Study of Concept of Virtual Learning Centers to Enhance Student Learning and Performance in Civil Engineering.

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ABSTRACT

The need to improve STEM education has never been felt more chronically than now, as the US ranks 24th place globally, and the numbers of women and underrepresented groups enrolling in engineering programs is on decline. In midst of this bleak picture, it is now estimated that by 2018, there will be about 8 million additional STEM related jobs in the US. Therefore, it becomes essential to find ways and means to strengthen STEM education so that our STEM work force will be globally competitive. This paper describes the results of a pilot study focused on determining the effects of a Learning Centered Approach on Retention and Educational Outcomes of undergraduate students in civil and environmental engineering (CEE) at the University of North Carolina at Charlotte. Specifically, the paper presents assessment results to investigate the impacts of Virtual Learning Centers (VLCs) to improve student learning and retention in engineering in the College of Engineering at UNC Charlotte, Charlotte, NC, an urban public research institution in North Carolina with a culturally and socioeconomically diverse undergraduate population. While a few elite engineering schools have graduation rates above 95%, on average, only about 50% of entering freshman engineering students graduate from college, similar to overall graduation rates in US colleges (ASEE 2009)[1]. While it is clear that insufficient numbers of students entering engineering is the most important contributor to the current levels of graduation rates (Grose 2006)[2], one important strategy for increasing the numbers of underrepresented groups in engineering is to increase graduation rates at large public and minority serving institutions through strategies similar to the one presented herein. The objective of this pilot study was to test the effectiveness of VLCs to overcome academic and social barriers and enhance student learning and performance. VLCs were created with the intent to increase student connections to peers, faculty and Graduate Assistants during “Virtual Office Hours” and “Off-time” on-line chats and mass tutoring. The pilot study has been conducted for four years and the level of success has been primarily measured by tracking retention trends and the average score of the FE exams by CEE seniors. Not all components of the study have been fully implemented. Data of the FE exam pass rate of the UNC Charlotte CEE department shows improved passing rates near or above the national average, above the state average, and significantly above our students' performance in years past. We consider that this improvement can be contributed in some part to the implementation of our virtual learning center pilot project, as no other major curricular changes or enrollment profile changes have taken place during this timeframe.

INTRODUCTION

Virtual Learning Centers or Communities (VLC) are a relatively new concept that has the potential to offer an alternative or complementary learning environment to students. The VLC concept capitalizes on recent advances of computing and communication technologies which allow students to interact and share knowledge and experiences in ways that traditional university settings were not originally based on. Several authors have presented key elements of VLC's to ensure a rich learning environment is achieved (e.g., Augar et al., 2004; Peng et al., 2010; Daniel and Schwier, 2010; and Wei and Jienping, 2011). In Civil and Environmental Engineering (CEE) the implementation of VLC's has not been reported in the literature, at least not nearly to the same extent as the use of virtual learning strategies for particular CEE courses. Table 1 presents a list of some examples of course-level implementation of virtual learning strategies. The focus on this paper is an implementation at a larger scale towards the establishment of a virtual community. Herein we report on results of an initial pilot study.

Reference	Course or CEE Area	Summary
Larson (1998)	Wood and Masonry Design	Presented results to deliver a web-based wood and masonry design course.
Considine and Lewis Jr. (2001)	CE laboratories	Authors present results of implementing 3 virtual labs for distance learning. Labs included: materials, soil testing, and structural.
Budhu (2002)	CE Materials	Describes a virtual module related to steel lab tests using multimedia and online interaction.
Dado et al (2010)	Concrete Materials	Implemented virtual testing environments (VTEs).

Table 1. Examples of Implementation of Virtual Learning Strategies in CEE

A thorough review of student performance on the Fundamentals of Engineering exam (FE) indicated there was not one particular area or issue that stood out as problematic. Scores in topic areas were generally at or slightly below (2-5%) the national and comparator group scores. To address the FE performance issue, several processes were discussed by the faculty members. One process that was easy to implement was to increase use and emphasize FE style problems on homework and tests in the classroom. Also, faculty members believed a program that would engage students outside of the classroom could be helpful in increasing student understanding of topics and also encourage interaction between faculty members and students. The general idea is to lower the barriers to interaction between students and faculty members by employing methods that students are comfortable using, and removing some of the rigidity of the time-constrained scheduled class meeting times and established office hours. The idea is to increase the number of interactions with students in the desire to help them "feel" closer to the program. In cooperation with faculty members in the Department of Psychology (Blanchard et al. 1998)[3] with expertise in non-traditional methods of engaging students, a variety of methods were considered. Methods that appeared promising were: Virtual Office Hours, email message exchange, and scheduled Teaching Assistant (TA) chats. Participation in the chats could be in-person and online. This more intensive treatment protocol was labeled the "Virtual Learning Community (VLC)." How to make all of this happen would be the challenge.

