019	Spring 2020
Peer-Taught Software	Microsoft Project	Microsoft Project	Microsoft Project	Primavera P6	Primavera P6	Primavera P6
Number of Students in Peer-Teaching Group	4	4	4	4	4	4
Number of Males in Peer Teaching Group	3	4	4	2	3	4
Number of Females in Peer Teaching Group	1	0	0	2	1	0
Average Age of Peer-Teaching Group	23	25	24	24	27	24
Number of Remaining Students in the Same Course	21	19	24	15	22	20
Average Age of Remaining Students in the Same Course	25	24	28	27	23	23
Number of Males in Remaining Students in the Same Course	17	15	12	10	13	11
Number of Females in Remaining Students in the Same Course	4	4	12	5	9	9

As seen in Table 1, the embedded QM peer-teaching methodology took place a total of six different times with 144 students with an average age of 25 years old. The same instructor taught all six implementations of the study who is a male and was 28 years old at the beginning of this study. The particular QM for each implementation was selected by sending an email to the class 1-2 weeks prior to the first day. Typically, the majority of students are registered for the course months ahead of time, which gives the instructor a list of the students' information. The email sought out a student with prior knowledge and experience with the particular scheduling software and their willingness to participate in this study. Due to the technical nature of the master's degree program, the majority of students are also part-time or full-time employees in the industry and have prior experience with scheduling software, so it was typical to find at least one student with experience and who was willing. To the students who responded, a brief questionnaire was issued in order to gauge their experience level with the particular scheduling software. The following questions were asked:

1. How many years/months of experience do you have with [insert specific name] scheduling software?
2. Where did you initially learn [insert specific name] scheduling software?
3. On a scale of 1-10 (10 being the highest), how comfortable are you creating a schedule in [insert specific name] scheduling software of approximately 30-50 activities?
    a. Do you know how to show the critical path?
    b. Do you know how to show/print a bar-chart, network diagram, or a three-week look ahead schedule?
    c. Do you know how to input and manage resources linked to each activity?
4. On a scale of 1-10 (10 being the highest), how comfortable are you presenting in front of other and teaching your classmates?

On average, the students had 1-3 years of experience with the particular scheduling software program. Most students had originally learned the software from their undergraduate degree from another institution, however, a few learned it while on the job. The majority of the students who responded, indicated that they use the scheduling software everyday as part of their job. In regards to comfort level (question 3), the answers ranged from 8-10, with 10 being the most common answer. All students surveyed answered "Yes" to sub-questions 3a-c. Prior to submitting the survey, the initial email to the class provided brief detail regarding the experience, which included information regarding presenting one lecture to the rest of the class. Therefore, the answers to question 4, were typically high, and in the range of 7-10, with most answers being 9. Following the survey, and once a student was selected, the student was asked to meet with the instructor to complete a 10-minute schedule demonstration using the specific scheduling software. The student was asked to open the software program, begin entering approximately 5-10 activities, add resources, and manipulate the schedule. This step was brief and simply served as a secondary check of the student's

skills. This meeting also served as an additional occasion to further describe the teaching opportunity, answer any questions, and provide any additional guidance. The process of self-reporting their skills and checking them in person was necessary to ensure the quality of the student's knowledge, as well as to offer assurances that the pertinent knowledge would be transferred during the lecture. Often times, there was only one student interested in this opportunity, but on two occasions there were two students interested, and one occasion three. In that instance, the instructor went with the student who reported the most years of experience with the particular software. The student identified, now served as the QM for the particular iteration of the study.

Following the selection of the QM, the instructor announced the opportunity to the remaining class as well as identifying the QM. The instructor asked for three volunteers who had no experience with the particular software program and who would be interested in the teaching opportunity, and particularly presenting one lecture near the end of the semester. To motivate the volunteers (including the QM), the volunteers were offered 10 extra credit points to their lowest scored homework assignment and they were also excused from the homework assignment attached to the lesson they taught. If more than three students volunteered, the instructor selected the first three hands that were raised. For control purposes the volunteers were limited to three, plus the QM. These four selected students (including the QM) were then referred to as the "teaching team". Their overall goal was to teach one lecture covering the particular scheduling software program. Their lecture date was pre-arranged at the start of the semester, such that they knew when they were presenting. Their assignment documentation included the following specific requirements to be included in their lecture.

