AC 2012-5117: CIVIL ENGINEERING MENTORED LEARNING ENVIRONMENT

Dr. Blair J. McDonald, University of Texas, Pan American

Associate Professor and Civil Engineering Program Director

Civil Engineering Mentored Learning Environment

Abstract

Early in their college career, many Civil Engineering students experience problems learning. Their problems may be associated with inadequate study skills, insufficient prerequisite knowledge, an unfamiliar environment or a host of other things that a program can neither predict nor control. Regardless of the cause, the hurdles to learning must be quickly overcome for students to progress in their degree program and be successful. Identifying learning issues mid semester or later during an advising session that is focused on selecting classes for the next term is probably too late to effectively rescue a student in the current term.

The Civil Engineering Mentored Learning Environment was established to provide students access to the faculty, upper division and/or graduate student mentors and a common study area. It is a deliberate attempt to get new students to mingle with mature students and faculty without "enrolling" them in a "special" program. The program's key objective is to get students to teach each other with mentors available for support and to intervene only when necessary. Started with virtually no funding, laboratory space with 20% utilization was made available to students to study in during the unused 80% of the schedule. The program was initiated in the Fall 2011 term. The academic performance of a targeted set of at risk students was observed during the semester.

The motivation for this program and its objectives are discussed. Data collected following the first semester of operation is presented and discussed. Conclusions are drawn regarding the environments impact on the program.

Introduction

Students at every academic level are prone to fall behind during the semester. Key to “keeping up” is having adequate prerequisite knowledge to comprehend and implement new concepts as they are presented in class. When faced with spending time to refresh or maybe even learn for the first time what an instructor assumes is background information many students elect to skip it and jump into the new lessons. It only takes a couple of skips for a student to be hopelessly lost. Initially, it doesn’t seem like much and the student may get most of the introductory concepts. But without adequate preparation and foundation knowledge, the time soon comes when nothing is making any sense. At that point, just like an engine without oil, learning has ceased.

Providing the Mentored Learning Environment is an attempt to place students in a situation where there are resources readily available to learn the little things that were assumed to be there but aren’t, and to be available in a manner that students are comfortable using. The environment requires the availability of space and knowledge. The space is necessary to provide a study area with some level of comfort, structure and organization. The knowledge is to share. How does

knowledge increase? By using it; and teaching is a practical use. Space is a scarce commodity on any campus but knowledge is abundant.

Students naturally look to the course instructor as the ultimate source of knowledge in a course. The typical classroom situation is an attempt to pass (possibly even force feed) the instructor's knowledge of a subject to an assembled group of students. The attempt to pass along knowledge may be accomplished by leading the class through a curriculum using discussions, lectures, slide shows, example problems, assignments, projects, etc. There are all kinds of tools to help with this. Devices like smart boards, document cameras, clickers, online recorded video, and even some old standards like chalk and books as well as a host of techniques such as lecturing, experience based learning, challenge based instruction, and numerous other methods. All of the aforementioned have been used successfully all over the world; however, some students just don't get it. They need a little more, some need a little one on one attention. In a large class, it doesn't take long for the instructor to run out of "one on one" time and regardless of when an office hour is posted, it's probably not at a time when many of those that need help are available to get help.

To solve the problem, consider using the knowledge accumulated in the entire academic community, not just that of the instructor. Traditionally, a TA might be hired; graduate students are cheaper than an instructor, they can be persuaded to make more time available than most instructors (by paying them), they can be knowledgeable enough, and it's good experience…for the TA. Hopefully, all those that passed the class the last time it was offered also qualify as knowledgeable enough! And many of these students may already have a social acquaintance with the current students. Even if they don't, developing one might be good…for the students and the program.

Situation

A Civil Engineering Program was recently introduced in a College with five other well established and supportive engineering departments. The new program immediately experienced unpredicted growth. After the first year the three new professors hired to operate the program found themselves trying to advise 237 declared majors at the same time they were learning all the ins and outs of a new campus and a new degree plan. The time for helping students "one on one" quickly disappeared. Not all of the 237 students were Rhodes Scholars, in fact, many had deficiencies of some sort and some found ways to enroll in courses well above their academic ability.

A quick inventory of program resources revealed that lab space dedicated to 3 courses in the Civil Engineering curriculum was only used 9 hours each week. The lab and a conference/break room were located in the same hall as the Program Office and the three Instructor's offices and funding for one Teaching Assistant was available.

Identifying Student Needs

Nothing is more beneficial to the success of a current assignment than having succeeded in a prior. Having successfully completed a job provides confidence in one's ability to repeat that job and to take on increasingly difficult or complex work. On the other hand, few things are more demoralizing than failing. Students are advised to insure that they progress along an academic path with enough foundation knowledge to be successful and continuously moving toward graduation. In a degree plan, skipping steps almost always results in a setback; therefore, it is essential that students be positioned at the correct starting point and not allowed to deviate from the plan. To accomplish this, regular advising and strict adherence to a degree plan is common in engineering programs. Similar measures need to be taken at the course level.