IDENTIFYING AT-RISK STUDENTS

Retention of knowledge from prerequisite courses is essential. To assess student knowledge of prerequisite material, a Pre-test/Post-test process was created. Students were given a pre-test at the beginning of the semester with the purpose of determining the level of retention of prerequisite information, both individually and as a group. Since the retention assessment would be evaluated in several courses, a test bank was created by faculty members responsible for the particular courses. The questions were rated as general, intermediate, and hard. Faculty members could change the questions between semesters to introduce a level of randomness to the process and also maintain a comparative level of difficulty from semester to semester. At the end of the semester a post-test was given assessing the same knowledge of prerequisite material. The performance on the pre-test and the post-test was shared with faculty members who teach the prerequisite classes to offer some insight to where improvements in the prerequisite courses could be made to address general weaknesses. In addition to determining the general level of knowledge across the class, individual students whose performance was below a certain level were identified for a greater level of intervention. The courses identified for implementation of the process and the flow between these classes is shown in Figure 1.

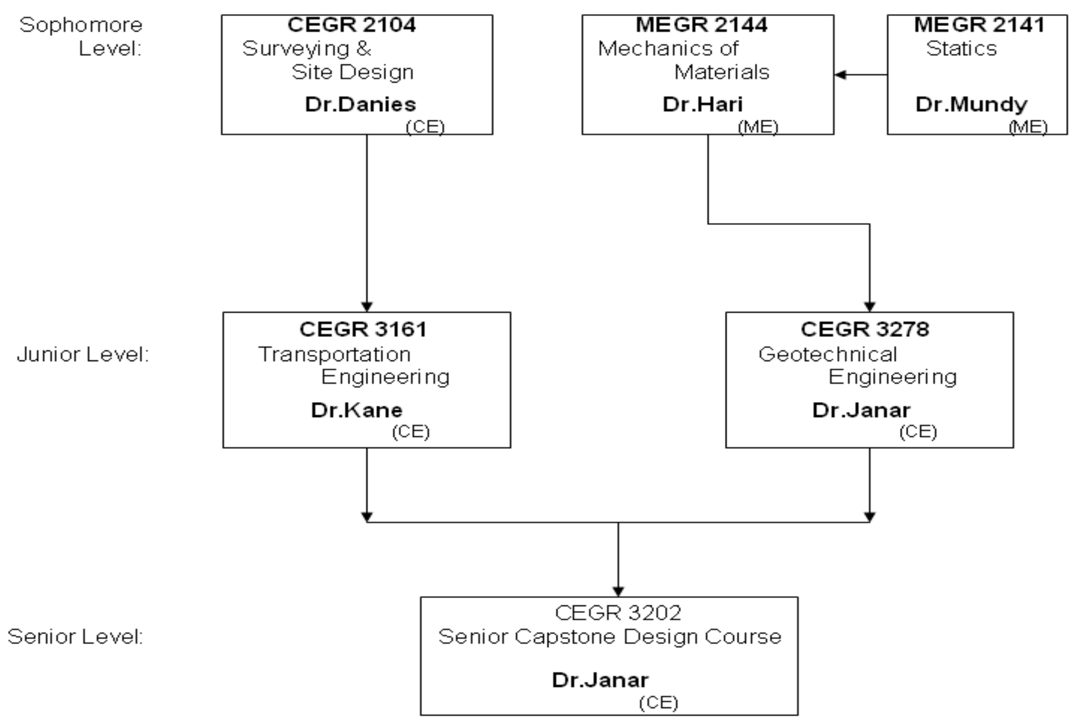

Figure.1 Vertical Integration in Civil Engineering through "VLC"

INTERVENTION STRATEGIES

The courses identified for the VLC treatment were focused in the late sophomore to junior level engineering courses (e.g. Statics, Solid Mechanics, Structural Analysis, Geotechnical Engineering I). Once the at-risk students were identified, all students in the classes were subdivided into two groups: one group would receive the normal treatments of scheduled office hours (Traditional) and the other group would receive the more intensive treatment (the Virtual Learning Community). The assignment to the groups was stratified so that most of the at-risk students would be in the group that would be offered the option of the more intensive VLC treatment. The students were told that the process was part of a research project and that participation was voluntary and could be terminated at any time, if they wished. The membership in each group was as we had desired, with more of the at-risk students in the VLC. We also believed that if the VLC became attractive to members in the Traditional group, they should be allowed to participate in the VLC events. This would also be one measure of the perceived value of the VLC since it would be the students who were evaluating and assessing the benefit of participation in VLC events.

Early in the semester as the groups were determined, the VLC events schedule was provided to the students in the class. Faculty members set up chats, and video conferencing when available at hours late in the evening (e.g. 9:00 to 11:00 pm), weekends, and were available in the virtual realm during regularly scheduled office hours. The TA’s set up similar online interactions at different times, and maintained a virtual bulletin board where students could go to see what topics were being discussed and any pertinent information that was being shared.

