Tapping Hidden Talent

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Abstract

We have developed a summer program intended to tap the talent of high school students who have the capability to succeed in college, but are currently not on a college bound path. The courses in the program consist of a merging of arts and media with engineering. The courses rely on a combination of lecture, hands-on class work, and predominately a project which requires significant student effort and time. Students are eligible to attend the courses during the summers following their sophomore, junior, and senior years.

To date we have offered two courses entitled "The Science of Guitars" and "Introduction to Musical Recording." In The Science of Guitars course, students learn about playing the guitar as well as the physics behind acoustics, vibrations, and electronic amplification. The attraction of the course is that each student constructs an electric guitar from a kit which they own at the end of the course. In the Introduction to Music Recording course, the students learn about running a music recording business and the technical aspects of music recording. In this course the project is focused on recording bands and then sweetening the original tracks into finished CD tracks. There are other courses planned that would appeal to a wider student demographic.

One goal of the program is to tailor courses to the students and their interests, not tailor the students to the courses. Additionally, we want to show students that their interests can be turned to an academic path and also future careers, albeit not necessarily as lead guitarists in death metal bands! Often as academicians, whether at the secondary or post-secondary level, we inherently push career paths that can be labeled traditional, as opposed to the myriad of non-traditional career offshoots that exist relative to every field of study.

Both quantitative and qualitative assessment methods were used to evaluate the program on its stated goals and objectives. Quantitative methods included pre- and post course content testing and attitude surveys as well as a learning styles assessment. Qualitative methods included mid and post course student focus groups and post course staff interviews. Assessment results were documented and presented at a year-end debrief and evaluation meeting. These results will be discussed in the paper.

Introduction

The shortage of engineering, science, and mathematics students in our nation's colleges and universities requires attracting students to science and technology programs that have not historically been attracted to such programs [1]. Over the past 50 years these fields have predominately recruited students that have had an inherent interest in the fields, but one could also submit that there also existed a national fervor for science fueled by the momentum from World War II and the space race. After 50 years this momentum has dissipated [2]. The percentage of science and engineering graduates relative to the total number of bachelor's degrees has decreased from approximately 35% in the late 1960's to approximately 31% since 1990 [3]. It is our contention that in order to attract more students into these fields of study, there are a few fundamental precepts. First, the students that are already committed to these fields need not be the focus of new recruitment efforts. They will enter these fields without an additional sales pitch or incentive. Second, other students that do not currently possess an interest in the technical fields can be interested in these areas [4]. Third, there are a significant number of students with the ability to succeed in college who are not performing well in high school and are not being served by existing pre-collegiate programs. It is this group of students that we are targeting with our program titled "Tapping Hidden Talent".

There is often hidden talent in our nation's high schools that goes untapped at the post-secondary level. This happens for a myriad of reasons: socio-economic, cultural, and family history of education. There are many programs that target minority and economically disadvantaged students. Additionally, there are a variety of programs that target the talented and gifted students who are performing well in high school. The intent of our program is to target the talented students who are not demonstrating their ability through classroom performance, and who are not targeted by other programs. Often these students are underperforming due to boredom or lack of interest or challenge in the classroom. There are also other factors such as social, cultural, and family circumstances that either contribute to or dominate this situation. The Education Commission of the States [5] released a report in 2003 showing that on average only 37% of the students who enter ninth grade will enroll in college within one year of graduating high school. For low income students the national average drops to 23% and for Colorado to 17%. This means that 63% of the high school students do not go on to college within 1 year of their potential high school graduation date. In the 7 county Denver Metro area this results in approximately 90,000 students that will not make it to college within one year of graduation. There is a percentage of this 90,000 who have the ability to attend college, and are also highly talented. Our goal over the next 6 years is to create a summer program that will identify individuals meeting our criteria in this population, hook them through innovative laboratory courses that create an engaging learning experience, and then create a bridge for them from high school to college. One of the major keys to this program is that the students already have a deep interest in the course topics and many already participate in related activities.

