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Commentary

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Make Math a Gateway, Not a Gatekeeper

By Anthony S. Bryk and Uri Treisman

The story is a familiar one: A high-school dropout and single mother works the supermarket late shift. Motivated to earn a four-year degree so she can have a better life for herself and her 4-year-old daughter, she enrolls in a community college after earning a GED. Three years later, she still hasn't completed the sequence of three remedial math courses required before she can take college-level math. Defeated, she says, "I just couldn't do it anymore." For this student and too many others, the dream stops here.

Remedial math has become an insurmountable barrier for many students, ending their aspirations for higher education. To earn a degree, certificate, or license, community-college students usually must complete a college-level math course. However, the relationship between this particular course requirement and the specific quantitative competencies necessary for future success at work is often unclear to students. In addition, some students must take as many as four remedial courses before they are considered "college ready." Recent studies report that between 60 and 70 percent of students placed into remedial math either do not successfully complete the sequence of required courses or avoid taking math altogether and therefore never graduate.

The relevance question—"Why do I really need this to succeed?"—is often hard to answer. It's time to ask fundamental questions about why people who care about student learning, despite Herculean efforts, are still not able to help these students realize success. It's time to decide what these students really need to know to succeed. For these reasons, we think that it's time to revisit both the structure and goals of remedial math. We want to create a challenging, alternative math pathway that emboldens students to realize their goals and prepares them well for life beyond the math classroom.

Math should be a gateway, not a gatekeeper, to a successful college

education. Students must come to see math as an essential aspect of their everyday lives, no matter what their field of study. They need to think, "I can understand this, I can do this, this is important to know." The math pathway for students pursuing majors in the math-oriented disciplines is well established: Students work their way through algebra to calculus. Certainly, students entering science, technology, engineering, and mathematics fields need to be proficient in pre-calculus and the algebra on which it depends.

However, many students in the social sciences, arts, and humanities, and those seeking careers in business, applied technologies, health sciences, and other fields, could be served just as well by another pathway. The skills in those professions can require rigorous preparation in statistics. Statistical reasoning supports decision making under conditions of uncertainty, an inescapable condition of modern life. This is math that will help these students understand the world around them, and it's the math they can use right now.

The current lengthy sequence does little to support student success. The Carnegie Foundation for the Advancement of Teaching is organizing a network of faculty members, researchers, community colleges, and professional groups to develop a statistics pathway that will provide a challenging alternative to the current developmental-mathematics sequence. This sequence will bring students to and through a course in statistics in one year that would count toward both college credit and transfer. This would replace the current sequence that takes multiple years, if—and that's a big if—students persist through the process.

We know that redesigning the mathematical content isn't enough to help these students through. With the dismal pass rates of students in math, it is clear that we must change not only the curriculum itself, but also the academic-support system that should be integrated within it. Students need college knowledge as well as content knowledge. Many community-college students are the first in their extended families to pursue postsecondary degrees; they need to learn how to "do" college in order to be successful in college. And, yes, colleges need to review their policies and practices to make sure they are doing everything possible to help their students realize their hopes. We need to strengthen the connections of students to successful peers, to their institutions, and to pathways to occupations and education.

The development of a statistics pathway is Carnegie's best bet for what might help solve the remedial-math problem for a significant

number of community-college students. We have consulted community-college leaders and members of national education and mathematics groups. We are also coordinating closely with such programs as Achieving the Dream and the California community-college system's Basic Skills Initiative. These programs have redesigned mathematics courses and created courses that help students succeed in college, as well as mentoring and tutoring programs. While successful intervention strategies exist at many community colleges, they tend to be costly add-ons and extra courses and therefore can have an impact on only a small number of students. Carnegie will instead weave into developmental courses units and activities that provide students with strategies that support persistence while building skills in mathematics. If we integrate such concepts as goal setting, resilience, time management, and study skills into the classroom, they could gain the serious attention they deserve.

The groundwork begins this summer, when Carnegie will bring community-college teams together to collaborate with other practitioners, designers, and researchers to begin the development of materials and assessments for this pathway. During the next year, Carnegie, through face-to-face and online collaborations, will support a networked community using newly developed materials and ideas, continuously improving them and documenting practices that will guide expansion. If we are initially successful, we aim to expand the network to more than 100 colleges over the following three years. Our ultimate goal is to double the proportion of students who, within one year of continuous community-college enrollment, are mathematically prepared to succeed in further academic study or occupational pursuits.

If we truly want to make math the gateway rather than the gatekeeper to a college education, then remedial math is an obvious place to help students develop the knowledge, skills, and social connections for success beyond the math classroom. We need to create a sense of opportunity, of possibilities for those who otherwise might see a lengthy road ahead. This pathway would make it possible for students to fulfill the mathematics requirement needed for many occupations and learn what it takes to be academically successful.

We want to help community colleges build new pathways worthy of mathematics, worthy of their students, and worthy of their institutional missions.

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Acceleration for ALL Students

Posted on August 30, 2011 by Bruce Vandal

The proposals at many community colleges to set a minimum cut score that students must achieve to enter remedial education assumes that the current system of assessment, placement and instruction in developmental education is essentially sound, but that certain students have academic skills so weak that they can not be successful in that system. Katie Hern of Chabot College and Myra Snell of Los Medanos Community College take issue with this assumption and suggest that this view is nothing more than blaming the victim for a failed system.

Katie and Myra lead the California Acceleration Project, an initiative of the California Community College's Success Network (3CSN) where they have become champions for accelerated learning models that successfully serve all students, regardless of how they perform on placement exams. Katie and Myra have become champions for single-semester accelerated developmental courses in math and reading/English that immediately lead to college level courses. The courses do not set a minimum cut score for entrance. They firmly believe that current assessments do a poor job of determining if a student can succeed in any given developmental course. As a result, students should not be denied the opportunity to pursue an accelerated path to college-level courses because of a cut score on assessment. In fact, they have found that many students who are assessed at the lowest levels can be successful in a single, semester-long, accelerated course.

