Technology-Enabled, After-Hours, Asynchronous, Peer-Led Supplementary Instruction and Mentoring in Engineering Gatekeeper Courses

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***Abstract*—Experience and observations indicate that students often work on problem sets at hours outside those traditionally scheduled for office hours, tutoring, and supplemental instruction (SI). Moreover, their tendency is to focus their effort the night before the assignment is due. Add to this the complexity of a distributed university where students are taking engineering courses towards their degree at campuses distributed over 60+ miles. Moreover, a considerable number of University of Texas Rio Grande Valley (UTRGV) Engineering students transfer from neighboring two-year institutions with limited to no supplemental instruction (SI) support for Engineering courses due to the lack of access to upper division students with the expertise. These complexities (i.e. students' study habits, the regional distribution of UTRGV, and the underserved needs of its transfer students) necessitate rethinking the practice of supplemental instruction. In this paper, the authors review all the different modalities of supplementary instruction reported in the literature and make the case for a technology-enabled, real-time, after-hours, and asynchronous model. In this model we employ the use of web-enabled, collaboration tools to facilitate real-time tutoring, asynchronous supplemental instruction, and peer-mentoring on a regional scale to serve the needs of students at both primary campuses and neighboring two-year institutions. The paper also describes plans to implement and the proposed model and provides a preliminary comparative study of the impact of traditional supplemental instruction versus this alternative approach on student learning outcomes.**

I. Introduction and Background

The University of Texas Rio Grande Valley (UTRGV) was established in the fall of 2015 through a merger of the former University of Texas at Brownsville, The University of Texas-Pan American, and the former Regional Academic Health Centers (RAHCs) of the University of Texas Health Science Center at San Antonio. Its enrollment fall semester of 2015 exceeded 29,000 students. With a population that is around 90% Hispanic, it has one of the largest enrollments of Hispanic students in the Nation. The two legacy universities and the RAHCs reside in the Rio Grande Valley of South Texas several hundred miles south of San Antonio. Engineering and Computer Science programs are offered on the Edinburg and Brownsville campuses which are more than 60 miles apart.

According to the 2010 U.S. Census, 91.0% of the South Texas' 1,544,713 residents are Hispanic. The Hispanic population of the area's public schools is even higher, at 95.2%. The percentage of economically-disadvantaged public school students in the region is even higher than the rest of the state at 85.6%, and 34% of the population is under the age of 18 compared to 27.8% statewide and 24.6% nationally (2010 U.S. Census Bureau).

Additionally, South Texas College (STC) and Texas State Technical College in Harlingen (TSTC) are two-year institutions in the Rio Grande Valley that offer Associates of Science degrees in Engineering. STC is the largest post-secondary institution in South Texas, with over 34,000 students pursuing certificates, associates degrees, and bachelor degrees at five campuses, three teaching centers, and one virtual campus. More than 70% of students enrolled at STC are first-generation college goers; over 95% are Hispanic. TSTC is a system of four technical colleges. Its Harlingen campus is located in the Rio Grande Valley and has over 5,000 students . TSTC is a technical vocational institute offering a variety of two-year programs including an Associates of Science in Engineering. The student population is approximately 90% Hispanics and 65% economically disadvantaged.

The Rio Grande Valley faces some unique regional challenges that hinder retention, success, persistence, and progression. These place an undue burden on the students, lengthen their time to graduation, and hinder their performance in many gatekeeper courses. To overcome these, we identified four proven practices that accelerate math-preparedness of incoming freshman, overcome misconceptions that hinder progression from lower to upper division, and enhance sustained student engagement throughout. The interventions include

1) A targeted, STEM-focused, concurrent-enrollment program;

2) An entering-first-year, summer-bridge program;
3) Just-in-time, inquiry-based, supplemental instruction; and
4) Peer-led, mentoring and teaching.

Together these practices form a strategy intended to engender a sustainable ecosystem of student success in Engineering and Computer Science in the Rio South Texas region. Through an NSF STEP grant, we are establishing, assessing, and enhancing these practices [1], [2], [3], [4]. In the process, we have identified some important issues regarding the students' study patterns and resource access for transfer students, in particular, which critically influence the ecosystem. Of particular interest to this project is the peer-led, mentoring and teaching.

Through our fourth intervention, we have instituted peer-mentoring in key gatekeeper courses throughout the UTRGV College of Engineering and Computer Science. The intervention design and implementation is based in part of peer-lead team learning. The Peer-Led Team Learning (PLTL) curriculum enhancement model has shown evidence to transform the learning environment for the majority of students enrolled in a course and/or program [5], [6], [7]. PLTL is a student-centered instructional model for STEM where students actively learn in a group. PLTL engages an experienced student as the overseer of a small group of learners in the capacity of a "more capable peer" [8]. It has been recognized that the PLTL strategy reduces student anxiety and builds student confidence [5].

Though presently formal SI sessions have been commonly used, feedback from peer-mentors and participants indicates that students commonly require assistance outside of those sessions and often late in the evening or night. As a formative assessment to inform our peer-mentoring intervention, one of the authors has interviewed peer-mentors and conducted some preliminary surveys to gauge how and when mentees would employ SI sessions. Moreover, as expected, the need increases prior to homework due dates or exams. Also, while working with STC and TSTC, we have come to recognize the need for peer-mentoring and similar just-in-time assistance. Our intervention relies heavily upper division students, which the two-year programs at STC and TSTC do not have. Hence, to enhance our ecosystem, and better serve Engineering and Computer Science students across the Rio Grande Valley.