The numbers of students that do not go on to post-secondary education are somewhat abysmal for a nation that wants to be at the forefront of technology. However, this group of students can be considered an excellent pool of untapped potential. Our thesis is that one avenue of future student enrollment growth in technical fields can occur in a non-traditional manner. Specifically, we propose to combine engineering with arts and media. One reason for this proposed path is

that many arts and media topics are of interest to high school students. Perhaps the greatest example of this is the field of music. Many high school students want to tour the country at the front of a rock band. While statistically this dream will rarely be realized, this interest can be funneled into related career paths. A high school student that has an interest in playing music can turn that interest into a technical career of sound recording, acoustics, electronics, vibration analysis, etc. The combination of engineering and arts and media has been embraced at the undergraduate level by schools such as Tufts University. Tufts offers an undergraduate minor titled "Musical Instrument Engineering" [6]. In a sense, a portion of our program can be considered a pre-collegiate version of the Tufts program. Additionally, an interest in playing computer/video games can turn into a career in computer science or mathematics. With a suitable program, students can turn these artistic interests into academic pursuits. We, as educators, just have to show them how to connect the dots between topics in which they have an inherent interest and the technical studies that are related to these topics.

Thus, we have termed our program "Tapping Hidden Talent" (THT). The uniqueness of our proposed program is that we are targeting students that have the capability to succeed in technical studies, but are, for various reasons, disenfranchised from the secondary educational process.

Specific Plans and Goals

The principal goal of THT is to increase matriculation rate of talented but non-college bound high school students, by reaching out to students who would not have otherwise attended college at all. These targeted populations are students who are bright and capable, but not motivated in high school. Without help, they would not qualify for entrance into many colleges and universities. Often they are not achieving academic success in high school simply because of their lack of motivation. These are students who do not see reasons to study science and mathematics.

The overall plan includes getting students to attend summer "hook" courses. A hook course is defined as a laboratory course on a topic the student is very interested in, but not usually offered as a course. Examples in our program include Science of Guitars, Introduction to Music Recording, Computer Gaming, Movie Making, and Biomechanics of Dance courses. High school students will desire to take these courses because they are interested in the topic. In these courses students will be introduced to topics from mathematics and physics that are pertinent to the course. After finding some success in the "hook" course(s), they will be motivated to learn more about these topics through "bridge" courses in mathematics and writing.

These bridge courses will be college level courses and upon completion of these courses the students will be better prepared to matriculate into a degree program. Scheduling will be such that students could take two courses in a summer semester. These courses have been developed by the departments of Mechanical Engineering, Electrical Engineering, Mathematics, Music & Entertainment Industry Studies, Computer Science and Theater, Film/Video.

The program goals are:

1. Increase and diversify the pipeline of potential engineering and technology students,
2. Guide THT students down the pathway toward college,
3. Develop the skills and knowledge of THT students,
4. Create a university/K-12 program that can be replicated and disseminated to other colleges and K-12 school districts, and
5. Integrate the THT program into the Engineering and Arts Colleges' educational programs.

The impact for students is that they will have an opportunity to study something they find fun and exciting. Through the use of hook and bridge courses, many students, that otherwise were not headed that direction, will become interested in attending higher education. Some will start college with credits applied towards their degree while some will enter programs that will not accept the credits towards a degree program. In cases where the credits do not apply to a degree program the course credits will help qualify the student for University admission. Our program will ease the transition from a high school student not planning to attend college to a motivated college student.

Pilot Courses

In the summer of 2003, we taught a pilot Science of Guitars course for high school students. As we anticipated, some of the students who were not initially planning on attending college became interested in attending college as the summer progressed (5 of the 23). This was demonstrated at the final ceremony when three of the students stated that the course had inspired them to attend college. This was in addition to the other students that expressed interest in attending college during the course and in the months following the course completion. This experience solidified within us the idea that there are talented high school students not planning on attending college who can be hooked by innovative courses such as the science of guitar course and then bridged into pathways that lead to receiving a college degree. We found that many students who took the course needed to have the path forward or educational system explained to them. Our experience shows that there is a natural educational mentoring that occurs between the faculty and students in courses such as these. If for no other reason than the time spent and the opportunity it provides for social interaction, there are many instances of informal mentoring that occur.

For the first summer twenty high schools students out of the original twenty-three students completed the Science of Guitars course. This course was a combination of studying the physics of guitars, building an electric guitar from a kit, music theory, and history. The course started with 23 students-3 female students, 20 male students (2 Hispanic males and, 2 who identified themselves as neither white nor Hispanic). The school demographic was 4 from local alternative high schools, 1 high school drop-out, 1 initially homeless teenager with a GED, and the other 17 were traditional high school students. There was 1 sophomore, 10 juniors, and 11 seniors. All of the original 23 students received some form of financial support for the course, with 17 receiving full financial support.