They argue that the current system of multiple levels of remedial education where students assessed at the lowest level may require upwards of 3 or more semesters of work in a single subject is the real problem. Students simply do not persist through each level, inevitably dropping out before they ever reach college level courses. As a result, they have eliminated the levels and focused on a single course, reducing the time in remediation and the likelihood that they will drop out of the system.

The results prove them correct. Moving students to the new course doubled student success in college level English for students placed at the lowest levels. 45% of students who enrolled in Chabot's accelerated reading/English course passed college-level English, compared to only 23% of students who enrolled in two levels of remedial English/reading.

Most impressive was that the students who scored the lowest on placement tests had significantly improved outcomes. Students who scored below a 50 on the Accuplacer reading and sentence tests, which represent the lowest 7% of scores on the exam at Chabot, passed the accelerated course at the same rate as they did the lowest-level English/reading course. Meaning students that many colleges are considering excluding from remedial education on their campuses showed significant improvements by virtue of only having to complete one remedial course before enrolling directly into college-level English. Furthermore, the inclusion of more students who were assessed at the lowest levels in the college-level English did not negatively impact the completion rate for the college-level English class. The bottom line – the multi-layered system was the problem – not the students.

Myra has achieved similar results with her accelerated Path2Stats course. Path2Stats bypasses the traditional four-course sequence of developmental math courses leading to calculus by offering a single four credit developmental course that prepares students for college-level statistics. Given that the vast majority of students entering college will pursue non-Algebra/calculus based majors – Path2Stats provides a more practical and realistic way for students to fulfill their math requirements.The results are tremendous:

- 85% of students completed the course
- 93% enrolled in college-level statistics
- 85% completed college-level statistics resulting in . . .

. . . an overall college-level math completion rate of 64%.

Most amazing is that 31% of students tested into the lowest level of math – pre-algebra/arithmetic completed college-level statistics compared to only 5% in the traditional model.

I have always thought that the discussion about denying students access to remedial education because of the evidence of failure was putting the cart before the horse. We all have seen that recent innovations in remedial education show that redesigned instruction can increase student success. We also know that the system of assessing students for remedial education is clearly broken and in need of a complete overhaul. So it seems premature for system leaders to advocate for the denial of service to students without first engaging in a full blown reform of their remedial education system. Katie and Myra have proven that setting a floor for entrance to remedial education is further codifying an existing system that is about weeding students out, not facilitating student success.

Katie and Myra have a wonderful webinar online that you can view that does a much better job than I in describing their success. View it here.

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Rethinking Developmental Education in Community College

Thomas Bailey

Community colleges are charged with teaching students college-level material, yet a majority of their students arrive with academic skills judged too weak to allow them to engage successfully in college-level work in at least one subject area. Colleges address this problem by providing extensive programs of developmental education designed to strengthen students' skills so they can successfully complete college-level courses.

This Brief, based on a longer paper, reviews evidence on students who enter community college with weak academic skills, and it summarizes study findings on the effectiveness of developmental education. (Note that the terms developmental education and remediation are used interchangeably throughout.) It suggests that, on average, developmental education is not very effective in overcoming student weaknesses. The Brief concludes with recommendations for a broad reform agenda based on a comprehensive approach to assessment, more research that tracks students through their early experiences at college, a blurring of the distinction between developmental and "college-level" students that could improve pedagogy for both groups of students, and strategies to streamline developmental programs and accelerate students' enrollment in college-level courses.

Developmental Assessment

Developmental education assessments are in reality high stakes tests. Failing such tests often leads to remediation, which has high costs for students as well as for community colleges and the public sector. Yet, despite the importance of test outcomes, there is no national consensus about what level of skills is needed to be college ready or about how to assess that level. Although versions of Accuplacer and Compass are the most common, many different tests are used to determine developmental need, even, in some cases, within one state; furthermore, even when the same test is used within a state, institutions are often free to choose their own cutoff scores. Attempts to articulate a comprehensive understanding of what skills and knowledge are needed to succeed in college (see Conley, 2005) highlight the narrowness of the assessments used for remedial placement, which measure only some of the skills needed for a successful college experience. Students who pass the placement assessments may still lack many of the skills and knowledge that are essential for success in college. Indeed, students with similar scores vary widely in their subsequent academic outcomes.

Developmental education assessments are designed to determine a student's skill level, yet assessment scores may do little to reveal what type of help students need to be successful in college. Students who share the same low score on a mathematics placement test could face very different problems. For example, some students may have learned math successfully but scored poorly because they had been out of school for many years; other students may never have learned in high school the math being assessed; others may have taken the appropriate courses but failed to learn the material nonetheless; still others may be immigrants who had trouble understanding the English used in the math placement test. Each of these four groups of students, all with the same assessment test score, probably needs very different types of services to prepare them to be successful in college-level mathematics.

Participation in Developmental Education

Incidence of Weak Academic Skills

Two different analyses of community college students — one using data from the National Education Longitudinal Study (NELS) (Attewell, Lavin, Domina, & Levey, 2006) and the other (by the author) based on data on more than 250,000 first-time students at colleges participating in the Achieving the Dream: Community Colleges Count initiative — indicate that nearly 60 percent of students take at least one developmental education course during their community college career. While high, this proportion still underestimates the number of students arriving at community colleges with weak academic skills: in some states developmental courses are not mandatory for students with demonstrated skill deficiencies, while in the others, students, professors, and colleges often find ways to exempt students from the courses even if they meet the eligibility requirement for them. Thus it is reasonable to conclude that two thirds or more of community college students enter college with academic skills weak enough in at least one major subject area to threaten their ability to succeed in college-level courses.

