Peer-Tutors: to Embed or Not to Embed? An Exploratory Study

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Abstract

The Business Department together with tutoring services in Student Academic Services at ECSU are investigating the effects on student performance of embedding peer-tutors in the classroom as well as having peer-tutors hold peer-tutor led review/help sessions. In this study, three sections of BUS 205 were involved in this experiment. Though sample sizes are small, in this initial roll out, we found no significant differences to support the hypothesis that there is a difference in student performance between sections with an embedded tutor and sections without. However, there is more support for the hypothesis that students in sections with an embedded tutor that also attend peer review/help sessions perform better than students in a section without an embedded tutor.

Keywords: Peer tutoring, higher education tutors, peer teaching, peer teach, tutors.

1. INTRODUCTION

The introductory course to information systems, called information management, is an information technology course offered as part of both the liberal arts curriculum, and the business and business information systems (BIS) majors. For BIS, the course is often an opportunity to introduce students to the area of information systems. The course is taught by information systems faculty. Studies show having a good first experience in a computing course may encourage students to take an additional computing course, and/or consider computing as a major in the case of Freshmen (Campbell, 1992). In our experience, students have been motivated to take additional BIS classes which often leads to minoring or majoring in BIS.

Students need basic arithmetic skills to do well in the course, e.g., understanding orders of operations, working with fractions and percentages. For many of the students, the course is a first look at data analysis and analytical problem solving using Microsoft Excel and to a lesser extent Microsoft Access. The student pool in this course is diverse with students originating from a panoply of majors. The course is a challenge for instructors. Specifically, guiding and assisting students in class during the problem- solving segments of the course has always been a challenge: (1) the instructor does not always have the personal bandwidth to assist all students individually or in their teams; (2) not all students have the confidence to signal if they are experiencing difficulties to the instructor – which then requires the instructor to attempt to (re)view the work of all students in a class session; (3) peer-groups don't always work, weaker students don't always feel comfortable revealing their lack of understanding to a peer when the latter is comfortable and perhaps even bored with steps taken to help weaker students catch up. Recently, together with student advising services (SAC), we started experimenting with engaging peer-tutors to (1) "embed" in the classroom to assist with the one-on-one, or small-team consultation, typically required of the instructor in the classroom during problem-solving segments of the class. And to (2) conduct tutor-driven help/ review sessions, outside of class, that focus on

helping students on problem solving and analysis content of the course.

This paper presents the initial results from the piloting of this program, we compare the two interventions, namely (i) embedding the tutor in the classroom and having him/her assist students in class and (ii) having the tutor hold review/help sessions on the same content problems outside of class. We ask: (1) all else being equal for the course, do class sections with an active embedded tutor perform better than class sections whose students are given access to a dedicated, outside of class, peer-tutor that conducts help/review sessions? (2) Do students with an active embedded peer-tutor who attend review/help sessions do better than students who attend review/help sessions without an active embedded tutor?

2. LITERATURE REVIEW

Peer assisted learning, or so-called near-peer teaching, is on the rise, and in the medical field is firmly established (Ten Cate & Durning, 2007b). Peer teaching is defined as "an educational arrangement in which one student teaches one or more fellow students" (Ten Cate & Durning, 2007a). It offers opportunity to both student and tutor to acquire new knowledge and skills, and helps better utilize stretched resources (Rees, Quinn, Davies, & Fotheringham, 2016). The engagement of peers in teaching is also motivated by a belief or expectation that a tutor, especially peer or near-peer, likely has more in common with a student. Specifically, that a tutor has more role congruence and cognitive congruence with students. A tutor's role congruence is defined as the willingness to be "student among the students" (Lockspeiser, O'Sullivan, Teherani, & Muller, 2008; Moust, 1993; Schmidt & Moust, 1995). It implies aiming for an informal relationship with students and being able to display care and interest (Schmidt & Moust, 1995). Cognitive congruence, on the other hand, is defined as the ability to express oneself in the language of the students, using concepts they use and explaining things in a way that is readily understood by students (Schmidt & Moust, 1995).