1. Demonstrate how to open the software, create a new schedule, as well as how to access a previously saved schedule.
2. Demonstrate how to name the schedule, establish a start date, set working days and hours.
3. Demonstrate how to input activities, activity names, activity durations, and predecessor/successor information.
4. Demonstrate how to tell the software to run/complete the schedule automatically and manually.
5. Demonstrate how to input resources and how to link those to specific activities.
6. Demonstrate how to show the critical path, float, lags.
7. Demonstrate how to show and print a bar-chart schedule, network-based schedule, and a three-week lookahead schedule.
8. Demonstrate how to troubleshoot any of the above should an issue occur.

The teaching group then had approximately 12 weeks to learn, prepare, and become the expert, in order to teach the software program. The three volunteers within the teaching group were asked to be primarily reliant on learning through the embedded QM. The teaching team was asked to meet with the instructor three times throughout the semester to check-in on their progress. The third meeting, the students were asked to give a mock

lecture to the instructor, in which the instructor provided advice and suggestions regarding their instruction. The teaching team were asked to demonstrate a residential schedule that would include approximately 30 activities and related resources. They were also asked to produce a document/hand-out showing the step-by-step procedure as well as any acronyms or keyboard shortcuts. Lastly, the teaching team was asked to have at least one person serve as a "roaming lecturer" throughout their lecture. A roaming lecturer is a term created for this study, in which a lecturer could move about the classroom helping individual students who need specific attention. From experience, the authors have found that when teaching software, there are often students who accidentally click the wrong menu/item, leading them far off-track. This often results in the instructor having to pause the lecture, walk over to the student's workstation, and help them get back on track. However, this typically leads to other students getting impatient and likely ended up off-track themselves. Therefore, since four students will be presenting, two students could remain at the podium (one operating the computer, and the other pointing out important items on the screen) and the other two students could "roam" the classroom helping the off-track students, thus allowing the overall lecture to continue, uninterrupted.

To assess the effectiveness of the implemented embedded QM, peer teaching, pedagogy a pre and post questionnaire was presented to just the teaching group, in order to assess the effectiveness of the QM, from the perspective of the three non-QM students. The same pre and post questionnaire was also issued to the embedded QM, however, their answers were analyzed separately. Also, the post questionnaire included additional questions that were only submitted to the non-QM students. The questions can be seen in Table 2. Additionally, the remaining students in the class that received the student-led lecture were provided with a questionnaire following the peer-taught lecture to assess their feelings toward the peer teaching method implemented. The remaining student questionnaire can be seen in Table 3. Lastly, an objective assessment was completed, which compared student homework grades from the student-led lecture versus the instructor-led lecture. All questionnaires submitted used a 5-point Likert scale in which 5 was highest.

Table 2
Pre and post questionnaire questions for the non-QM students in the teaching group

Learning
1. I prefer to figure things out on my own.
2. I prefer to learn from a traditional professor/instructor.
3. I prefer to learn from my peers.
Teamwork
4. I prefer to be a leader and give directions.
5. I expect to be able to work effectively in a team environment.
6. I prefer to be a valuable team member as opposed to a leader.
Scheduling Software
7. I am knowledgeable with Microsoft Project/Primavera P6 and can produce a scheduling using the software.
8. I know how to use scheduling software other than Microsoft Project/Primavera P6.
9. This topic is very valuable to my career.
Additional Questions (only included on the post-questionnaire and only submitted to the non-QM students)
10. Please rate your experiences learning Microsoft Project/Primavera P6 through the QM.
11. Would you have rather learned Microsoft Project/Primavera P6 from the instructor?
12. Please rate the quality of the lectures provided to you from the QM.
13. Please provide any additional comments on your experiences that you would like to share.

Table 3
Remaining student post lecture questionnaire questions

1. Instructor explanations were clear and carefully explained.
2. The instructor(s) was knowledgeable in the subject matter.
3. The use of a "roaming" lecturer helped me learn the software.
4. This topic is very important to my career.
5. I preferred the use of peer teachers to learn Microsoft Project/Primavera P6.
6. Please provide any additional comments on your experiences that you would like to share.

FINDINGS AND ANALYSIS

The data gathered from the pre and post questionnaires submitted to the peer-teaching group indicate a large increase in preference of peer teaching over an instructor-led lecture. This was observed across all questions, in all semesters of this investigation, which include both scheduling software programs. This is an excellent result, as this ultimately demonstrates that the specific software program is not having an impact on the teaching methodology, and that the teaching methodology is the dominant variable tested in this investigation. Table 4 show the results of the peer-teaching group pre and post questionnaire.