Progression through Developmental Education

Students struggle, in particular, with developmental math courses. NELS data show that 68 percent of students pass all of the developmental writing courses in which they enroll and 71 percent pass all of their developmental reading courses, but only 30 percent pass all of their developmental math courses (Attewell et al., 2006).

Students are often referred to a sequence of developmental courses of increasing difficulty in one subject area because their skills are considered to be more than one level below college-entry level. Yet some students never even

begin their developmental course sequence. In the Achieving the Dream sample, one fifth of all students referred to developmental math and one third of students referred to developmental reading did not enroll in any developmental course within three years. Many others failed to complete their sequence. Only 44 percent of those referred to developmental reading completed their full sequence, and only 31 percent of those referred to developmental math completed theirs. Further, the more courses in the referred sequence, reflecting a greater skills deficiency, the more likely students were to fail to complete it.

Degree completion for remedial students is also rare. Less than one fourth of developmental education community college students in the NELS sample completed a degree or certificate within eight years of enrollment. In comparison, almost 40 percent of community college students in the NELS sample who did not enroll in any developmental education course completed a degree or certificate.

The Effectiveness of Developmental Education

Even though developmental education students are less likely than non-developmental students to complete degrees, it is not necessarily true that developmental education itself contributes to worse outcomes or even that it does not improve student outcomes. It is possible that developmental students, who have, on average, weaker skills than other students, would have even poorer outcomes if they did not avail themselves of remedial services. Indeed, some research that controls for entering academic skills and other demographic characteristics has found that developmental students in community colleges do as well as students who never participate in developmental education. Controlling for student characteristics, Attewell and his colleagues (2006) found that students who enroll in developmental reading are more likely to earn a degree, though those who enroll in developmental math were found less likely to do so.

Such studies do not, however, account for unmeasured differences that may exist between developmental and non-developmental students (more motivated students might, for example, find ways of avoiding remediation, thus skewing the results). Several recent studies address this problem. They use large, longitudinal state datasets and quasi-experimental methods to derive more reliable estimates of the effects of developmental education on *those students near the cutoff score* for developmental placement. These include studies of Ohio by Bettinger and Long (2005), of Florida by Calcagno and Long (2008), and of Texas by Martorell and McFarlin (2007).

The studies give mixed results — the Texas and Florida studies suggest students gain little from developmental classes while the Ohio study shows some positive results. Yet, among other limitations, these studies do not provide much insight into the effectiveness of developmental education for students with very weak skills. Moreover, these studies measure the *average* effects of all developmental education offered in a state, which actually represent a broad range of remedial programs and pedagogies.

There is in fact no strong consensus about how to carry out developmental education most effectively. As a result, the content and organization of remediation varies widely. Many in the field argue that assessment should be mandatory and that appropriate counseling and support services should be made available. The use of learning communities to provide developmental education has also gained wide attention recently, and some researchers are enthusiastic about this practice. An MDRC random assignment study of a learning communities program provides some evidence for its effectiveness (see Scrivener, Bloom, LeBlanc, Paxson, Rouse, & Sommo, 2008). But with the exception of this MDRC study, there is very little research that reliably measures the causal impact of different approaches to remediation. Still, if particular practices really are effective, the disappointing research on the overall effects of remediation suggests that they have not so far been widely adopted.

The Costs of Developmental Education

The modest benefits of developmental services need to be evaluated in relation to their significant costs to the state and the institution, and especially to students. A recent study calculated the annual cost of remediation at $1.9 to $2.3 billion at community colleges and another $500 million at four-year colleges (Strong American Schools, 2008). Reports from various states cite expenditures of tens or hundreds of millions of dollars annually.

Developmental education carries significant financial and psychological costs to students. While in developmental classes, students spend money, accumulate debt, and, in many cases, sacrifice financial aid eligibility. In addition, taking developmental courses lengthens the time required to complete a degree, which has been shown to be a factor in reducing the probability of degree completion (Horn & Nevill, 2006). Moreover, students referred to developmental classes, most of whom are high school graduates, are often discouraged when they learn that they must delay entrance into credit-bearing classes; they may become frustrated and leave college (Deil-Amen & Rosenbaum, 2002). Thus, resistance to remediation may help explain the low enrollment and high attrition rates of developmental students, and it may be a reason why faculty and advisors help students avoid developmental education by using loopholes and exceptions in regulations and guidelines (Perin, 2006).

Discussion and Conclusion

Summary of Findings

The broad picture of developmental education outlined here shows an extensive system that involves thousands of dedicated counselors and professors carrying out a crucial community college function. At the same time, however, the system is characterized by uncertainty, a lack of consensus on either the definition of being college ready or the best strategies to pursue, high costs, and varied and often unknown benefits. This picture is further complicated by the bewildering plethora of remediation assessments and cutoff points used around the country, many of which may have only a weak relationship to subsequent educational performance. Indeed, many students who test out of remediation nonetheless struggle in their college courses, and their educational outcomes are poor. Thus, a sharp distinction in the services received by developmental and non-developmental students is not justified.

Overall, fewer than one half of students who are referred to developmental education complete their recommended sequence. What is more, many students who do complete their developmental courses do not go on to enroll in the associated college-level courses. The evaluation data concerning developmental education are equally

discouraging. Much of the research on developmental education is suggestive but cannot reliably measure the effect of remediation or differentiate among various approaches. The handful of more definitive studies shows mixed results at best.