The research on the effectiveness of student tutors in higher education is sparse, many of these studies are from the medical field and on peer-tutoring (Dolmans et al., 2002; Rees et al., 2016). In information systems, some studies have reported on peer tutoring for programming courses (Gerhardt & Olan, 2010; Hartness & Shannon, 2011). Peer tutor effectiveness has been discussed from two predominant perspectives: one perspective focuses on the tutor's subject-matter knowledge as a determinant for learning (Moust, 1993), the other draws on the tutor's personal qualities, i.e. the ability to communicate with students informally and display an empathic attitude. Schmidt and Moust (1995) advocated for a combination of both subject-matter expertise and tutor personal qualities.

Moust's (1993) theory of tutor performance proposes that cognitive congruence (i.e. being able to frame communication and contribution in a manner readily accessible to students' understanding of the subject-matter) is a necessary condition for tutor effectiveness. Cognitive congruence also assumes a tutor posesses sensitivity to the difficulties students may encounter while dealing with a problem or with the content relevant to that problem. "He or she should know when to intervene and what to offer: asking for clarification, suggesting a counterexample, or providing some brief explanation" (Schmidt & Moust, 1995, p. 5). This requires the tutor to master the subject matter and to have appropriate interpersonal qualities.

The two types of tutor interventions in our study are also informed in part by functional resource needs. From student evaluations, lack of opportunity to get assistance in class has been associated with student satisfaction. The program objective is to understand which of these interventions is better for student outcomes and as well as student satisfaction. In this paper we focus, on student outcomes related to demonstrating problem-solving skills related to the subject-matter.

3. METHODOLOGY

At the start of 2018, the Business Department together with Student Academic Services piloted a new peer-tutoring program for the information management course, named BUS 205. Two tutors were employed in three sections of course. Two interventions were identified:

(1) Embed an active peer or near peer tutor in class to assist students with in class activities
(2) Have a peer-tutor hold review/help sessions outside of class with students. Note, this tutor also attends class but does not actively participate in in-class activities

Section	Class Size
A*	17
B*	17
C	22
Total	56
*with active embedded tutor	

Table 1 The three course sections and size

Two of the sections (A and B) had an active embedded peer-tutor, one section (C) did not have an embed, students were told they could access a peer-tutor dedicated to the course. The peer-tutor in Section C would however regularly attend the class section to stay on top of the topic and to be a familiar face to students. She would periodically make announcements about peer-teaching sessions held within designated peer spaces within Academic Student Services. All three sections of the course discussed here were taught by the same instructor, with class sizes for each section shown in Table 1 above. The study does not include course withdrawals or "stopped attending" cases.

4. STUDY CONTEXT

The course: The goal of the course is as described:

> "*The course introduces the use of information technology for ethical problem solving and decision-making across all major functions of organizations. Particular attention is given to the critical analysis, organization, communication and presentation of information for organizational planning and control, with critical reflection on project work*."

The requisite data analysis and information processing for problem solving and decision making is performed using Microsoft's productivity tools, Excel and Access. Many students find this aspect of the course challenging which motivated the peer-teaching initiative. The course is offered across the university as part of liberal arts curriculum; and Business and BIS majors. Table 2 below shows the number of students and their majors for all three sections.

For most of the students, the course is a first look at analytical problem solving and decision-making using information systems. Though there is variation in when students actually take the course, the course is intended to be taken in the second semester of Freshman year, or the first semester Sophomore year.