Table 4
Peer-Teaching group pre and post questionnaire results

	2015		2016		2017		2018		2019		2020	
Question Number	Pre Results	Post Results	Pre Results	Post Results	Pre Results	Post Results	Pre Results	Post Results	Pre Results	Post Results	Pre Results	Post Results
1	2.4	3.9	3.1	3.8	2.9	3.5	3.3	4.3	3.1	4.4	2.8	4.3
2	2.8	3.4	3.3	3.5	3.8	3.8	3.1	4.4	2.8	4.3	2.8	4.4
3	2.2	4.8	2.3	4.5	2.7	4.7	3.1	4.8	3.2	4.7	2.9	5
4	2.2	4.8	2.8	3.1	2.5	2.9	2.2	3.9	2.9	4.1	2.9	4.3
5	3.5	4.3	4.1	4.2	4.2	4.4	3.3	4.7	3.1	4.6	3	4.7
6	3.7	4.5	3.8	3.8	4.1	4.2	4.3	4.8	3.8	4.8	3.9	4.7
7	1.5	4.9	2.1	4.8	1.7	4.7	1.9	5	2.3	4.8	2.8	4.8
8	1.3	2.8	2.2	3.1	2.4	2.6	1.3	2.8	1.5	2.3	2.3	3.5
9	4.1	4.9	4.8	5	4.7	4.9	3.9	4.8	3.6	4.7	3.2	4.9
10	n/a	5	n/a	5	n/a	4.8	n/a	5	n/a	4.8	n/a	5
11	n/a	2.4	n/a	1.8	n/a	1.7	n/a	1.4	n/a	2	n/a	1.9
12	n/a	5	n/a	5	n/a	4.8	n/a	4.9	n/a	5	n/a	4.9

Questions 1-3, which pertain to the students' learning preference (self-taught, professor, or peers) show an increase in all post-questionnaire analysis. Question 1 and 2, showed an average improvement of 1.1 and 0.9 respectively. Question 1 probed students' perception of figuring things out on their own. This improvement was likely contributed to the students being taught in a smaller, more personal environment, that garners more personal and instant gratification from learning, rather than learning from a classroom, then completing assignments at a later time. Question 2, had a lower improvement from pre- to post-questionnaire, and was one of the lowest improvements observed in the study. This question assesses students' preference to learn from their instructor in a traditional manner. This result is expected, as a traditional lecture environment can often feel stale and not very interesting. The lower improvements with Questions 1-2 are likely due to an uncertainty in personal preference or an uncertainty in regards to the specific topic learned. Boud (2001) describes that the effectiveness of traditional instructor-led teaching versus peer-led teaching could depend upon the specific topic learned. Therefore, when the students were asked to answer the pre-questionnaire, they may have been uncertain of their preference at that stage in the process. Having been taught the specific software, the students' perception changed as they have more information. The question in this category that has the largest improvement is Question 3, which probes students' preference to learn from their peers. The scores of the pre and post questionnaire from all iteration years illustrates a strong positive increase associated to this particular question. The results an increase from 2.7 to 4.8, which was the highest improvement observed in this study. This shows that there was noteworthy perception development preference of the peer teaching methodology implemented in this study. Assessing the Question 3 between the three semesters that used Microsoft Project versus the three semesters that used Primavera P6 showed marginal difference (0.4) between the students' perception, indicating that the specific software did not have an effect on the embedded QM peer-teaching methodology. This result supports hypothesis Question 1, assessing students' preference towards peer-teaching over instructor-led instruction.