In the summer of 2004, the Science of Guitars was taught for a second time. In addition, we offered a new course entitled "Introduction to Music Recording." For this second phase of the pilot program an assessment and evaluation of the program was performed and the student demographic and results of the assessment will be discussed in greater detail later.

Description of Program

The premise that our philosophy is based upon is that many students are not motivated in a traditional class setting. We will implement an innovative course methodology designed to motivate students with project-based hook courses in which concepts from mathematics and physics are introduced and utilized. The hook courses will be followed by more academically rigorous college level bridge courses in which these concepts are part of the course content. In addition, the bridge courses will stress applications that the students have been exposed to in the hook courses. This technique, termed spiraling, has been utilized with success in the mathematics curriculum at the UCDHSC (University of Colorado at Denver and Health Sciences Center). Successful completion of one of the bridge courses will require the students to perform college level work.

For example, students taking the science of guitars hook course will be introduced to the concept of frequency content in acoustical and electrical signals as they study the physics of an electric guitar. During the trigonometry bridge course, students will work on projects involving physical illustrations of frequency, wavelength and complex signals. The trigonometry course will be accepted as a core mathematics course for all but a few majors at the UCDHSC.

Our proposed program is such that a student can take anywhere from one to a maximum of four courses. Students participating in our program can take two of the hook courses shown in Table 1, followed by two of the bridge courses shown in Table 2. Table 1 also indicates the academic topics that will be introduced in these courses and Table 2 indicates possible in-depth projects given in the bridge courses. Note that the bridge course projects are related to the academic topics introduced in the hook courses. In fact, the bridge courses are intended to spiral back and revisit the content utilized in the hook courses. The spiraling is intended to continue the utilization of topics that interest the students and extend that interest in courses that are typically considered sterile by many students.

The hook courses may be taken in the summers prior to the 11^{th} and 12^{th} grades, as well as the summer before entry into college. These courses will be three credit hour courses that may apply towards a college degree. For example, the "Science of Guitars" course has been accepted as an introductory course in engineering by the Mechanical Engineering Department and as an elective course in the College of Arts and Media. There is an intended synergy between the hook courses as can be seen from some of the possible paths that students may take through the program as shown in Fig. 1. The bridge courses may be taken upon completion of two hook courses.

Table 1. Project Based Hook Courses and Associated Academic Topics

Course	Academic Topics
Science of Guitars	Physics of vibrations, build an electric guitar, develop understanding of music based both upon quantitative and qualitative measures, understanding of acoustics, electronics and physics.
Introduction to Music Recording	Physics of sound, record live music to a CD, understand room acoustics, transmission adsorption of sound, and psychophysics of hearing.
Computer Gaming	Computer science, create a computer game, develop programming skills, understanding of graphics, human/computer interface, and artificial intelligence.
Biomechanics of Dance	Study biomechanics, create a movie of dance with anatomical markers or simulate the biomechanical movement via computer models and graphics.
Page to Screen: A Filmmaking Workshop	Technical aspects of film production.

Table 2. Academic Bridge Courses and Associated Projects.

Course	Project Related to Hook Course Academic Topics
College Trigonometry	Project using a guitar, microphone, hardware and software necessary to perform a harmonic analysis of an acoustical signal. Project utilizing the concepts of wave addition (fourier series), consonance and dissonance to understand concepts from music.
Movie Script Critiquing	In depth critique and modification of an existing script, script writing and development.
Technical Reading and Writing	Reading comprehension of technical reviews, creation of a technical review of a product.

The bridge courses will be college level core courses in mathematics and writing designed to build upon the academic topics introduced in the hook courses. The mathematics course will be a college trigonometry course that utilizes concepts from the physics of vibration, acoustics, the psychophysics of hearing and kinematics to introduce and apply concepts in trigonometry. It is anticipated that some students will take hook courses without having taken algebra. However, in order for those students to take the trigonometry course, they will have to take high-school algebra as a prerequisite.

One of the writing courses will be a script-critiquing course that will provide in-depth writing experiences associated with script writing. The technical writing course will provide an in-depth writing experience directly related to the technical aspects covered in the hook courses.

