AC 2011-2548: NSF GRANTEE PRESENTATION: CHALLENGES OF IMPLEMENTING A PEER MENTORING PROGRAM TO SUPPORT STEM LEARNING

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Challenges of Implementing a Peer Mentoring Program to Support STEM Learning

Abstract

The College of Technology – Computer Engineering Technology (CoT – CETE) program at the University of Houston has implemented a peer mentoring model funded through an NSF-sponsored grant supporting undergraduate STEM learning. A group of high achieving seniors were recruited to serve as mentors to students in lower-division laboratories. These mentors were expected to have a high level of technical knowledge and skill and also serve as guides and role models for their mentees. To support this process, training for the mentors was adapted from a peer-led team learning program and incorporated concept mapping as a primary pedagogical tool for increasing mentee understanding of key concepts. Over the course of a two-year implementation, mentors faced several challenges that undercut the impact of the mentoring sessions. Ultimately, faculty had to redesign the peer-mentor model to address these challenges and improve the potential efficacy of the program. This paper discusses the challenges faced by mentors and lessons learned during the project implementation.

Introduction

It is clear that the U.S. has "struggled to persuade sufficient number of its citizens to pursue highly technical careers"[1]. Undergraduate science education in particular has faced many challenges in retaining students. However, a growing body of literature suggests that new pedagogical strategies and approaches may help attract and retain a wider range of students by enhancing engagement[2].

For the past three years, the University of Houston has collaborated with Houston Community College System and Texas A&M University at Corpus Christi as part of an NSF-CCLI grant program aimed at improving the STEM education experience of underrepresented students. The project was initiated first as a pilot program to acquire relevant skills for managing peer mentoring program. Today the project is in its implementation phase[3-5] which contributes to improving their skills and fosters knowledge and experience transfer between peers. A central component of this project was the development of a peer-mentoring model that would contribute to the academic success of underrepresented students. It was proposed that the peer-mentoring activity would enhance the current curricular model by reinforcing academic concepts and knowledge while also providing guidance and insight about the degree program as a whole. When appropriate, mentors would use concept maps to help guide students to a better understanding of the material covered in the course. A concept map is a spatial representation of concepts and their interrelationships that is intended to visually represent the structural knowledge that a learner has stored in long-term memory[6-7]. The process of building a concept map engages the learner with the content and is considered an active learning strategy.

Specific program objectives included:

- *Increasing students' capacity to engage in "real world" problem solving*
- *Improving students' written and oral communications*
- *Increasing students' conceptual and factual knowledge of engineering technology*

- *Improve retention and engagement of underrepresented students*

Generally speaking, the curricular and instructional activities of the courses would address the first two objectives while mentor activities would attempt to address the last two objectives—although, it should be apparent that all components of the project are interrelated at some level.

The remainder of this paper focuses on the peer led mentoring model used and the challenges faced by mentors in the process of implementing the program activities at the primary project institution. It also describes lessons learned as a result of these challenges and how these experiences helped the model evolve to its current form which makes much wider use of senior capstone students' knowledge and experiences in the program.

Peer-led Mentoring Model

The project activities launched with selection of mentors with the appropriate knowledge base and experiences that would make them good role models for the project. Based on their academic records and feedback by the professors, lab managers and teaching assistants, potential mentor candidates were shortlisted. They were then thoroughly interviewed by the project team. Selected mentors were given extensive training with guidance from the Houston-Louis Stokes Alliance for Minority Participation at UH to familiarize them with the mentoring role and how to conduct the mentoring sessions. Specifically the mentors were taught about different approaches for conducting mentoring sessions and strategies for how to address the issues commonly faced by mentees. Mentors were also given the opportunity to learn about concept maps development tools and other administrative procedures. At the beginning of the each academic session, mentees were asked to complete a survey and schedule where they indicated their available time slots to meet with the mentors. Table 1 illustrates the total number of mentors available to freshman-level electrical circuits (average enrollment of 50 students per semester) and sophomore-level digital systems (average enrollment of 30 students per semester) classes from fall 2008 to spring 2010.

Table 1. Mentor Totals by Semester

Fall 2008	Spring 2009	Fall 2009	Spring 2010
3	4	3	3

There were a total of nine individuals that served as mentors during this time, three of which served two or more semesters.

One of the major responsibilities of each of the mentors was writing weekly reports of their meetings with their mentees. In order to help them in this activity, the project PI's conducted an extensive training for the mentors which included guidance on how to write reports regarding the outcomes, issues and resolutions discussed with students during the sessions. The mentors turned in a report for every mentoring session they conducted. While concept maps were the central focus of these sessions, mentees also took the opportunity to clarify theoretical concepts and ask questions about homework assignments.