The next set of questions (4-6) focus on student teamwork and their individual opinion on working by oneself or with the team, or being a leader within a team. These three questions have a fluctuating degree of preference, but what is noticed is that the pre and post answers are very similar. Question 4, which pertained to being a leader within a group scored the lowest values amongst the three questions and also had the widest difference between the three questions averages. This is expected as being a leader and having extra responsibility could initially be a daunting task, therefore upon receiving the pre-questionnaire, the students may have been apprehensive about the situation. However, contrast that to their post-questionnaire results, in which their perspectives improved. This result suggests that, after the students committed to being a leader and providing directions, they enjoyed their experience more than initially surmised. Question 5 probed the students' perceptions regarding being able to work in a team. Like all other questions, this one also improved in all iterations of this study, however, it was observed that in the 2016 and 2017 iteration of the study the students had a high initial perception regarding their willingness to participate effectively in a team environment. This is expected, as previously stated, the students enrolled in the course typically work full time, in which their full-time employment is already team based. Question 6 received high results with an average of 3.9 for the pre questionnaire and 4.5 for the post-questionnaire. This question pertained specifically to working within a team not as the leader, but as a valuable contributor. Therefore, this result indicated that all four students in the peer-teaching group ultimately preferred to work as a team. Question 7, compares students' perception of understanding Microsoft Project or Primavera P6 depending on the specific iteration of the study. This question has one of the highest perception differences, such that the pre question had an average score of 2.1 and the post had an average of 4.8. This was also one of the highest post-questionnaire results, with the majority of the students selecting 5 as their post-questionnaire answer. This result demonstrates that student comprehension within the teaching group was very high for the specific scheduling software program, which helps to answers hypothesis Question 2, regarding students having a deeper perceived understanding of the software when taught from their peers. Question 8 measured the students self-assessed proficiency with other scheduling software, in order to assess whether the students had experience with other scheduling software that may have influenced their ability to learn the other scheduling software. This question had the lowest average pre-questionnaire value of 1.8 and only increased to 2.9 with the average post-questionnaire result. These results put the students in the strongly disagree and disagree category of the Likert scale, ultimately demonstrating that the students did not have any prior scheduling software experience, which helps validate the impact of the embedded QM in the peer-teaching group, such that all of the knowledge is being transmitted through the QM and no other previous experience is contributing. The small increase to the post-questionnaire results is likely due to the students feeling more comfortable with the software and/or looking into the other software program on their own time, having previously acquired confidence with the software in which they were required to learn and subsequently teach. It is important to note that the post questionnaire was submitted prior to the instructor-led instruction of the opposite software. Question 9, inquired if the students believed that the topic was valuable to their career. The results for this question were

high on both pre and post questionnaire (4.1 and 4.9, respectively) which provides positive student feedback on the priority of each scheduling software. This question had the lowest difference between the pre- and post-questionnaire, which is expected, and a reasonable result as before and after the intervention the opinion regarding the importance of the specific software programs did not change.

Also included on the questionnaire were four additional questions, only submitted to the non-QM students in the peer-teaching group and only included on the post-questionnaire. Question 10 asks the students to rate their experience learning the specific software program through the embedded QM. Question 10 had one of the highest response values of 4.9, which was an almost perfect 5/5 in the Likert scale. This result indicates that the students drastically preferred learning from the embedded QM. Also, when averaging the results from the three semesters that implemented Microsoft Project versus the three semesters, which implemented Primavera P6, the answers are the exact same, at a result 4.9. This result further indicates no affect from the different software programs. Question 11 ask students if they would rather have learned the specific software program from the instructor. The results from this question produced the overall lowest in the study at an average of 1.9, which is on the boarder of strongly disagree and disagree. This result indicates that the students strongly preferred the QM-led instruction. Question 12 asked the non-QM students to rate the quality of the lectures provided by the QM, in which they learned their specific software program. The average outcome from this question produced one of the highest results in the study at 4.9. This result is very favorable for all QMs used in this study. Additionally, the outcome of Questions 10-12 further supports hypothesis 1. To ascertain the validity and reliability of the pre- and post-questionnaire analysis a Confirmatory Factor Analysis (CFA) was completed on the pre and post questionnaire data. The results demonstrated that the questionnaire had a good fit to the data. The alpha coefficients also demonstrated acceptable levels. Additionally, a Mann-Whitney U-test was used to asses if the results between the pre- and post-questionnaires were statistically significant. A Mann-Whitney U-test was used as it allows a comparison between two groups that are not normally distributed. The confidence level was set at 95%, $\alpha = 0.05$. The results of the Mann-Whitney U-test indicated that all results from the questionnaire assessment are statistically significant.

The last question in the questionnaire, asked the students to provide any additional comments regarding their experience learning from the QM and participating in the peer-teaching group. Below are representative answers from a few students across all years of this study.

“I highly enjoyed learning from [name of QM]. She really knew the software and made it really easy to learn.