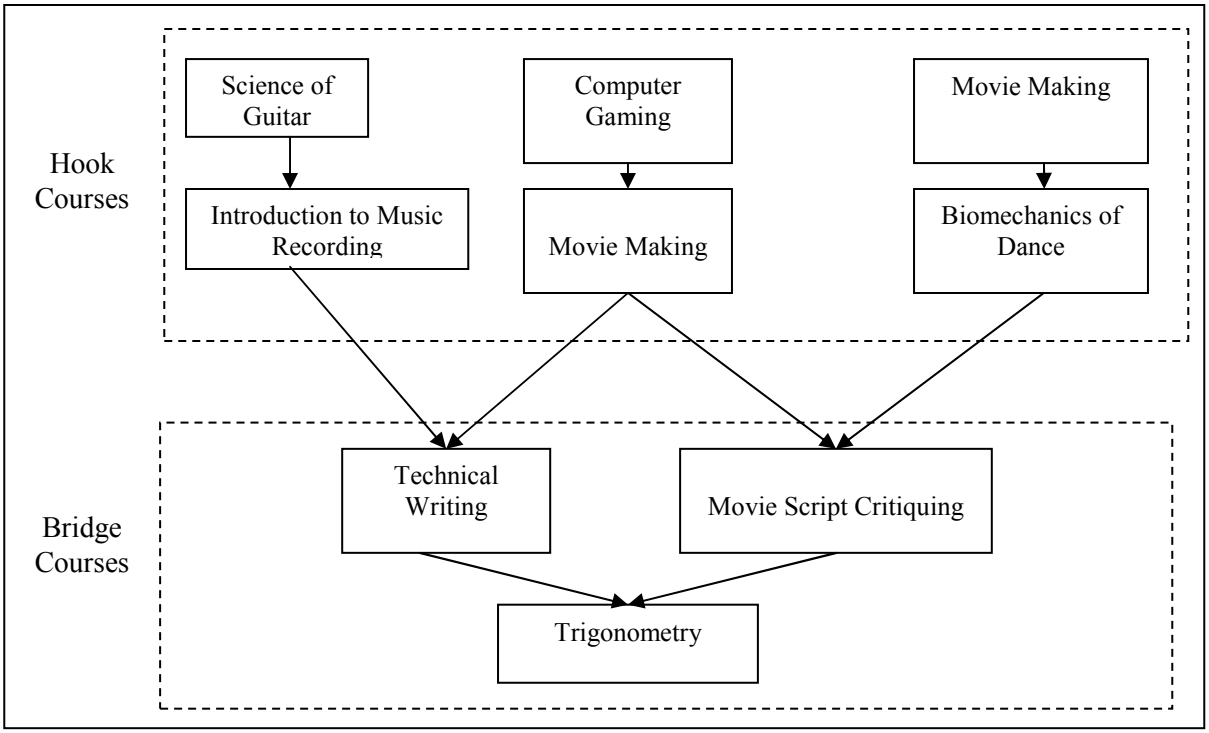

Figure 1. Three Possible Independent Paths

Mentoring

Mentoring of these students is performed by both the instructors and by college students who serve as teaching assistants (TA's) for the courses. The nature of our courses is such that there is significant instructor-student and TA-student contact time on campus. In addition to classroom activity assistance, a significant portion of the TA's duties is to provide mentoring for the students. Mentoring involves discussion of the pathways forward to college for each individual high school student. The pathways will include identifying high school courses students should take to help complete their background before attending college. Once the students are "hooked", the mentoring component will be necessary to help the students understand the long-term gains of a college education. The "bridging" of a student into a degree program will be accomplished through the parallel components of the bridge courses and the mentoring process that will help guide the students through the admissions and financial aide maze.

Implementation Schedule

The implementation of the courses will occur over six years. In the summer of 2004 we expanded the program from the Science of Guitar course to also include the Introduction to Music Recording course. The schedule for implementation of the courses is shown in Table 3.