Major	Count	%
Business Administration	21	38%
Finance	8	14%
Exploratory Prof. Studies	6	11%
Computer Science	4	7%
Communication	3	5%
Criminology	2	4%
Sport & Leisure Management	2	4%
Accounting, Early Childhood Education, Economics, English, Exploratory Social Sciences, Exploratory STEM, General Studies, History and Social Science, Pre-Secondary Education Certification, Sociology	1 (each)	18%
Total	56	

Table 2 Representation of diverse majors

The Peer-Tutors: Two students were hired as peer-tutors for the course, one a female, traditional student (which we will call PT-A) and the other a male (which we will call PT-B), non-traditional student (i.e. about 10- years older than the average student enrolled in the class). Both students had taken the course in the semester immediately prior with the same instructor. The two students had some obvious contrasting personalities, the younger was relatively quieter, soft-spoken and friendly, while the older was more self-assured outspoken, and friendly. Both students had earned an A or above for the course in the preceding semester.

The Embedded Tutor (PT-B): To understand what the embedded tutor did, it is necessary to briefly describe the general nature of related class activities.

- *Preparation:* As preparation for the class, students would be assigned a walkthrough tutorial from the text that introduces basic concepts, e.g. data entry, basic functions and formulae. The tutorial must be submitted before the related class.
- *Lecture:* For between 5-20 mins, depending on context, instructor reviews and/or introduces targeted concepts (e.g. describe a

scenario for typical usage, review basic functions, plus an additional function, and emphasize role and general structure of syntax)
- *Instructor "I do":* Instructor guides students through a few examples drawing attention to previously discussed concepts. For between 5-20 mins (depending on context).
- *Student "You do":* Students are given related, unseen problems of rising complexity to solve in class. In general solutions are due at the end of class. This means students have to solve the problem(s) in class and submit solutions by class's end. There can large variability in how many students can "walk" on their own and those that can't. Many of the difficulties are related to students who seem to expect to learn only by illustrative examples, and ignore conceptual information. They engage in selective attention-spend. This is when instructor help or peer help may be needed. The help typically entails drawing the student's attention back to the foundational concepts necessary to think through the problem, or to clarify where there is misunderstanding. The objective is not to solve the problem for the student.
- *Final step:* The instructor quickly solves the problem on the board. Sometimes this step isn't necessary, particularly when the instructor has verified everyone has correctly solved the problem on their own.

Whereas, PT-A conducted peer review/help sessions outside of class time in a classroom hosted by SAC, PT-B acted as an active embedded tutor. PT-B engage in direct one-to-one consultations with students in class, assisting during the problem-solving, "you do" case-oriented segments of the course. Students would raise their hands when they needed help, and PT-B would attend to anyone who would have otherwise had to wait for the instructor to finish helping another student.

We note, for administrative and personnel verification reasons, the tutors started working during the fourth week of the semester.

Peer-Tutor Instruction: Tutors were given some instruction prior to commencing their task. Here, we briefly outline the primary goals of this instruction. We wanted to impress upon the peer-tutors to be conscious of the importance of empathy (Chng, Yew, & Schmidt, 2011; Dolmans et al., 2002; Maudsley, 1999) listening to and asking questions of the students (Maudsley, 1999) to help students learn for themselves, using their interpersonal skills (Topping, 1996) and what they have in common with students to help students learn what many of the students find challenging.
Briefly peer-tutors were instructed to: Aim to act as a facilitator for their peers' learning. Plan not to solve the assigned problems for students. If a student claims "I don't know how to do this, help me", the peer tutor should first seek to get the student to articulate what it is they *do understand*. They were instructed that *listening* to the student and *asking questions* of the student was more important than providing answers to a student. They were also told to feel free to tell a student to take a moment and review the related class notes/recorded class lecture on the topic and be specific about what they do understand as well as where they are having difficulties. PT-A was also told, in addition to using instructor created content, to feel free to create her own applicable examples. They were also reminded that the advantage of being a peer is that they are more likely to share the same language and experiences as the students, it was our hope that it would be easier to put themselves in their peers' shoes and share their own similar experiences.