Although this picture is pessimistic, there are some reasons to temper that pessimism. Findings from Ohio (Bettinger & Long, 2005) and several studies of individual colleges show more positive results. Also, it may be that students make significant progress in developmental education, but their skills still do not reach the college-level standard. Getting a student from a sixth to a tenth grade math level is a significant accomplishment, even if such improvement is not enough to provide a solid foundation for a college education. Finally, the aggregate results found in large studies can obscure strong programs at individual colleges.

Recommendations

The above caveats notwithstanding, it is difficult to escape the conclusion that the developmental function in community colleges is not working well. The analysis presented here suggests some promising areas for exploration and innovation, however. I suggest that any comprehensive strategy to improve the developmental function in community colleges should include a reform and research agenda focused on the following three recommendations:

1. Rethink assessment, focusing on understanding what students need in order to be successful in college rather than simply concentrating on placement within the sequence of a curriculum. Two students with the same score on an assessment test may need different types of assistance to be successful in college-level courses, as evidenced by the weak relationship between test scores and subsequent measures of student success in developmental and college-level courses. Moreover, the blizzard of assessments and cutoff scores suggests that there is no consensus about what constitutes being college ready or how to measure it. The growing national movement for better high school-college alignment may offer a framework within which progress can be made on answering these questions (Achieve, 2006; Kirst & Venezia, 2004).

2. Abandon the dichotomy between developmental and college-ready students for a wide range of students above and below current developmental cutoff scores by opening college-level courses to more students and by incorporating academic support assistance into college-level courses. Current policies on assistance distinguish between developmental and college-ready students as identified by assessment cutoff scores. Yet the discouraging evidence about the effectiveness of developmental education (especially for students who score around the cutoff point), the uncertainty about assessment strategies, and the absence of any clear relationship between student assessment scores and student outcomes, suggest that a policy based on categorizing students as developmental or college-ready is misguided. Students who score even slightly below the cutoff point are asked to spend time and money on services of dubious value, while those who score above it are assigned to college-level courses without special help, even though many of them have weak academic skills.

There are many approaches to incorporating extra support into regular courses. Perhaps the best known strategy — and one demonstrated to be effective for first-level college courses — is the supplemental instruction model, which relies on peer tutoring (International Center for Supplemental Instruction, 2006). Another approach, used by the Digital Bridge Academy at Cabrillo College in California, draws on a variety of experiential learning and other pedagogic strategies to incorporate learning into the pedagogy of actual college-level courses (Navarro, 2007). This approach, which is consistent with the accelerated learning strategy used in the K-12 sector and which has been found to have positive effects, eschews special programs for weaker students, maintaining that good pedagogy for those students is the same as it is for advanced students (Bloom, Rock, Ham, Melton, & O'Brien, 2001). The principle of dual enrollment or early college is also based on the notion that students benefit from being pushed to achieve at levels that traditionally were not thought to be appropriate for high school students. Preliminary assessments of the effect of dual enrollment on postsecondary outcomes are also encouraging (Karp, Calcagno, Hughes, Jeong, & Bailey, 2007).

3. For those students whose skills are so weak that they could not be successful even in augmented college-level courses, explicitly work to minimize the time necessary to prepare students for entry into those courses. Little is known about the effects of remedial courses on students with very weak skills, although there is evidence that students who are referred to developmental courses two or three steps below college-level rarely complete introductory college courses and are even less likely to complete degrees.

One objective should be to move low-skill students into college-level courses as soon as possible in order to minimize the expense and discouragement associated with remediation. The suggestions outlined above will facilitate this process. In addition, many colleges are now experimenting with accelerated strategies, and the results are encouraging. They include intensive bridge programs in the summer, such as the aforementioned Digital Bridge Academy, which includes a two-week intensive immersion program (Navarro, 2007). Since many students who complete one level of remediation fail to show up for the next level, another simple way to accelerate movement through various levels of remediation is to combine levels or eliminate any elapsed time between levels. At the Community College of Denver, for example, students can combine two levels of developmental math, reading, or writing to accelerate their progress (Baker & Brancard, 2008).

Contextualization of developmental education is another way to engage students and to allow them to make progress in their areas of interest while they are still in remedial classes. Indeed, some research suggests that teaching to adults is more effective when it is linked to meaningful applications (Rubenson & Schutze, 1995).

Growing Interest in Reform

Introducing these and other needed reforms will be an extremely difficult task, but now may be a good time to work on improving the developmental education function of community colleges. The last few years have seen a dramatic growth of interest in the strengthening of weak academic skills of college students. The promising practices discussed above are products of that new interest. Several states, including California, Texas, Tennessee, and Kentucky, are organizing comprehensive initiatives to improve their developmental programs.

In addition, a growing number of private foundations and the federal government have turned their attention to this problem, and as a result colleges all over the country are trying new approaches to developmental education. Developmental education is a core part of Achieving the Dream, a $100 million initiative, funded by Lumina Foundation for Education and many other funders, to improve student success at 84 community colleges (www.achievingthedream.org). The U.S. Department of Education's Institute of Education Sciences has funded a National Center for Postsecondary Research (NCPR, www.postsecondaryresearch.org), whose research is focused mainly on evaluating initiatives (primarily but not exclusively in community colleges) to improve outcomes for students with weak academic skills. The Bill & Melinda Gates Foundation has begun a major initiative designed to improve college opportunities for low-income youth and young adults. All these undertakings illustrate the growing focus on developmental education in policy, practice, and research.

There is also a growing commitment by colleges, state agencies, and researchers to more detailed analysis of student progression through college and to more systematic and rigorous evaluation of program interventions. The recent interest in using state longitudinal unit record datasets provides a tremendous opportunity to increase our understanding of the barriers that students with weak academic skills face. Some of the best research discussed above was based on these state datasets. All of these developments provide an opportunity for a major and much needed effort to rethink and strengthen developmental education.