In order to check on the proceedings of the sessions and keep track of the project progress, a weekly meeting between mentors and a graduate student project assistant was also scheduled. Such meetings helped ensure that the mentor-mentee activities for the project were being implemented as intended. This also helped in identifying specific needs (e.g. preparation for the tests) and allowed the mentors to learn

from each other's experiences. If any mentor faced a particular problem (e.g. at-risk students), it was resolved by discussing with fellow mentors and the project assistant. The matter was also reported to the project team, so they were aware of any immediate challenges.

Implementation Challenges

Based on a review of mentor notes and documentation of the mentor process, several implementation challenges were noted. For example, simple scheduling issues became a major concern almost immediately. The project tried to create as many mentoring session time slots as possible so that mentees would be able to find one that suits them. In some sessions there may only have been a single mentee or even no mentees per time slot. A partial-explanation for this scheduling issue is the large proportion of student that worked part-time and full-time. Table 2 illustrates the percentage of students in the freshman-level electrical circuits class that worked at least part time.

Table 2. Percentage of Students Working at Least Part-time Outside the University in Electrical Circuits Class by Semester. Average enrollment is 70 students per semester

Fall 2008	Spring 2009	Fall 2009	Spring 2010
72%	59%	66%	50%

Similar numbers were encountered in the sophomore digital systems class. Here, the percentage figures of students who worked at least part-time outside of school in fall 2009 and spring 2010 were 66% and 75% percent respectively. While it is certainly possible to mentor students that work outside of class, the high percentage of student fitting this description, even early in the program, made scheduling difficult.

Further complicating the scheduling was the lack of dedicated meeting space for mentor-mentee sessions. In other words, there was no consistent space for mentor-mentee interaction. Rather, sessions were relegated to rooms or meeting spaces as they became available. As such, there was an element of uncertainty to the scheduling process that resulted in some unanticipated tensions since it is harder to plan a session when it is unclear what types of learning tools may be available in a given location (e.g. white board, projector). Unfortunately, this was a continuous struggle due to limited space availability in the college. Nevertheless, different mentors did make note of this issue during each semester.

A general issue observed by mentors across semesters was the inconsistency of student attendance. When asked to describe concerns about the entire process, one mentor from spring 2009 said, "*I would like an entire semester and a structure that requires the students to meet at least one time with us to get to know us and more about the program.*" Another mentor from the same period stated that "*Mentees were not motivated enough to attend the sessions*". A mentor from spring 2010 simply said, "*I just wish more students would come to the sessions.*" One solution mentioned by several mentors suggested that faculty incentivize the sessions for students. As one mentor, based on experiences in fall 2008, observed that "*Many of the students are motivated with their grade and the sessions should have an extra credit for the class.*"

Another characteristic of mentees was their desire to focus on concepts and knowledge during the mentoring sessions. In other words, the mentoring could be more accurately described as tutoring. As one mentor observed in spring 2009, "*All mentees that made contact were under the impression that the*

mentors were tutors. They were less than impressed with the program when informed that we were not tutors. To build a little rapport with the mentee, the mentor was forced to alter his approach and become a tutor." During each semester of the mentoring implementation, mentors invariably took on the role of tutors to satisfy student needs. Most documentation of these sessions alludes to more technical discussions and review of concepts through concept mapping and other instructional strategies. Very little is actually said about any psycho-social issues (e.g. the difficulty of working and being in school, future career plans, life lessons, etc.) discussed during the meetings. It is unclear whether this situation represents a true challenge to the program or merely reflects the reality of what students in the program need. It is equally unclear from the mentor documents whether this tutoring mode was more congruent with the mentors' range of experience which made it a more comfortable default position.

Traditional vs. Mentor Group The challenges faced by mentors may have muddled the potential impact of this peer-mentoring model. For instance, the program was able to utilize naturally occurring sections within courses as a means of comparing student outcomes between those who had an opportunity to participate in mentoring and those that did not. Yet results of these comparisons paint a murky picture of mentor program impacts. Tables 3-5 highlight some basic comparisons from fall 2008 in the freshman electronic circuits course.