The three sections: Two of the three classes had PT-B as an active embedded peer-tutor; these were a section held at 8:00 AM, and a mid-afternoon (2pm) session. For the third class, a mid-morning session, students were introduced to PT-A and given an opportunity to vote for the most preferable times to hold the peer-tutoring sessions. PT-A would however attend the same, mid-morning section to stay abreast of what was happening in class and to be a familiar face to students. The scheduled peer-tutoring review/help sessions were also open to all students, including sections with an embedded peer-tutor.

Peer-teaching review/help sessions: Review sessions were conducted by PT-A using a combination of content created by the instructor: practice problems created for the class, homework assignments as well examples she created on her own. According to PT-A, in general, when a student asked a question, she would check in with the student for understanding of the underlying concept(s) first, then probe for other issues that may be getting in the way of understanding. Though impossible to police, both peer-tutors understood that simply solving problems for students was not constructive for students. Six review/help sessions were held with no less than eight attendees per session. However, 22 distinct students attended the review sessions at least once, with most students

attending 4-6 sessions. Each session lasted 120 minutes.

Session	Attendance
Session 1	8
Session 2	9
Session 3	9
Session 4	8
Session 5	8
Session 6	8
Average Attendance	**8.3**

Table 3 Peer review/help session attendance

5. HYPOTHESES

The focus of the intervention was the effect on students' performance on data/information analysis and problem-solving course assessments. There are obviously many factors that affect students' performance in this regard, e.g. prior academic preparation, interests and major, intrinsic motivation and engagement with the material, self-directed learning, execution and completion of related assignments. Some students are academically better prepared for analytical work through prior education and/or the major. In our case, computer science majors/minors, *ceteris paribus*, historically perform better in the course. Peer tutoring may moderate some of these effects on student performance. It may, we suppose, for example inspire engagement and self-directed learning through the example of peer or near-peers.

Hypothesis Testing: Based on Moust's theory of tutor performance, we would expect, all things being equal, expect that peer directed review/help sessions give more opportunity and control to the peer tutor, and more time to direct the tutorial group environment than the embedded peer tutor whose work is carried out within the confines of class time and class activities only. We would hypothesize that students who attend peer review/help sessions do better on related tasks than those that do not (even those that have an embedded peer tutor).

Null hypotheses,

> H_{01}: There is no significant difference in student performance scores between a course section with an active embedded peer-tutor and a course section without an active embedded peer-tutor.
>
> H_{02}: For students who attend peer review/help sessions, there is no significant difference in student performance scores between a section with an active embedded tutor and one without an active embedded tutor.

To test the hypothesis, course assessment scores on related tasks were compared to determine if significant differences existed in performance between the two sections with an embedded peer tutor and the one section without.

6. RESULTS AND DISCUSSION

We tested for differences between four course assessment items of varying degrees of difficulty with three of them taken under time-restricted testing conditions and one a comprehensive project assignment completed outside of class. An initial assessment (*Quiz 1*) is used as a baseline measure that was taken earlier in the semester prior to the engagement of the peer tutors. The items were:

- *Mid-PS-Excel*, a problem-solving, decision making task completed under testing conditions during the midterm, where students are given a data set in Excel from a case, asked to generate information and format the representation to answer specific questions about the case.
- *Fin-PS-Excel* was similar to *Mid-PS-Excel* in structure and requirements, the key difference is, because it is completed at the end of the semester (under testing conditions), it is more complex. It requires a synthesis of a larger knowledge base.
- C*ommonAssess* is also completed under testing conditions at the end of the semester, but comprises three smaller and less complex cases problems. It is expected that students should perform better than for the *Fin-PS-Excel*.
- *Assignm* is a comprehensive project assignment completed during the last month of the semester; it also requires the synthesis of the broad array of concepts learned throughout the semester. However, this assignment is completed as homework at the students' own pace, and with opportunity to seek out help.

In general, the possible minimum score for each item is 0. The maximum is 100 for *Mid-PS-Excel* and *CommonAssess*, and *Fin-PS-Excel* and for *Assignm* the maximum for required work was 100, with opportunity to earn extra credit on more challenging problems up to 125.