Table 3. Implementation Schedule of Courses

	2003	2004	2005	2006	2007	2008
Hook Courses	Science of Guitars	Science of Guitars	Science of Guitars	Science of Guitars	Science of Guitars	Science of Guitars
		Intro to Music Recording	Intro to Music Recording	Intro to Music Recording	Intro to Music Recording	Intro to Music Recording
			Computer Gaming	Computer Gaming	Computer Gaming	Computer Gaming
			Movie Making	Movie Making	Movie Making	Movie Making
						Biomechanics of Dance
Bridge Courses			Film Criticism Script Writing	Film Criticism Script Writing	Film Criticism Script Writing	Film Criticism Script Writing
			Technical Writing	Technical Writing	Technical Writing	Technical Writing
			Trigonometry	Trigonometry	Trigonometry	Trigonometry

Recruitment and Identification of Students

Students were recruited from the 85 high schools in the seven county Metro Denver area. This region has approximately 150,000 high school students. Students had to apply for the program, thus it was dependent upon self-selection. In addition, a high school counselor or teacher was required as a reference.

Students will either be self-nominated, nominated by a high school teacher, guidance counselor, or some one else in the support community. Support community can include organizations such as the Boys and Girls Clubs and Colorado MESA (Mathematics Engineering Science Achievement) program, which we have connections, as well as any other organization that works with youth. We have been able to find references in the support system for all of our students including the high school dropouts. We are searching for students that have talent that is not identified in the normal academic filtering process as potential candidates for higher education. Basically, these are students that have the mental capability to succeed in a college or university setting, but have not been necessarily demonstrating this in the traditional secondary school metrics. Thus, regardless of whether or not a student is self-selected, inclusion in the candidate pool will require a third party (high school teacher, guidance counselor, etc.) recommendation. For example, students can be included with almost any GPA. We will be specifically targeting students that would not normally be accepted in college based upon their high school academic performance. To state this more definitively, this is not an advanced placement or traditional gifted and talented program.

In addition, we are working to establish other relationships with local high schools. The pilot course in the summer of 2003 and 2004 relied on such relationships to find some of the students and we are exploring various alternatives to build more of these relationships. We are exploring the concept of developing "partner school" relationships in the metro area and we will soon begin the process of visiting local high schools as we continue to build relationships. Another concept for student recruitment will be to hold “Saturday Academies,” where we present a condensed

version of the courses presented to middle and early high school students to whet their appetites for our program.

Some of our targeted students will not have the high school GPA to meet competitive college or university admissions. However, in Colorado, the public universities such as CU-Denver will accept students from open admission community colleges or state colleges after 12 credit hours with a GPA of 3.0. The students in our target group very often will not have the scholastic skills required to be successful in college. Thus, completion of these courses establishes an educational base from which the students can be successful in their academic endeavors. Completion of the 12 credit hour program would allow a student to enter traditional venues of engineering, computer science, or arts & media. Students completing this program could also use these courses as entrée into any college program they choose.

Evaluation

The Tapping Hidden Talent (THT) program at the University of Colorado at Denver has been assessed and evaluated with respect to program goals. For the 2004 offering of the program, data were collected from 26 students, 15 for the Science of Guitars course and 11 in the Introduction to Recording Course. Data were collected at the beginning, middle, and end of the courses and a range of quantitative and qualitative methods were used including a student learning styles assessment using the Kolb instrument [7], interest assessment, skills confidence assessment, content testing, retention analysis, focus groups, and staff interviews. Staff met after the summer to debrief and evaluate assessment results.

Assessment results revealed successes and areas of improvement for each of the goals. For ***Goal 1, increase and diversify the pipeline of potential engineering and technology students***, the learning styles assessment results revealed that the program attracted a diverse range of learning styles beyond the style typical of engineering. The Kolb Learning Styles inventory distinguishes between four learning styles. The Converging Learning style is most typical of engineering students and is focused on arriving at a single best solution to a question or problem. In engineering, these types like design. The Diverging Learning style is most typical of arts and social sciences and is focused on using imaginative ability to generate alternative ideas to benefit people. The Assimilating Learning style is most typical of the hard sciences and is focused on using analytical skills to develop integrated rational explanations, theoretical models, and systematic plans. Finally, the Accommodating Learning style is action oriented and focused on learning by testing, carrying out plans, and getting involved in new experiences. These types are often found in business, but also in the performing arts.

It was expected that the THT program would attract learning styles other than the typical engineering learning style, Converging. Across both programs, assessment results were as follows:

1. Converging – 19%
2. Diverging – 19%
3. Assimilating – 43%
4. Accomodating – 19%

These results indicate that the THT program draws from a variety of learning styles and diversifies the engineering and technology pipeline.