Table 3. Midterm Mean Comparison: Traditional Group vs. Mentor Group

	N	Midterm Mark Mean[1]	Max. Possible Score
Traditional Group	40	17	40
Mentor Group	33	20	

[1] *p > .05*

Table 4. Project Mean Comparison: Traditional vs. Mentor Group

	N	Project Grade Mean[1]	Max. Possible Score
Traditional Group	36	53	100
Mentor Group	33	54	

[1] *p > .05*

Table 5. Final Lab Mean Comparison: Traditional vs. Mentor Group

	N	Final Lab Grade Mean[1]	Max. Possible Score
Traditional Group	36	63	100
Mentor Group	33	69	

[1]*p > .05*

Overall, students generally performed below expectations although these outputs do not represent the full array of assessment in the course-laboratory sequence. In terms of the mentoring impact, while students that had opportunities for mentoring outperformed the comparison group, the difference was negligible. Indeed, when correlating mentor attendance to project and final lab outcomes, the resulting correlation statistics (r) were positive but not statistically significant. This pattern was consistent in subsequent outcome comparisons for this class as well as the digital systems class. Table 6 highlights comparisons between the mentor group and traditional group in the fall 2009 digital systems class.

Table 6. Traditional vs. Mentor Group, Comparison of Mean Performance on Sample of Assessments

	N	Homework[1]	Exam 1[1]	Exam 2[1]	Exam 3[1]	Max. Possible Score
Traditional Group	24	85	82	73	70	100
Mentor Group	11	91	81	80	79	

[1]$p > .05$

In this instance, scores were generally acceptable. However, again, performance differences between groups were not statistically significant. A full treatment of evaluation results for this project is available in more extensive documents examining the entire program[8].

Despite the inconsistent nature of the performance outcomes, there were some practical program impacts at the individual and mentor-level. Mentors described instances of specific students developing understanding of particular technical concepts suggesting incremental academic progress at the individual student level. In addition, mentors themselves reported personal benefits to their involvement in the program. The following statements by mentors illustrate some of these positive dimensions.

- "Because of the mentoring sessions, I have a much better understanding of the basic concepts of DC circuits. I have noticed that one learns more as a teacher than as a student." Fall 2008
- "I did practice more instruction by working problems with them [mentees]." Spring 2009
- "I have learned a lot from the mentoring sessions, this is also a review of the basics for me." Spring 2010 – Mentor A
- "Teaching now seems like a viable option for me in the future. The project has created opportunities that I had not considered before." Spring 2010 – Mentor B

Reflecting on the mentors' experiences and the experiences of program personnel, several lessons have been learned including:

1. Any mentoring model must have dedicated space available for the actual mentoring session. Lack of space makes scheduling difficult especially when serving a working student population. Although purely speculative, the space issue combined with inconsistent scheduling may also inadvertently signal to students that the process is not deemed that important.
2. It may be useful to incentivize or make mandatory participation in the mentoring process. Overall student performance throughout the project indicates that more students could have benefited from extra help than mentee attendance suggested. Simply put, students having difficulty in a new discipline (as is the case with freshmen and to a certain degree sophomores) may not always recognize the extent of their need. Tying participation to grades or making at least some mentoring mandatory as part of the course could help identify and address some of these issues. A corollary to this lesson is the need to potentially identify a way to make the sessions more accessible to students that want to participate either by integrating mentoring into scheduled instructional activities (e.g. labs) or providing electronic venues for interaction (e.g. discussion boards).

3. Although relatively obvious, mentors require significant training especially in terms of non-technical skills such as learning how to engage non-responsive students or how to ask the right probing questions to gauge student understanding.
4. It may not always be possible to engage students as true mentors if their immediate needs are related to knowledge-acquisition, practice, and comprehension. If mentoring is the actual goal of a program, the process may need to be integrated into the framework of the curriculum further emphasizing its importance to students and mentors alike.

Conclusion and Future Directions

The mentoring model at the University of Houston – College of Technology continues to evolve. Building on the lessons from the previous work, the CETE program has implemented a new peer-mentoring model incorporating a larger sample of seniors into the process. The basic idea is to provide lower division students in freshman and sophomore level courses with opportunities to interact with students enrolled in the Senior Project course. As part of the Senior Project course requirements, seniors are asked to visit freshman and sophomore level classes to provide guidance and feedback on these students' projects. There are multiple visits throughout the semester and, at the end, seniors participate in the evaluation of the final projects in these lower-division classes. Initial feedback from both upper and lower level students from fall 2010 has been mostly positive. In terms of the lessons described earlier, the refined model essentially attempts to make the mentoring activity part of the overall learning experience of the CETE program. Lower level students gain access to practical knowledge from their peers while seniors (reflecting the sentiments of one of the previous mentors) have an opportunity to hone their technical knowledge by engaging in basic instruction. The fact that the visits take place during actual laboratory sessions mitigates to an extent the scheduling problems encountered in previous implementations. The downside is that the seniors do not receive formal mentor training. Instead, the activity lends itself more to the tutoring side with mentoring growing organically as a result of the consistent interactions between students. The program will continue to monitor these developments as part of the continuing effort to create the best possible environment for STEM education and learning.

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