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Figure below shows the mean scores for these assessments for the three sections. We observe, in general, that the testing scores improve overtime from the early baseline score (Quiz 1) with the exception of *Fin-PS-Excel,* the more complex case problem.

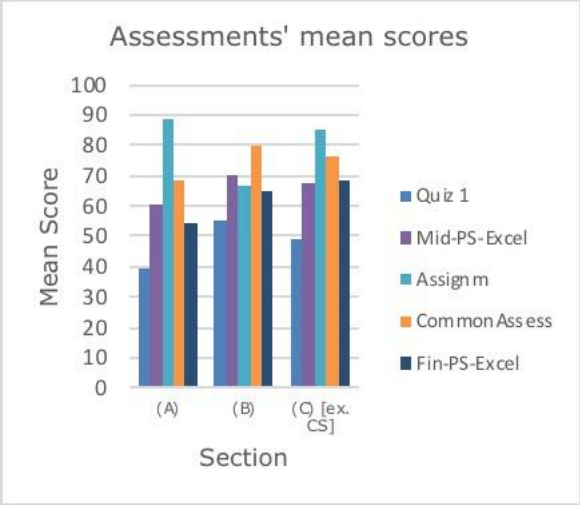

Figure 1 Assessment mean scores

For Section C [ex CS], we ultimately chose to exclude the scores of the computer science majors from the study, for the simple reason that their scores on the final and more complex assessment skewed the results because of their somewhat disproportionate relative numbers in the class; there were three computer science students in the class out of 22. To be consistent, we eliminated all computer science majors.

With respect to the hypotheses,

First, when comparing the mean scores of all the assessments between the sections (A, B) with an active embedded tutor and the section with no active embedded tutor section (C) on each of the problem-solving assessments, we found only one case where there is a significant difference in the [Assignm] scores of students in the section [B] with an active embedded tutor (mean=66.8, SD=30.5) and a section with no active embedded tutor [section C] (mean=85.6, SD=24) conditions; p(26),p=0.06. We cannot read too much into this result yet, but there may be a cockiness that builds among students who feel they understand and even mastered the material in class that leads them to phone in their homework assignment or underestimate how many hours would be required to complete the project assignment. A number of students in section B simply did not complete the assignment accounting for the relatively lower mean score for the section.

This means, none of the assessments taken under testing conditions support rejecting the null hypothesis ($H0_1$), whereas a comparison of the comprehensive project assignment would support rejecting the null hypothesis. The comparison of scores between section (A) and (C) on the same item are not significant. It is quite possible from our sample that for the comprehensive project assignment, some students without the active embedded were able use the month-long period and relationship with PT-A to repeatedly consult with the peer-tutor outside of class. we cannot reject nor fail to reject the null hypothesis. Additional research is needed.

Secondly, we asked, for students who attended peer review/help sessions are there differences in scores between the sections with an active embedded tutor and the section without an active embedded tutor.

Table 4 (appendix) shows the number of peer review/help-session attendees. As intended, students from section (C) predominated attendance; attendance was voluntary. Section C had twice as many unique attendees with an average attendance of more than 4/6 sessions attended. 57% of the students from section C attended these sessions.

On average, for those students who attended review sessions, students with an embedded tutor appear to do better than those without an active embedded tutor, i.e. Section (C). See Table 5 (appendix), where the largest mean is highlighted. Are these differences significant?

Regarding the null hypothesis, H_{02}, we found the following:

- For students who attended review sessions, there was a significant difference in the [*Assignm*] assessment scores for the section with an active embedded tutor [section A] (mean=104.7, SD=6.6) and no embedded tutor [section C] (mean=92.0, SD=18.4) conditions; t(12)=, p=0.08
- For students who attended review sessions, there was a significant difference in the [*CommonAssess*] assessment scores for the section with an active embedded tutor [section B] (mean=88.0, SD=7.2) and no embedded tutor [section C] (mean=75.1, SD=13.2) conditions; t(12)=, p=0.03
- For students who attended review sessions, there was a significant difference in the [*Fin-*

PS-Excel] assessment scores for the section with an active embedded tutor [section B] (mean=77.3, SD=48.6) and no embedded tutor [section C] (mean=37.9, SD=38.2) conditions; t(14)=, p=0.09

The above results are interesting because of the diversity of items that would support rejecting the null hypothesis in favor of the alternative hypothesis: for students who attend peer review/help sessions, there is a significant difference in student performance scores between a section with an active embedded tutor and one without an active embedded tutor.

