Developmental Education Option: Alternative Math Remediation for High School Seniors and State College and Community College Students

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Abstract: This white paper discusses an on-going dilemma for both graduating high school students and colleges in America – the ubiquitous problem of entering college freshmen not being able to enroll in college-level math courses due to inadequate understanding of essential math concepts and skills. A lack of preparation for college math placement exams typically results in poor exam performance and/or failures leading to institutional requirements for the student to enroll in a long path of math remediation courses. This leads to increased time and costs for a student to graduate from college. Statistics show that math remediation students frequently withdraw, fail, or receive an incomplete in their courses, which often results in increased college dropout rates. Furthermore, studies have shown that traditional methods of math remediation are not always effective and/or affordable. New technologies exist, however, to enable successful self-paced, independent math remediation. This paper presents one such technology developed by Advanced Training & Learning Technology, LLC (AT&LT). The paper introduces key features and capabilities of the AT&LT’s math remediation tool and highlights how the tool is used to provide successful student math remediation and improved student scores on college math placement exams.

Introduction

Approximately 80% of students who enroll in a non-selective state college or community college have math skills deficiencies that preclude them from taking college level math their first semester. These “at-risk” students must take a minimum of one semester of non-credit remedial math before taking a for-credit college level math course; however, many of these at-risk students end up completing two or more semesters of remedial math prior to taking the first credit-bearing college level math course. These students often utilize the limited financial aid available to them taking non-credit bearing remedial courses, resulting in a high percentage of them dropping out of college. The extra time and finances students must devote to remedial courses affect them adversely, often resulting in graduation rates for full-time community college students of less than 25% after three years. Students who are deemed at-risk due to poor math proficiency, as evidenced by a low math SAT score, are currently required to take a college math placement exam prior to starting college. (Some school systems have students take the college math placement exam during their junior or senior year of high school, so those who are at-risk for math can be identified –and hopefully remediated– prior to graduating from high school.) The results of this math placement exam are used to assign the student to the appropriate non-credit remedial math course. The lower the student scores, the more remedial math that he/she must take prior to taking credit-bearing college math courses.
For example, at-risk math students in Virginia’s community college system may need to take up to 10 units of remedial math depending on their math placement exam score. These remedial math units are taken in chunks of four units each semester. If a student receives a low score on the Virginia placement exam for math, he may need to take remedial math a minimum of three semesters. The tuition for each remedial math unit is $160. Students who must take all 10 remedial math units will pay tuition costs of $1,600 over three semesters, or 1 1/2 college-years, before taking the first college level for-credit math course. The 10 remedial math units provided by Virginia community colleges cover arithmetic and algebra math topics including: whole numbers; operations with positive fractions; operations with positive decimals and percents; algebra basics; first degree equations/inequalities in one variable; linear equations/inequalities and systems of equations in two variables; exponents, factoring, and polynomial equations; rational expressions and equations; rational exponents and radicals; and functions, quadratic equations, and parabolas. These math topics are all addressed in middle school and high school pre-algebra and algebra I courses.

Students who enroll in a non-selective state college or community college must possess a high school diploma. In order to receive a high school diploma in most states, including Virginia, these students must have passed an algebra I course in middle school or high school, and they must also have passed the state’s algebra end-of-course exam. Prior to successfully graduating from high school, students successfully mastered the math topics covered in middle school/high school math classes (which are paralleled to the 10 remedial math units provided by Virginia community colleges), but for whatever reason, 80% do not retain this math knowledge; consequently, they must re-take basic middle school and high math in college before they can take credit-bearing college math courses.

**College Math Education Trends**

Students are provided with a free, public education in middle school and high school in which they are taught (and must successfully pass) the pre-algebra and algebra math courses necessary to receive a high school diploma. Upon graduating from high school, for some students who attend publicly subsidized state colleges or community colleges, it is necessary for them to complete non-credit remedial math courses, which are costly for the schools to facilitate. Some members of the public question paying for incoming freshman identified as at-risk math students to repeat math courses that were provided for free in middle school and high school. The result of this “concern” is that very few four-year colleges and universities now provide remedial math courses. Students who are admitted to four-year colleges/ universities with math skills deficiencies that preclude them from taking college level math must first attend a community college to obtain required remedial math credits.

Another trend that we are likely to see more of in the future is the paradigm that it is student’s responsibility to become proficient in math. Oklahoma and Nevada do not fund remediation in their four-year colleges and universities; Colorado, South Carolina, and Tennessee have moved remediation to their community colleges, and Ohio will no longer fund remedial university classes in 2014. Florida enacted legislation in July of 2013 that alters the process of providing remedial math, also known as “developmental math,” to at-risk students. The Florida legislation restructures remedial college preparatory instruction as developmental education and requires Florida college system institutions to provide developmental education that is more tailored to the specific communication and computation skills a student needs to develop to be successful in
performing college-level work. The bill does not repeal non-credit remedial courses but requires colleges to offer developmental education options a student may pursue while simultaneously taking college-credit courses. Students whose test scores indicate the need for developmental education must be advised of options and may enroll in the developmental education options of their choice.