While the intention of the study was to establish several VLCs, desiring one VLC per course, the amount of effort required to establish all the components of the VLC was higher than anticipated. The necessary computing resources were available but the technical support needed to establish and manage the process could not be provided at the level desired. The course with the highest level of implementation was Solid Mechanics, a course that students in the second semester of the sophomore year should be taking. In this course, the students generally liked the asynchronous availability of the instructor notes and the online meetings, but there were some negative issues regarding testing validity and academic integrity. The validity and academic integrity issues revolved around testing and the inability to provide sufficient safeguards for online testing. The subsequent semester an on-campus testing policy was adopted and continues today. The parts of the process that were implemented were the pre-test/post-test, the identification of at-risk students, and some intervention strategies. The primary intervention strategy was to provide the participating course instructors assistance in targeting the at-risk students through additional TA hours and use of on-campus help centers, such as the Writing Resource Center (WRC) and the menu of assistance programs through the college’s MAPS (Maximizing Academic and Professional Success) program. The at-risk students were identified as part of the end-of-semester process that identified students that should be on probation or suspended from the college of engineering due to poor performance in the courses taught in the college of engineering. These courses are used to calculate the Major GPA for engineering students (2.0 minimum requirement). While the full complement of potential student assistance programs were not reached, there has been an increase in contact hours for at-risk students by faculty members and student support programs. We believe the increase in contact has been a positive situation for all the students who take advantage of the process, especially the at-risk students.

RESULTS SO FAR

We looked at two measures: FE performance and Retention. The FE performance of CEE students has generally been below the national average, with some exceptions, for a number of years prior to the implementation of the VLC process and the increased emphasis in the classroom on FE type testing (figure 2). Since the beginning of the process in the Fall of 2008, the FE performance for the affected students has improved. The first group of VLC students began taking the FE exam in the Fall of 2010. In the subsequent FE examinations the gap between the national average and the CEE students has decreased dramatically with scores on two exams (Fall 2011, Fall 2012) slightly above the national average, and two exams (Spring 2011, Spring 2012) slightly below the national average, and one exam (Fall 2010) well below the national average. The CEE faculty members are encouraged by the improvements in the student scores.

The impact on retention is harder to ascertain with the current data. The university tracks retention data for Freshman to Sophomore, Minority Freshman, Female Freshman, and Transfer students. The 4-year and 6-year graduation rates are also tracked. The first cohort of 4-year to graduation students is now graduating. There is not sufficient data to make a definitive statement about retention for the 4-year to graduation cohort. However, the trends are promising with engineering retention relatively flat compared to the slightly decreasing university trend.

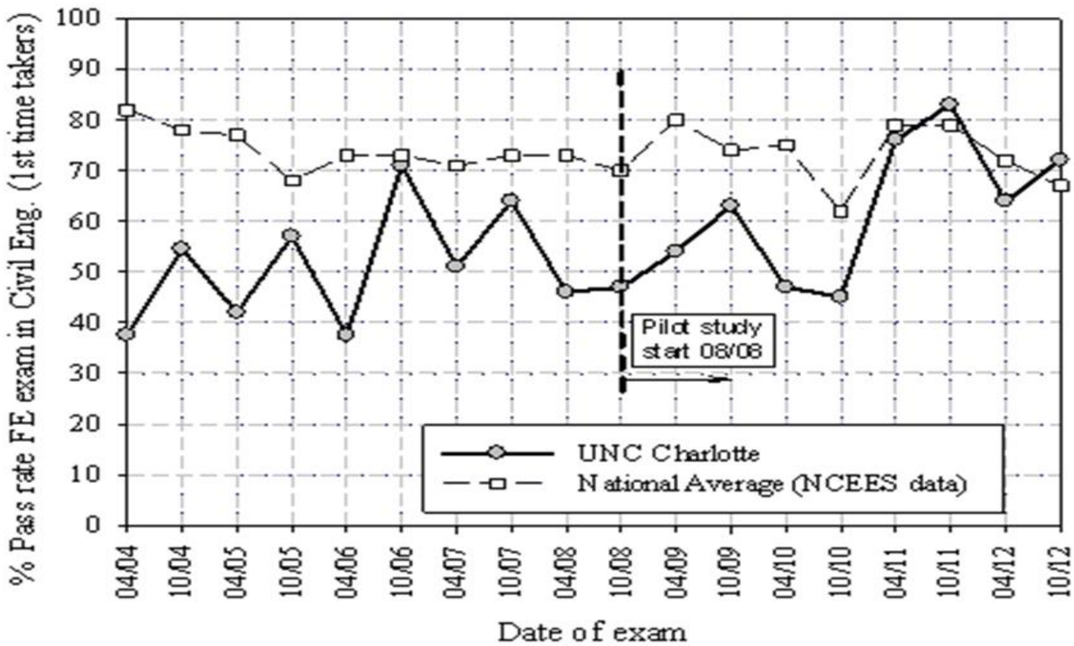

Figure 2. CEE Student FE Performance

CONCLUSIONS

This approach appears to be promising and the trends are encouraging. We still believe the full establishment of VLCs will continue the development of students through increased interaction with faculty members through the variety of communication technologies, including communication technologies to come. We believe this process will build a stronger student community through these support strategies that lower barriers between students and faculty members, and between individual students. We will continue to track student performance and make changes as necessary to continue to support student success.

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