On the other hand, both the items completed under testing conditions were done at the end of the semester, with *Fin-PS-Excel* problems being more complex, requiring more synthesizing of the material, and critical thinking about material learned. The students with an embedded tutor (Section B) who also attended review/help sessions did better overall. They also do better for the other, easier, end of semester assessment (CommonAssess).

For section A (Table 5 - appendix). We think the results are difficult to interpret. Section B is a more reliable counterpoint to Section C between embedded peer-tutors and no embeds. Section A was an 8:00 class with too many students who should have known better than to attempt an 8:00 section. Too many students regularly observed barely awake (Adolescent Sleep Working Group, 2014; Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998; Hansen, Janssen, Schiff, Zee, & Dubocovich, 2005; Lund, Reider, Whiting, & Prichard, 2010). It is something that came up in class. It is also possible that they themselves knew this to be true, and put it a lot of effort on the project assignment to offset in-class performance. Thus, seeking out the review/help session tutor and attempting extra-credit questions. This would be counter to the competence cockiness that we may have developed with Section B regarding the project assignment.

The results for *FIN-PS-Excel* (Table 5 -appendix) suggest that for complex problem solving, requiring synthesis and critical thinking under testing conditions, initial deep understanding in the classroom is required. From observation, the mid-afternoon (Section B) understood and were able to better think with concepts. It may the presence of an embed gives the instructor more time and opportunity to consult with more students, or consult with those students who would prefer instructor intervention. However, more data is needed.

Therefore, the support for rejecting the null hypothesis,

> *H_{02}: For students who attend peer review/help sessions, there is no significant difference in student performance scores between a section with an active embedded tutor and one without an active embedded tutor.*

in favor of the alternative i.e., that students exposed to both treatments (an embedded tutor as well as attend the review sessions) do better than students who only attend the review sessions seems more plausible. However, additional research is needed.

Lastly, there is a self-selection dynamic between attendees and non-attendees of review/help sessions. Attendees are likely more predisposed to perceiving that they need additional help, or motivated to improve a grade or grades as was the case of one student in (section B) who was at risk of failing the final exam after spending at least half the semester coming to class sessions but not completing work assessments; she needed to score high for final assessments including the project to pass the class, she attended the final review. On the other hand, non-attendees are likely to self-perceive as competent with the material with no need for additional tutelage; or they may not be intrinsically motivated to do "extra work" or may not have the time to attend tutorial sessions. It may be useful to assign some extra credit as incentive to attend the help/review sessions.

For future research we also plan to incorporate a required survey student satisfaction about the peer-tutors. As our current survey had 12 responses of students who attended help/review sessions; there were no perceived differences in likeability, expertise, effectiveness, or relatability between the two tutors, 70% of the respondents agreed or strongly agreed with positive statement on expertise and likeability for both. However, a larger sample is required, the survey will be a required component of the course.

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Appendices

Section	Number of unique attendees	As % of section size	Mean attendance
A*	5	26%	5.6
B*	5	26%	4.6
C	11	57%	4.5

Table 4 Peer review/help session attendees. *sessions with embed

Section	*Mid-PS-Excel*	*Assignm*	*Commo Assess*	*Fin-PS-Excel*
A*	49.64	104.72	67.16	33.33
B*	74.36	78.56	88.03	77.33
C	64.8	92.0	75.1	37.9

Table 5 Section mean scores on assessments for students who attended review sessions