The legislation specifies that two groups of students must not be required to take the common placement test or to enroll in developmental education:

- Students who entered 9th grade in a Florida public school in 2003-2004 or thereafter and who earned a standard Florida high school diploma; or
- Students who are serving as active duty members of the United States Armed Services.

Students who are not required to be tested or to enroll in developmental education may request assessment and may enroll in developmental education if they wish. The Florida bill requires:

- By October 31, 2013, the State Board of Education must establish the test scores a student must achieve on the common placement test in order to perform college level-work.
- By December 31, 2013, the State Board of Education is required to approve a series of meta-majors and academic pathways and identify the gateway courses to the meta-majors.
- By March 1, 2014, Florida college system institutions must submit developmental education plans to the chancellor of the Florida college system for implementation beginning no later than fall 2014.
- Each Florida college system institution and the Florida college system chancellor will submit annual accountability reports to the state beginning in 2015.

This Florida legislation makes the math placement exam, which was previously mandatory for at-risk students with a low math SAT score, optional at the student’s discretion. Students entering Florida state colleges (Florida recently transitioned many of its community colleges into state colleges offering both two-year and four-year degrees) can enroll in a for-credit math course even if they have math skills deficiencies that would have previously resulted in them having to first take one or more non-credit remedial math courses prior to taking credit-bearing math courses. Florida state colleges must provide “developmental education options” other than remedial math courses for students who decide to take college level math courses.

The big question is, “What are these ‘developmental education options’ Florida state colleges must provide per this legislation?” Florida state colleges can certainly continue to provide remedial math courses, but it would be impractical for students performing poorly in college level math courses to simultaneously take remedial math classes that should have been completed in entirety prior to enrolling in college level math courses. Given the fact that the objective seems to be to cut education costs (or at least push more of those costs onto at-risk math students), there are not many viable “developmental education options” that are based on the use of traditional teaching techniques – including lecture, practice, and assessment – that can be used to effectively remediate at-risk students.
Math Remediation Challenges

The main challenge with preparing an at-risk high school senior for college level math is determining the student’s specific math skills deficiencies. If each at-risk student’s math skills deficiencies could be accurately determined at a very granular level, a custom plan could be generated to provide that student with precisely tailored remediation; however, while there are assessment programs available that can be used to identify the relative level of a student’s math proficiency, until now there has not been a practical assessment technique that could identify each student’s specific set of math skills deficiencies. For example, a student can take an assessment exam that determines that she is proficient at a particular math skill, such as systems of equations with two variables, but this student may still have more rudimentary math skill deficiencies, such as the inability to add/subtract negative numbers or multiply/divide positive and negative fractions, that will adversely impact her higher level math proficiency.

Another challenge associated with math remediation is the amount of time necessary to effectively remediate all the math skills deficiencies for an at-risk student. If the remediation provided to a class of students is through traditional classroom teaching techniques, with each math skill addressed by the teacher, some students in the class will already understand the skill (which becomes redundant for them), whereas the remainder of the students in the class will either re-learn the math skill or fail, altogether, to re-learn the math skill. There will be no way for the teacher to determine which students have refreshed the math skill(s) she just taught without testing the class to determine the efficacy of her teaching. Unfortunately, math remediation in a classroom environment for at-risk students is not highly effective.

Traditional Math Remediation

One math remediation option is to provide a college math preparatory class for at-risk high school seniors before they enroll in college. At-risk students normally take the minimum number of math courses required in high school and may not take a math course during their junior or senior years. Few of these at-risk math students will voluntarily take a math course their senior year that isn’t required for them to graduate. Making a college math preparatory course mandatory for at-risk math students is one method for increasing student math proficiency prior to college; however, the additional cost of providing this college math prep course to senior students must be borne by the high schools that offer it. The two primary traditional methods for teaching college math prep courses to at-risk students are teacher-centered classroom lectures and practice sessions that accompany classroom instruction. Traditional testing is used to determine if the prep course increases student math proficiency. Generally speaking, the success of the prep course is dependent on the effectiveness of the techniques used to teach the course and the amount of time an at-risk math student actually devotes to refreshing her math skills prior to taking the college math placement exam.

Another traditional student math remediation option is tutoring. While tutoring is usually a more effective teaching technique than learning in a classroom environment, mainly because a tutor can provide more precisely tailored instruction based on a student’s specific math skills deficiencies, given the high cost of tutoring, it is not a practical option for the majority of at-risk math students. Enrolling an at-risk math student in a for-profit education center, given its high cost, is also not a practical option.
Advanced Training & Learning Technology, LLC (AT&LT) recently released an advanced math remediation tool that is specifically designed for use by at-risk students, who have math skill deficiencies that if not effectively remediated, will be forced into taking remedial math courses (i.e. developmental math) before they can take the first required credit-bearing college level math course. The AT&LT math remediation tool is in the form of a 3D adventure quest style video game that integrates pre-algebra/algebra I math content into a mystery plot/storyline. The 3D video game format engages students and refreshes previously learned mathematical knowledge and skills. However, a student who does not wish to play the video game can selectively bypass the gaming features and only spend time refreshing their math skills. It should take approximately 10-15 hours for a student who has previously taken (and passed) pre-algebra and algebra I math courses to use the game in a math skills refresh mode to complete the entire curriculum, including remediation for the specific math skills for which the student is deficient.