“I always heard that Primavera P6 was super hard to learn, but [name of QM] made it super easy to understand. Now, I feel like an expert in it. I can’t wait to use it at work.”

"I loved that I got to learn from [name of QM], then had to turn around and teach that to the other students. I had to make sure I learned the stuff so that I could then teach it. I liked that added accountability."

"This idea was so cool. I wish that I could learn all of my classes this way. Having a 1-on-1 lecture who is my friend, is a great way to learn."

The QMs were also asked to provide comments regarding their experiences teaching within the peer-teaching group. A few representative responses from the QMs are listed below.

"I really enjoyed being a part of the peer-teaching group. I thought it was fun to teach others as well as teach the other students in the class"

"I thought it was cool how I had to teach some students, and then they had to teach the rest of the class. This made me make sure that my peers learned Microsoft Project"

"This was a fun idea. I liked teaching my peers and it was gratifying seeing them succeed"

It can be seen in the above comments from students in the peer teaching group and the QMs, that the students overall enjoyed their experiences. Although, this is the students' opinions, it still provides credible insight that supports the embedded QM peer-teaching methodology developed in this study as well as supporting hypothesis 1.

In addition to the questionnaire delivered to the student teaching group a second questionnaire was distributed and assessed from the remaining students enrolled in the class. This was completed to asses the impact of the peer teaching group-led lecture on the remaining students in the class. The results of the post questionnaire provided to the remaining students in class is shown in Table 5. This questionnaire was also recorded on a 5-point Likert scale in which 5 was the highest.

Table 5
Remaining student post lecture questionnaire results

Question Number	2015	2016	2017	2018	2019	2020
1	4.4	4.5	4.7	5	4.4	4.7
2	4.4	4.2	4.9	4.3	4.7	4.8
3	4.5	4.6	4.7	4.8	4.8	4.8
4	4.5	4.2	4.5	4.5	4.9	4.6
5	4.3	4.5	4.4	4.3	4.9	4.5

As seen in Table 5 the results are strongly in favor of the student-led lecture. All questions at minimum scored above 4.0 out of 5.0, in which 5 was "Strongly Agree". Therefore, all students at minimum "Agree" with all questions asked following the student-led scheduling software lecture. Assessment of each question shows more insight to this study. Question 1-2 focused on the quality of the student presentations regarding clear explanations and knowledge of the subject, in which each scored above 4.2; therefore, the remaining students in the class agreed that the students had clear and knowledgeable explanations and that they conveyed the appropriate knowledge

accurately. Question 3 relates to the use of the "roaming" student lecturer. As described previously, two of the four students in the teaching group were instructed to "roam" the classroom throughout the lecture to answer any questions that students had while the other two led the lecture, such that the lecture was more fluid with less interruptions. The students' perception of this technique was high with an average rating of 4.7 from all iterations of this study. Question 4 probed if the students felt this lecture was valuable to their career. The average results of this question were 4.5, such that every student agreed that this lecture was valuable to their career. Lastly, Question 5 asked if the students' preferred the student-led lecture. The average of Question 5 results were 4.5, indicating that the students preferred the student-led lecture. This result further confirms Hypothesis 1.

The last assessment instrument used in this study was an objective comparison of homework grades from an assignment associated with the student-led lecture versus an assignment associated with the instructor-led lecture. This exploration will allow for a direct (objective) measurement and conclusions to be made regarding the influence of the peer teaching pedagogical technique used in this study. The homework assignments were identical aside from the software program required to complete the assignment. To remove any bias from the study, an outside grader, with a provided rubric, graded the homework assignments. The results of this comparison can be seen in Figure 1.