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Associated Learning Project

(http://faculty.ccbcmd.edu/~padams/ALP/Site%20Folder/Fall%202010/others/toc%20others.html)

The Accelerated Learning Project (ALP) is a form of mainstreaming developed at the Community College Baltimore County. ALP attempts to combine the strongest features of earlier mainstreaming approaches and, thereby, to raise the success rates and lower the attrition rates for students placed in developmental writing.

The table below illustrates the structure of the ALP courses.

Under ALP, students whose placement is in the upper level developmental writing course are invited to register for one of the designated sections of ENG 101. Participation in ALP is completely voluntary, and any student placed in the upper-level writing course, including those who barely made it into the course, is eligible These ALP sections of ENGL 101 have 8 seats reserved for ALP students, shown in pink in the table above. The other 12 seats are designated for students whose placement is ENG 101, shown in blue.

As far as we know, ALP is the only mainstreaming program that places basic writers into a section of ENGL 101 along with students whose placement is ENGL 101. We think this is an important feature of our program. We do lots of group work in our writing classes, and we think it works much better in a section with some strong writers than it would in a section of all basic writers. We also think we ameliorate some of the stigmatizing effects when students are placed in a section composed completely of basic writers.

These same eight ALP students also register for a section of the ALP companion course which meets in the class period immediately following the ENGL 101 section. The same instructor teaches both the 101 and the companion course. this section functions more or less as a workshop to provide the support the basic writers need to succeed in ENGL 101.

An important feature of ALP is the relationship that develops among the eight students, who take the two courses together, and also between them and the instructor, who teaches both sections. We think this bonding is a major contribution to the persistence of these students.

The ENGL 101 class is conducted just like a regular 101 class. We consider it essential that we maintain the same standards and cover the same material in the 101 class as we would in any 101 section.

The instructor for the companion course has one goal: to do whatever will maximize the ALP students' likelihood of success in the 101 class. Typically, what we do in the companion course includes some of the following:

- answering questions left over from the 101 class
- discussing ideas for the next essay in 101
- reviewing drafts of essays the students are working on for 101
- writing short papers that reinforce what has been discussed in the 101 class or prepare for what will be discussed in the 101 class
- working on grammar and punctuation

- discussing how to succeed as a college student
- discussing problems interfering with the students' progress in 101

Students pay for six credits for the two courses. The ENG 101 counts as a three-credit course, but they do not receive credit for the companion course; in the state of Maryland, college credit cannot be awarded for developmental courses.

Faculty receive 3 credits on-load assignment for the 101, but only 2 credits for the companion course. Even though the companion course meets for three hours per week, faculty have found this arrangement equitable because of the small class size and because it is not a completely separate preparation. Even more important, most faculty find teaching in ALP to be the most rewarding teaching they have every done.

Results

For a comparison group we used the 1,023 students who took the traditional version on ENGL 052 in fall of 2006. There results are presented in table 1 below.

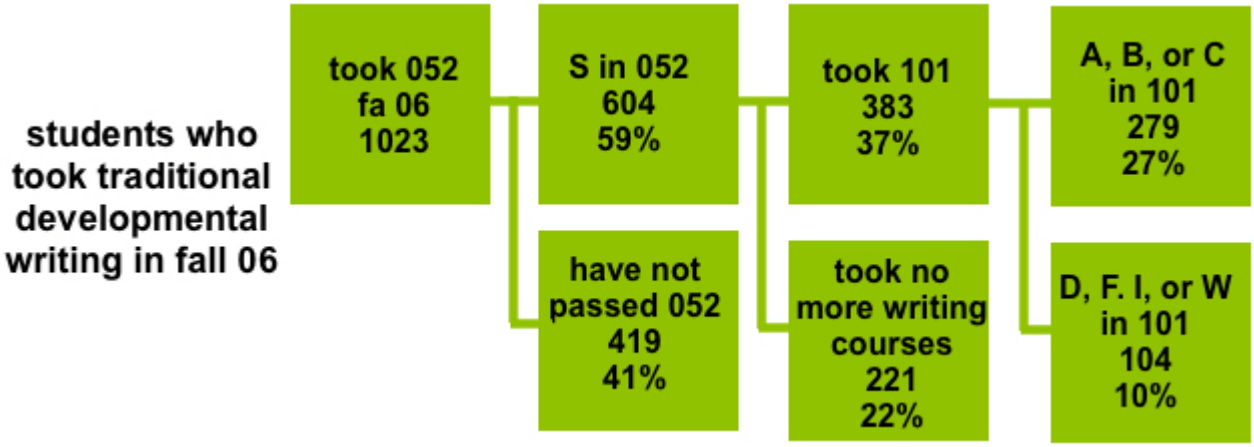

Table 1: results for students who took tradtional ENGL 052 in fall 2006

Table 1 reveals that only 27% of the original 1,023 students who took ENGL 052, our traditional upper-level developmental writing course, had passed ENGL 101 within three years. Perhaps the most surprising fact presented in Table 1 is that 221 students (22% of the original group) actually passed ENGL 052 and then gave up without ever even attempting ENGL 101.

Table 2 presents the corresponding data for the 227 students who took the ALP version of developmental writing during the first four semesters it was offered.