Student interest was assessed by a seven item scale created for this program to assess interest in attending college, majoring in science, technology or engineering, and spending more time at CU Denver. Students rated their interests on a 1-5 scale with 5 equal to "very interested." Counter to expectations, student interest ratings did not show significant improvement. Finally, retention analyses were split with the Science of Guitars course posting 100% retention while the Music Recording group retained 36% of its students.

For ***Goal 2, guide THT students down the pathway toward college,*** THT students demonstrated a significant increase in their confidence in their knowledge of the pathway to college. Students' confidence in their knowledge about the pathway to college was assessed at the beginning and end of the course. Students rated their confidence (1-5 scale, 5 = Highly Confident) on the items in Table 4 below. Ratings for the two courses were combined due to low numbers of students for the post assessment in the recording course.

Table 4. Students' Confidence in their Knowledge of the College Pathway, Assessment Results

Confidence Items	Pre-Assessment	Post-Assessment	Change
Overall	3.03	3.46	+14%*
Knowledge of the College Application Process	2.72	3.56	+31%*
Knowledge of Future Educational Opportunities at UCD	3.11	3.44	+11%
Knowledge of Career Opportunities in Technical Fields	3.28	3.39	+3%
			* $p < .05$

Results revealed an overall significant gain for students' confidence in their knowledge about the pathway to college with the strongest results in the area of knowledge of the college application process. Post-course scores were in the neutral range, and could be improved if students were hooked into future courses. The goal of educating students about the college application process was met.

For ***Goal 3, develop the skills and knowledge of THT students***, content tests for each course were developed by the instructors using multiple choice, true-false, and fill in the blank formats. Students took the tests at the beginning and end of each course. The Science of Guitar students posted a considerable content testing gain (+79%). This was the strongest quantitative gain observed for the THT program. In contrast, there were too few Introduction to Music Recording students on the post-test to analyze scores.

For ***Goal 4, create a university/K-12 program that can be replicated and disseminated to other colleges and K-12 school districts***, the THT program was developed for the current year in

several ways including the addition of another course and rigorous mathematical content in the guitars course. Also, a program evaluator was brought on board. A filmed documentary of the program has been developed for use as a funding and recruiting tool. Suggestions for additional program improvement include revised course content to combat math phobia in the guitars course and to incorporate more active learning into the recording course. It was also suggested that a person be hired to focus on recruiting the target population and that more funding sources should be found for the program.

For ***Goal 5, integrate the THT program into the Engineering and Arts Colleges' educational programs,*** a progressive relationship has been forged between the Colleges of Engineering and the Arts where staff of both colleges are excited about the program concept and feel comfortable working with one another. Suggestions for improvement are to institutionalize the program by putting a solid administrative infrastructure in place with clarified roles for recruiting, teaching, and coordinating and an equal sharing of the workload between colleges.

Summary

Thus far our program has mixed results. While we have achieved many of the goals of the pilot program, it has not been a complete success. On one hand, a progressive partnership has been formed between the Colleges of Engineering and the Arts at the University of Colorado at Denver with a unique niche, targeting unrecognized talent in Denver area high schools. In 2004, the program attracted students with a range of learning styles and built students' confidence about attending college and selecting a major. In the Guitar course, students posted considerable content learning gains and the course was well received by the students due to the simple fact that building and owning a guitar is an incredible inducement to completing the course in a satisfactory manner. However, as evidenced by the retention of students in the Music Recording course, the connection with the target student group can be tenuous. This can be attributed to two primary factors, one is our group of students, and the other is us and our delivery methods. For all of those that have attempted to deliver college or university level content to high school students, it comes as no surprise that the greatest adaptation has to come from the university instructors not the students. Both students and faculty made the observation that this course needed more hands-on student time in order to hold the students interest. This is something that all of us have struggled with in the two summers of the pilot program.

In addition, since these classes are a combination of arts and media with engineering, there is a certain minimum level of mathematical ability that is necessary to complete the courses. We have limited this primarily to algebra, but even though most of the students have had algebra prior to the pilot courses, a proficient skill level is not present for many of the students. This resulted in many long hours spent working with students on a one-on-one basis throughout the summer. Despite the lack of proficiency of some of the students that required significant amount of help, the motivation to complete the course often resulted in significant progress of the student. However, the lack of proficiency in mathematics is one of the greatest challenges to educating our target population at the post-secondary level.

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