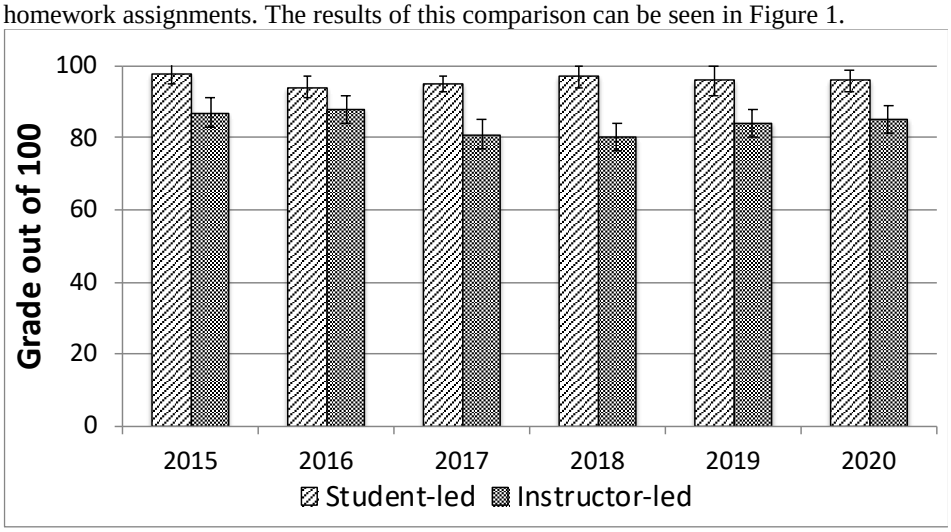

Figure 1
Student-led lecture assignment grades versus instructor-led lecture assignment grades

It is observed in Figure 1 that the homework grades from the student-led instruction yielded a higher result than the instructor-led homework assignment across all iterations of the study. The average grade from the student-led lecture was overall 96% compared to 84% overall average from the instructor-led assignment. This results in 12 percentage point reduction in homework assignment grades when the instructor led the scheduling software lecture. This result demonstrates that the embedded QM peer teaching

technique had an impact on student learning when it comes to learning two comparative scheduling software programs. This result confirms Hypothesis 3. To determine if these values are statistically significant a Mann-Whitney U-test was performed. The confidence level was set at 95%, $\alpha = 0.05$. The results of the Mann-Whitney U-test indicated that all results from the grade comparison analysis are statistically significant. The validity and reliability were also confirmed via a CFA statistical assessment.

DISCUSSION AND LIMITATIONS

The results of this study demonstrate the efficacy and desire to learn from one's peers. As described previously, learning from a peer is often less intimidating, informal, and has a higher sense of comfort that a typical lecture from an instructor (Boud, 2001). Students tend to feel more comfortable making mistakes, or asking questions that they normally would not ask to an instructor. As pointed out by Talley *et al.* (2016) and Torres *et al. (2022)* students who are struggling with a course, still do not feel it necessary to ask the instructor for help or visit with them outside of the classroom. This is primarily due to a sense of discomfort or fear of judgement from the instructor, whereas this is less likely with one's classroom peers. The results from the current study further validate these claims through the pre- and post-questionnaires as well as the objective assignment grades. This study also supports the idea that this particular QM embedded peer-teaching methodology can be done without negatively impacting the curricula or students. Further, it shows that peer-teaching utilizing QMs as an instructional assistance technique helps to bridge a learning gap between complex, technology-based curricula and engineering technology students. Furthermore, by switching which specific scheduling software program was taught after three years, removes the variable of the program, such that the implemented methodology could be assessed without impact of the software itself. Some limitations exist in this study. The first being the course, instructor, and university itself. To fully solidify the effectiveness of this method, additional iterations could be completed in a similar construction project management course by another instructor at a different institution. The assessment techniques were compared to the instructor-led instruction, which was consistently the same instructor. Although, this helps with consistency and reliability, one could wonder if a different instructor could have a different impact. For example, if the age gap between the students was closer or wider, or if any other demographic variable changed about the instructor. In this study, it can be seen that the grades from the instructor-led instruction were all passing grades, consistently above 80%, with an average of 84% across the six iterations. These grades are passing, but perhaps a different instructor could produce higher grades, possibly higher than the peer-led instruction. It should be pointed out that across the six implementation the peer-led instruction averaged a 96%, so the margin for improvement is low, however if the instructor-led instruction grades improved, the difference between the two instructions could become marginal, which would lead to a statistically insignificant result, resulting in little-to-no difference between the two instruction methods. However, if this were the case, the questionnaire analysis indicates a strong preference to the peer-led instruction, which provides justification that this instruction is worth-while, especially with the consistently high homework average. Additionally, this study was only completed on teaching two