On the first day of class, are all of the students prepared to start? Do the students have the same expectations as the instructor? How does the instructor determine who is prepared to move on; who has arrived expecting to work at the level they will require? The instructor determines this by assessment. A mature teacher may be able to discern the preparation of a class by gazing out into the sea of glassy eyed faces on the opening day of class and "read" the disposition of each charge. Others may rely upon some type of instrument, a survey or quiz that reveals the range of ability and student expectation within the group. During the first class period, identifying students that are not prepared for the class (the students that don't have the prerequisite knowledge and/or skills to move ahead) should be a priority of every instructor. The students with deficiencies should immediately be advised and a means of remediation discussed. Those students need to give their immediate attention to acquiring the prerequisite knowledge. Some may be able to quickly review and build enough competence to continue in the class; others should take the time to repeat the prerequisite course, master the material and attempt the course at a later time.

It takes a great deal of effort and discipline to assess and sort the enrollment of a class on that first day and especially to set a student back. Once assessed, all of the students allowed to continue expect the instructor to provide an environment and experiences that will result in the class obtaining an accepted level of proficiency in course related knowledge. Success isn’t the sole responsibility of the instructor. The students should also realize that they play an important role in the conduct of the course. They need to participate and do the assignments. There isn't a magic task that can be accomplished after the final grade is posted that miraculously installs the knowledge required to justify replacing a failing grade. The knowledge is gained prior to the final exam by working the assignments and for the engaged student, maybe by going a little beyond what is required in each or at the least, some of the lessons. During the term, constant assessment is required to determine which students are progressing and which are falling behind. The students falling behind are the students that need some degree of extra attention. If this group begins to dominate a class, the progress of the achievers may be slowed to the point that the desired curriculum is not completed. Therefore, it is critical to identify those out of step and get them back in step before the rank and file is lost.

Continuous assessment, although required, cannot be allowed to become a burden that interferes with completing the curriculum! Short quizzes, one liners or verbal questions and in class challenges may be all that is required to assess a concept and confirm that it has been accomplished; confirmed to the instructor and more importantly to the student. Of greater importance to the student, is the confirmation that a concept has NOT been accomplished. It is at this point that *the student* needs to seek out an extra to catch up. If a significant portion of the class has not yet mastered the subject, the instructor may need to provide additional discussion and/or assignments to clarify or reinforce the topic. More often, individual students need to take control of their own destiny. Many just don't know how.

Addressing Student Needs

Determining that a student is behind isn't nearly as difficult as finding ways to help them catch up; however, in the end, it is the student that has to spend time to do the work and stay up or, if necessary, catch up. Programs can smooth the way by providing pathways and support, but the student that just “doesn't have time” probably should not have taken the class. They need to re-evaluate their commitment to being a Civil Engineer. Instructors are a finite resource. They only have so much time and much of that must be dedicated to the preparation of the course presentation. Instructors need to be available to students outside of the course presentation time, but "one on one" may not be very efficient or affective for the overall needs of the class. Providing a Teaching Assistant or tutor can be helpful but has limitations and constraints. An untapped resource is the pool of knowledge accumulated by the students themselves.

As a whole, students in the class, and those in the program that have already taken the class, should possess a significant body of knowledge. This is especially true in aspects of the subject deemed to be the "essential minimum knowledge" that is required to pass a course. In any class, there are those students that only need to hear it once, be shown once, or go through the procedure once to have mastered that aspect. These knowledgeable students are a resource that students without a complete understanding can tap. These students often have time available and may even enjoy sharing what they know with their peers (teaching). Interestingly, it's not always the same students doing the teaching in every subject. Joe may teach Jack in hydraulics and Jack may reciprocate in structures.

The problem in networking student knowledge lies in how to establish and control the network. Some degree of observation and supervision is required to prevent the proliferation of bad information. To get students started, the best situation is a spontaneous sharing of ideas during an unsolicited gathering. Next best is the formation of student cohorts using students that have expressed a desire to study in a group environment. Workable, is the group of struggling students identified in a class and assigned a study hall to catch up. In each of these situations, the groups will in time self identify the leaders and followers. Group leadership roles may change as different topics are pursued. Regardless of who controls the direction and pace of the group, no one in the group should ever be overlooked or prevented from teaching what they

know to the others. If the groups are heterogeneous enough, members of the group with greater experience will naturally mentor the less experienced. In the case of a more homogeneous group, a mentor can be provided using an upper division student, graduate student or even the instructor. And in the case of a group that has been selected specifically to catch up, a mentor with demonstrated competency in the subject should be provided. External to the group, a fall back source of ultimate knowledge should be available; usually this will be the instructor or another member of the faculty. The students need to feel comfortable approaching the faculty with any question or situation that they have not been able to work out on their own. However, the best solution is for the instructor to direct the group along a path of investigation until the group eventually solves the problem on their own.