Given the distributed nature of UTRGV and its neighboring partners – STC and TSTC – and the after-hours nature of students' study patterns, an online-enabled, peer-mentoring model is inevitable. One of the primary roles our mentors serve is supplemental instruction.

II. Project Overview and Design

Peer mentors are in great need at the two-year institutions. Two-year institutions struggle to recruit and retain qualified students to serve as mentors and tutors, especially in Engineering and Computer Science, as most ready to do so are moving onto a four-year program. Additionally, as we have implemented the aforementioned interventions, we identified some related bottlenecks particular to students transferring from the two-year institutions serving the region. They include the following:

- Transfer students struggle with transitioning to the four-year program because they are not seamlessly integrated into the preexisting learning communities and are often uninformed about the learning resources the native first- and second-year students are exposed to since orientation.
- Standards and expectations are not transparently communicated across the four- and two-year institutions. The issue hinders time to graduation and can result in stop outs (i.e. students failing to continue in the degree program).

To better serve the transition of students from two-year colleges to our four-year Engineering and Computer Science programs, and address the need for supplemental instruction, we are establishing a distributed peer mentoring model across the institutions in Rio South Texas that leverages students at the two-year institutions, peer mentors from our intervention at UTRGV, and video conferencing resources.

Our preexisting peer mentoring model utilizes upper division students in the programs at UTRGV. **This** distributed model will employ students at both the Edinburg campus (formerly UTPA) and the Brownsville campus (formerly UTB) in addition to students at STC and TSTC. We have identified key characteristics for our distributed peer mentoring model to address the challenges and opportunities:

1) *Asynchronous.* Not all students progress through the material at the same rate. Nor do they need critical assistance at the same time. Though scheduled SI sessions are perhaps a convenient and efficient use of time, they are not optimal to meet all students' needs.
2) *Distributed.* UTRGV and STC have multiple campuses spaced out geographically. STC is primarily distributed across a single county while UTRGV has campuses distributed across three counties including the two counties where the Edinburg and Brownsville campuses reside. The peer mentoring model must be able to serve students where they are situated.
3) *Virtual.* Students need to interact in ways sufficiently similar to how they would face-to-face. The technologies employed must facilitate realtime communication around engineering and computer science problems, which is to mean they should enable writing equations, drawing schematics, and illustrating problem-solving processes.
4) *Accessible.* The students that attend UTRGV, STC, and TSTC having varying financial resources, time constraints, and external responsibilities. Mentoring must be made available to them using resources, spaces, and time that is readily accessible given their constraints.

Hence, we have conceived a model with these characteristics. Mentors will be available not just during SI sessions, but also after hours when they are most needed. Sessions will be individualized; mentors will meet with students one-one-one. With the assistance of colleagues at the two-year institutions

we will identify high performing second-year students who will later transfer to UTRGV to train them as peer mentors serving locally at the two-year institutions. Additionally, with the use of collaborative, online, virtual whiteboard tools that integrate Wolfram Alpha and LaTeX, and the use of pen tablets, we can host web-enabled peer mentoring sessions. Sessions can be held individually or in groups as needed.

III. Research Plan

Though, at present, we have some evidence that informs the framework for our model, we intend to investigate this need in detail to better formulate our model, conduct formative assessment on its efficacy, and optimize its implementation. We hypothesize that to effectively enhance student success in key gatekeeper courses, we must provide a peer mentoring model that is just-in-time. Our research questions are:

- How and when are students students practicing new engineering or computer science concepts outside of the classroom?
- How does a distributed peer-mentoring model influence student performance in gatekeeper courses and beyond?
- Is an online collaborative framework an effective platform for peer mentoring and tutoring communications?
- Can a distributed peer-mentoring model effectively facilitate the interactions of engineering and computer science students at multiple campuses distributed over 60+ miles?
- Can a distributed peer-mentoring model enhance the ecosystem and facilitate the transition of engineering and computer science students from two- to four-year programs?

We will employ a mixed methods approach that utilizes surveys, focus groups, course performance data, and online statistics. Surveys will be administered to mentors and mentees to collect self-reported data regarding when homework is conducted and at what hours peer-mentoring secessions occur. Surveys will also be employed to measure attitudes and perceptions regarding the efficacy of the sessions, the online collaborative framework, and the integration across campuses (geographic locations). Focus groups will be formed from transfer students to further investigate transition issues and assess the impact of peer-mentoring on facilitating that transition. We will assess the online collaborative framework by tracking statistics such as frequency of use, time used (i.e., when and how much), and tools used (e.g., virtual whiteboard, equation editor, etc.). The project is presently funded for several years. Thus, our intent to is conduct these assessments on a semester basis.

IV. Conclusion and Future Work

We have found that to better enhance the influence of peer mentoring on student success in gatekeeper courses, we must be more cognizant and thoughtful of how and when students employ mentoring sessions, tutoring, and supplemental instruction. In addition, given the distributed nature of our institution and the needs of our students who transfer from regional two-year institutions, we must rethink our present model to better establish the a supportive ecosystem. As a means to address these needs, we have devised a distributed peer-mentoring model that is asynchronous, virtually-enabled, and more readily accessible than our present model. We will be piloting this model over the summer with STC and in the fall with TSTC. We will conduct various formative and summative assessments to inform, optimize, and evaluate.

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