comparable scheduling software programs. Therefore, the positive results are currently only linked to this topic. Further evaluations and confirmation are required regarding if the two software programs are drastically different, as well as teaching a completely different topic. This topic does not have to be within construction project management, but could be in a completely different field entirely. This implementation was also in a graduate student course, therefore additional validation is needed in an undergraduate classroom. Due to the nature of the graduate program, in which the current study was implemented, it was likely that a QM was found within the enrolled students. However, different universities and classrooms may not be fortunate to find a QM with the required background and who is willing to participate in the study. In this instance, two recommendations are offered; i) find a student who would be interested in serving as the QM, and offer outside-of-class instruction through the professor (or a past QM), such that the instruction would create a QM, and ii) continue the implementation withouy the QM and the instructor would serve as the teaching mechanism, teaching the peer-teaching group the software. An additional idea, is to have a previous QM serve as the QM again in a new iteration, however, that student would not be enrolled in the class, but could still be considered a peer. One further issue that may arise is if the instructor cannot find the three additional student volunteers to form the peer-teaching group. As previously stated in this study, the students were incentivized with 10 extra credit points towards their lowest scored homework assignment. Therefore, one recommendation is to increase the incentivization, or possible have a smaller peer-teaching group. The reason a peer-teaching group was held to four students, in this study, was to keep the group small, such to not overwhelm the QM, and to provide at least three points of assessment of the QM (from the three other students in the peer-teaching group). Another limitation to this study would be an assessment of topic retention. Both instructions are provided toward the end of the semester and the homework assignments are provided immediately after each instruction, therefore, the information is relatively fresh in the students' minds. Therefore, it would be interesting to assess which method is producing longer lasting knowledge. This was not assessed in this study due to time constraints and the fact that the program is typically completed in two years, and students, on average, graduate within a year of taking this course. Therefore, only a short-term retention could be assessed while they were still students at the university, which was not completed.

CONCLUSIONS

This study develops and implements a unique embedded QM peer-teaching pedagogy that was implemented a total of six times to a construction project management course. A total of three assessment techniques were used to assess the impact of the implemented pedagogy, which assessed the embedded QM, the peer-teaching group, and the process as a whole. Based off of the findings from this study the following conclusions can be drawn.

Both objectives of this study have been met. A unique two-level peer-teaching methodology using an embedded QM was developed and implemented. Secondly, student comprehension of scheduling software programs was improved through peer-teaching.

The quality of the selected QM was confirmed through pre-questionnaire and an in-person demonstration.

Peer-teaching methodology was the preferred method of teaching from the perspective of the peer-teaching group as well as the remaining students. This conclusion confirms Hypothesis 1.

The teaching group preferred the use of the QM to learn their specific software program.

The students perceived a deeper understanding of the delivered content from the peer-led instruction. This conclusion confirms Hypothesis 2

The student's assignment grades were higher from the peer-led instruction compared to the instructor-led instruction. This conclusion confirms Hypothesis 3.

REFERENCES

Boud, D. (2001). Making the move to peer learning. In Boud, D., Cohen, R. & Sampson, J. (Eds.) (2001). Peer Learning in Higher Education: Learning from and with each other. London: Kogan Page (now Routledge), 1-20.

Jaeger, B. K., & Liss, K., & van den Heuvel, B., & Wilson, E. (2013). *Those who can, teach. Immersing Students as Peer Educators to Enhance Class Experience* ASEE Annual Conference & Exposition, Atlanta, Georgia. https://peer.asee.org/22633

Kim, Taehee & Schallert, Diane. (2014). Mediating Effects of Teacher Enthusiasm and Peer Enthusiasm on Students' Interest in the College Classroom. Contemporary Educational Psychology. 39. 10.1016/j.cedpsych.2014.03.002.

Talley, K. and Torres, A., "Measuring the Impact of Rapid Feedback Daily Objective Pedagogy" International Journal of Construction Education and Research, 2016, pg 1-23, doi: 10.1080/15578771.2016.1200697

Topping, K., & Ehly, S. (Eds). (1998). Peer-assisted learning. Mahwah,NJ: Lawrence Erlbaum.

Torres, A., Hu, J., Sriraman, V., Ortiz, A., Membrillo, J., "Assessing the Effectiveness of Problem-Based Learning Across Two Concrete Construction Courses" International Journal of Instruction, Accepted January 2022 (currently in press)

Velez, J., Cano, J., & Whittington, S. (2011). Cultivating Change Through Peer Teaching. *Journal of Agricultural Education, 52*(1), 40-49. doi:10.5032/jae.2011.01040

Whitman, N (1998), Peer Teaching: To Teach is to Learn Twice, Jossey – Bass, San Francisco.