To address student needs, the needy students must get around to doing their own work. Even when done in a group setting, each student needs to be working through every step of a problem, making decisions regarding the next step, doing their own calculations and formatting their own solution presentation. To facilitate this it is helpful to have a room with tables or benches that students can work around individually or in groups. The room doesn't need special furnishings, it does need enough space to not crowd the group, and it should be capable of isolating the group from too many outside distractions. Any software or reference materials that the course uses should also be readily available.

Establishing the Mentored Learning Environment

The first step to establishing the Civil Engineering Mentored Learning Environment was taken when the program administration recognized that unused lab space could be utilized for a study hall and unlocked the door to the lab. The open room was advertised to Civil Engineering students in classes and by word of mouth as available to study groups and individuals. The room was immediately utilized by a cadre of students who then requested dry erase markers so they could use the 12' whiteboard in their discussions. The lab has Wi-Fi connectivity to the campus network; the students bring in their own laptops and print using a nearby campus computer lab. During the term several informal groups developed. Some of these requested use of the lab on weekends and later in the evening at night. The Program Director monitored activity in the lab and professors were able to stop by unannounced and look in on their students. Whenever an instructor showed up, they were asked questions.

In the second semester, funding for a Teaching Assistant (TA) was made available. The TA worked 20 hours a week, scheduling the time in morning and afternoon periods that were hoped to be convenient for students. The TA acted as both a mentor and a tutor. The program Conference Room was provided to tutor identified groups of at risk students so they could work with fewer distractions and directly with the TA.

With the Learning Environment available, course instructors began to identify specific groups of students that were at risk and advise them to utilize the Learning Environment, the tutor and their

peers. The course taught by civil engineering faculty with the highest failure rate is Engineering Mechanics where as much as half the class may fail in some semesters. When the Mentored Learning Environment was initiated, half of the 15 students enrolled in mechanics were observed to be struggling during the early weeks of the semester. These students were encouraged to commit to spending at least 3 hours a week in the lab during the hours that the TA/tutor was available. Of those identified, most were willing to commit to the 3 hours a week and honored their commitment. A few of the students that were not at risk or falling behind also regularly studied in the lab.

Results

As students began using the lab to study, lower division students began interacting with upper division students. Freshmen were invited to the lab to study calculus, chemistry and physics. They were encouraged to interact with other CE students and use the Tutor. Camaraderie within the program increased. Seniors preparing for the Fundamentals of Engineering exam were provided opportunities to explain math and science concepts to freshman. There was no observed change in the utilization of instructor office hours. And a select group of students began teaching each other. The academic performance of students meeting in the lab noticeably improved as a result of their time working together.

The initial study hall success resulted in some formality and the coining of an identity. The program faculty didn't want students to use the lab space just to meet together and copy homework solutions from a solution manual downloaded from the internet; a process many students currently consider "studying." They hoped the students would openly discuss course topics, readings and assignments among themselves and work problems out while teaching each other. Formally banning the use of published solutions in the lab has been seriously discussed to promote more open discussion, experimentation, and *learning*. By identifying the lab as a space for mentored learning, the program is encouraging students to do more than just work out problems in a study hall.

In the second year of the program, additional structure was implemented. In courses that were determined to have higher failure rates, at risk students were advised in the opening week and mid semester to commit to meeting in the lab with the tutor at a scheduled time for 3 hours a week. Participation was voluntary and no credit or deficiency for either attending or skipping the lab was included in grading the course. In the sophomore Engineering Mechanics course, which only had an enrollment of 15 students, 9 students were advised and 7 agreed to participate. All 15 had the option to participate.

Of the students in the Engineering Mechanics course that agreed to participate in the Mentored Learning Environment, 6 met regularly with the tutor for approximately 9 weeks. All but one of the students participating in the tutoring passed the course and all of the participants experienced improved performance as a result of this effort. The distribution of grades for participating

students was: A(0), B(3), C(2), F(1). The final grade distribution for all students enrolled in the course was A(3), B(5), C(5), F(2). The other student failing the class did not attend regularly, had no interest in the tutoring offer and did not take the final. The typical failure rate for this course is between 30% and up to 50%.

Conclusions

Making available laboratory space for students to study in with minimal supervision and having basic tutoring available has resulted in improved student performance. This was a very low-grade and inexpensive study conducted out of a combination of opportunity and necessity. The effort has provided an excellent ROI. Faculty, which were short of time to interact with students one on one, are now able to easily meet with groups of students on a scheduled or unannounced basis and better use their time (they still maintain office hours and meet with students one on one as time permits). The students, in teaching each other, are gaining confidence and expanding their knowledge of course materials. They are also building a social network within the program that is beneficial and feel like they are an integral part of the Civil Engineering program.

The Civil Engineering program plans to continue offering the Mentored Learning Environment to all interested students and encourage students that are identified as at risk to make a special effort to frequent the lab, use the tutor provided, work with the faculty and get to know their peers.