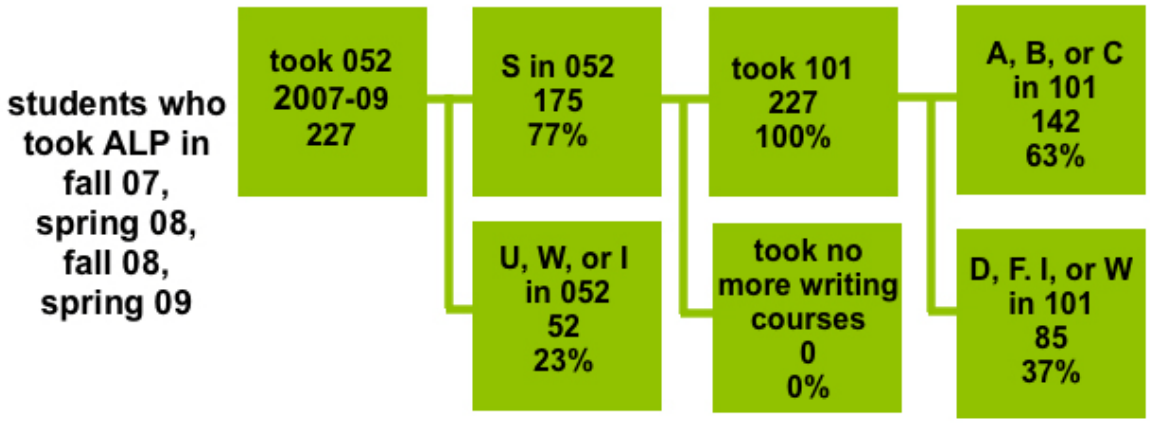

Table 2: results for students who took ALP from fall 07 to spring 09

Table 2 reveals that 63% of the 227 students who took the ALP route passed ENGL 101 withing two years or less. Note also that no students passed ENGL 052 and then failed to register for ENGL 101, because the program doesn't give them an opportunity to; they take the two courses simultaneously.

Table 3 presents data for the same students disagregated by semester.

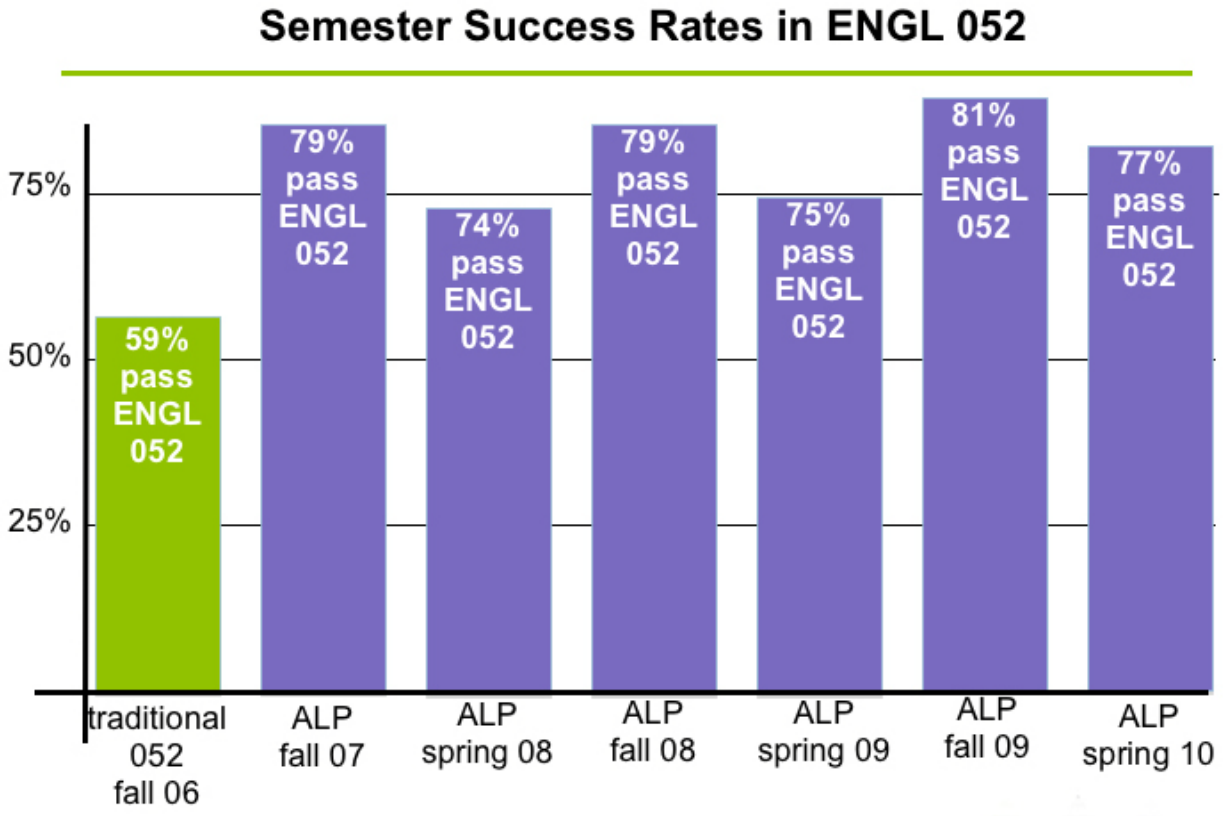

Table 3: Success Rates in ENGL 052 by Semester

Table 3 shows that for each semester that ALP has been offered, success rates for students in the ALP sectiions have exceeded those for students in the tradition ENGL 052 by 15 to 22 percentage points.

Table 4 presents the corresponding data for ENGL 101.