The curriculum covered within the game includes a full year of middle through high school math encompassing all the math skills a student must master to successfully complete pre-algebra, plus approximately 25% of the algebra I course content. The curriculum is very comprehensive and includes 9 levels (chapters) with 68 quests (lessons). There are 139 videos, 166 narrative texts, 895 guided practice problems, and 5,536 assessment problems included in the 68 quests. An Intelligent Tutoring Agent (ITA) monitors student performance and automatically intervenes upon detection of a student math skill deficiency by providing the student with context sensitive remediation through access to learning assets (videos, narratives, guided practice problems) in a virtual learning tablet. When the game is used in a student math skills refresh mode, the student will progress through the quests covered in the curriculum and only receive remediation when the ITA detects a skill deficiency. The game essentially adapts itself to each student’s unique set of math skill deficiencies, which allows a student to progress through the math concepts covered within the curriculum in the minimum amount of time dependent on the student’s proficiency.

As a student progresses though the curriculum, the game uploads detailed performance data to a secure AT&LT server. This detailed performance data is processed and made accessible to the student and to an authorized teacher or instructor, through a web app in the form of a color-coded progress and performance report.

Typically an at-risk student would use the game to play through the full curriculum as rapidly as possible. The student would only receive remediation for deficient math skills. When the student completes the curriculum, a custom remediation plan could then be generated based on the student’s detailed progress/performance report. The student would then replay each quest in which he received two or more forced interventions from the ITA, as indicated on the progress/performance report.

A specific example of this method is shown in Figure 1, which displays a student’s progress and performance with quests 8.10 through 8.17 in the Graphing level of the game, and quests 9.1 and 9.2 in the Probabilities & Statistics level of the game. (The report is continuous across all levels and quests in the curriculum, but only a portion of the report is shown herein due to space limitations.) The number of ITA forced interventions for a given quest is shown by the integer in the colored cell for the quest. The color code is also based on the number of ITA forced interventions for each quest – blue designates zero forced interventions, green designates one
forced intervention, yellow designates two forced interventions, and red designates three or more forced interventions. Additional progress and performance data provided in this report includes the average time the student took to complete a quest and the average time the student spent receiving remediation.

![Figure 1. Student Progress and Performance Summary Report](image1)

In the first pass through the curriculum, this student received two or more forced interventions from the ITA on four quests, 8.10, 8.14, 8.16, and 8.17. This student’s custom remediation plan was to replay each quest for which two or more forced interventions were received from the ITA. (This particular student received two or more forced interventions for 15 of the 68 quests in the full curriculum.) This student improved his performance on the second pass in all four quests by receiving “blues” (which indicate zero forced interventions by the ITA) on three of the quests and a “yellow” on the fourth quest. Figure 2 shows more of the same summary report to include time spent using the tool.

![Figure 2. Student Progress and Performance Summary w/Time Summary](image2)
The total time for this student to complete the full curriculum in a math skill refresh mode of game play, including the time it took him to replay the 15 quests for which he received two or more forced interventions from the ITA, was 9 hours and 44 minutes – 7 hours and 37 minutes for the first pass plus 2 hours and 7 minutes to replay the 15 quests for which he received two or more forced interventions from the ITA. In the first pass, it took this student an average of less than 7 minutes to complete each of the 68 quests in the curriculum. The average time for each quest for the second pass was 8 ½ minutes, which is to be expected, given the 15 quests this student replayed were those in which he needed to spend more time in remediation to successfully complete. This particular student actually played the game to progress from quest to quest. He reported he liked to play the game so he could take a break from the math for a couple of minutes between successive quests.

Cost

The cost of *Pi and the Lost Function – Episode 1* for use by individual students as a “developmental education option” is currently $24.97 (as of August 2013) when purchased through AT&LT’s website. A volume discount is available to high schools that elect to purchase Episode 1 for use by senior students as part of a college math prep course. Information and details can be obtained by contacting the author at eharvey@atltgames.com or sales@atltgames.com.

Summary

This paper discussed a general and persistent national problem related to poor student math performance on college placement exams and cited the challenges faced by students who are at-risk for math. We also highlighted the need for alternative, cost-effective solutions to successfully remediate math skills and enable student enrollment in college-level math courses as soon as possible. AT&LT has an effective and affordable developmental education option that is available for use by at-risk students who plan on attending college and would like to prepare for taking the college math placement exam, or who are attending college and find that they need math remediation in order to successfully complete a college level math course.