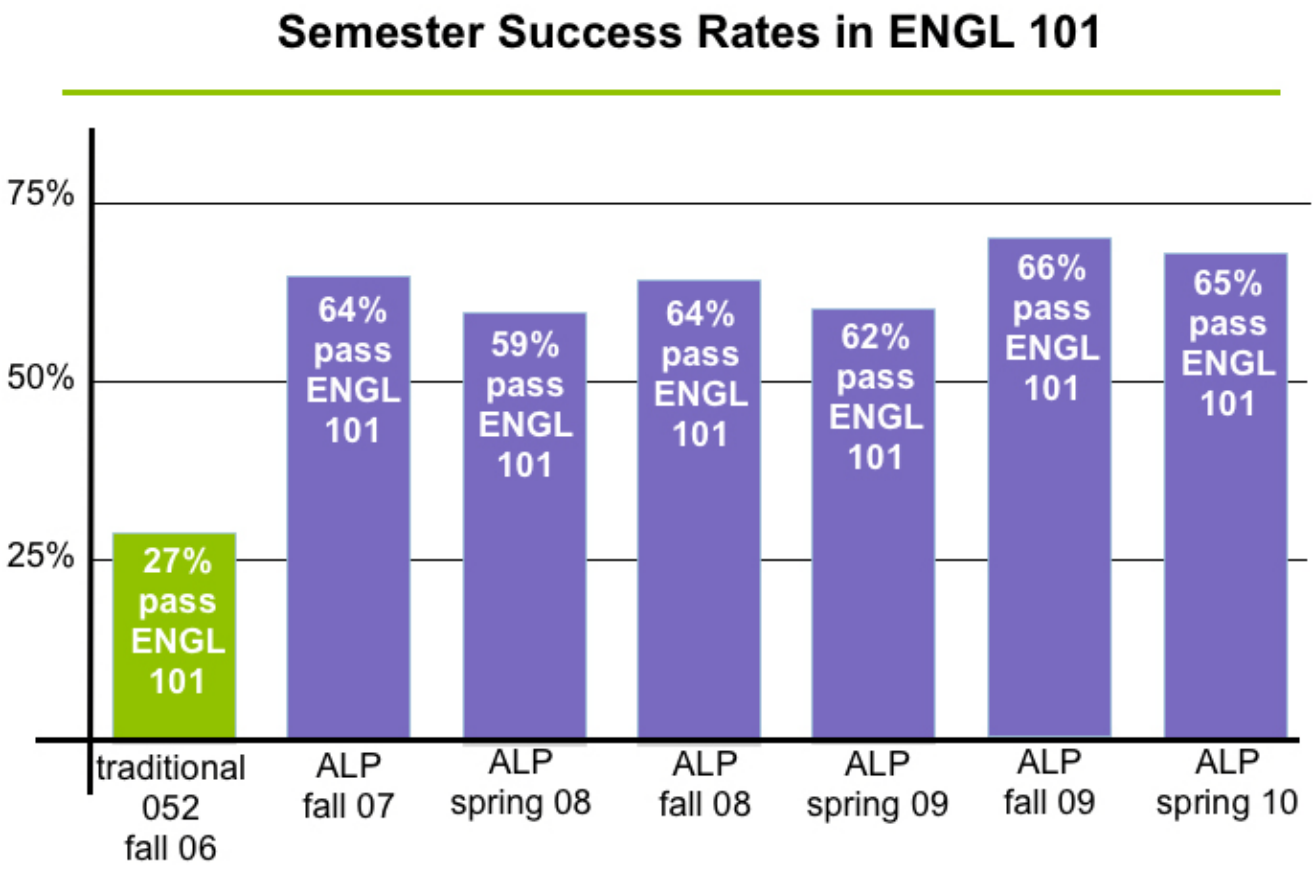

Table 4: Success Rates in ENGL 101 by Semester

Pass rates more than double the rate for students in traditional ENGL 052 have been consistent over six consecutive semesters.

Finally, Tables 5 and 6 compare the performance of ALP students in EnNGL 101, the second semester credit writing course.

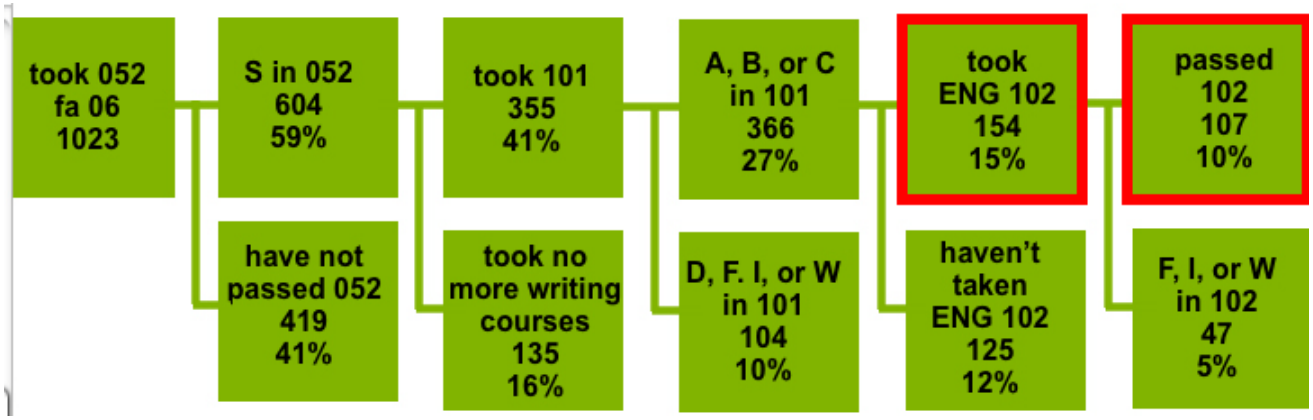

Table 5: ENGL 102 Results for Students Who Took Traditional ENGL 052

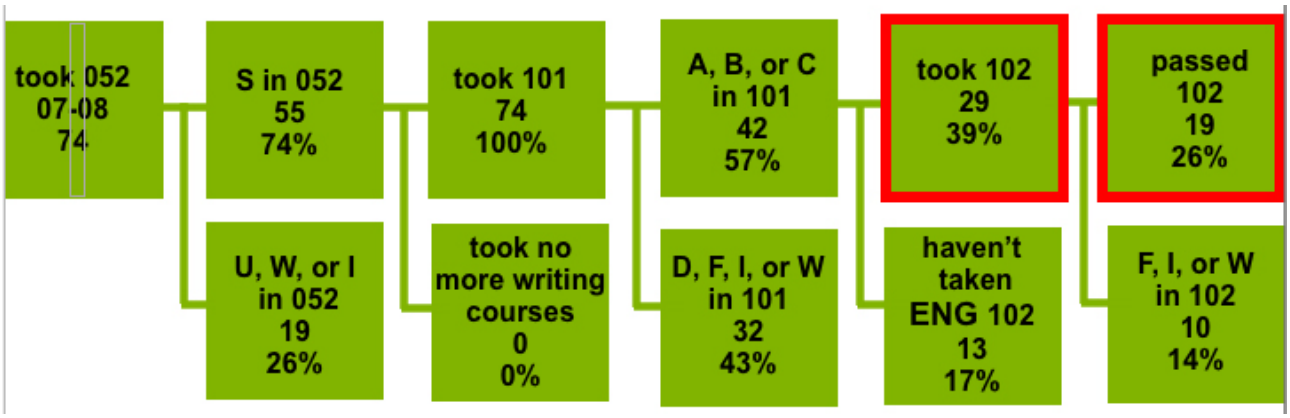

Table 6: ENGL 102 Results for Students Who Took ALP

Tables 5 and 6 reveal that the higher success rates of ALP students in ENGL 101 continue and, in fact, become even greater. While only 15% of the original students who started in ENGL 052 ever attempted ENGL 102, 39% of the original ALP students did. While only 10% of the original students who started in ENGL 052 had passed ENGL 102 by spring of 2009, 26% of the ALP students had.

It should be pointed out that of the students from the traditional group who attempted ENGL 102 (154 students), 69% (107 students) passed the course. Of the ALP students who attempted ENGL 102 (29 students), 66% (19 students) passed. While this difference is not statistically significant, it does suggest that ALP is not producing stronger writers. Rather, ALP produces a much higher percentage of students who write well enough to pass.

Colleges That Are Adopting/Adapting ALP

Bergen Community College (NJ)
Blue Ridge Technical and Community College (WV)
Brookdale Community College (NJ)
Cayuhoga Community College (OH)
Community College of District of Columbia (DC)
Community College of Vermont (VT)
El Paso Community College (TX)
Gateway Technical and Community College (KY)
The Graduate School (DC)
Ivy Tech Community College (IN)
Jackson Community College (MI)
Kapiolani Community College (HI)
LaGuardia Community College (NY)
Leeward Community College (HI)
Lone Star College Tomball (TX)
Metropolitan Community College (MO)
Missouri State University-West Plains (MO)
Northampton Communiy College (PA)
North Central State College (OH)
North Central Michigan College (MI)
Northeast Lakeview College (TX)
Patrick Henry Community College (VA)
Prairie State College (IL)
Santa Barbara Community College (CA)
Springfield Technical and Community College (MA)
SUNY Adirondack (NY)
Tulsa Community College (OK)
Valley Forge Military College (PA)
West Kentucky Technical and Community College (KY)
West Virginia Northern Community College (WV)
Windward Community College (HI)
York Technical College (SC)

Tennessee Board of Regents:
Developmental Studies Redesign Initiative

(http://www.thencat.org/States/TN/Abstracts/APSU%20Algebra_Abstract.htm)

Austin Peay State University

Course Title: Elementary Algebra and Intermediate Algebra
Contact: Harriett McQueen

Project Abstract
Final Report (as of 6/1/09)

Project Abstract

Austin Peay State University (APSU) plans to redesign two developmental math courses, Elementary Algebra and Intermediate Algebra. At least 900 students each year are placed in these two courses based on admissions test scores (ACT, SAT or Compass) in mathematics.

These developmental courses face two academic problems. University retention data show that approximately one-half of the students either fail or withdraw, and many of these students withdraw from the university before completing a baccalaureate degree. A second problem is that the links between the developmental courses and APSU's core college-level core mathematics courses, Fundamentals of Math and Elements of Statistics, are weak.

The redesign model selected by APSU is based on the Structured Learning Assistance (SLA) model developed by Ferris State University in Michigan. APSU plans to eliminate the developmental courses, which carry no university credit. Enhanced sections of the two core college-level courses, Fundamentals of Math and Elements of Statistics, will be created for students whose admissions test scores place them in developmental mathematics. These core courses will not change in content but will be linked to SLA workshops. Students requiring developmental instruction will enroll in the core course required for their major and receive supplemental academic support on a just-in-time basis to remove the deficiencies in mathematical competencies required for success in the core course. These workshops will consist of computer-based instruction (*MyMathLab*), small-group activities and test reviews to provide additional instruction on key mathematical concepts within the courses. The statistics workshops will also use *Fathom*and *Minitab* in addition to *MyMathLab*. SLA workshops will be facilitated by students who have excelled in math and have been recommended by math faculty.

During the initial meeting of the workshop, students will be assessed to determine their specific math deficiencies. The math faculty have collectively determined the prerequisite competencies that are required in order for students to successfully complete each of the two core math courses involved in the course redesign. Only the deficiencies which are deemed necessary for success in the core mathematics course will be addressed during the workshops. Students will be individually assigned modules within *MyMathLab*based on the results of the assessment. Students will complete the modules on a just-in-time basis so that they are prepared to use the associated mathematics skills as the core course requires. In addition, the workshop leader will review the more difficult concepts that were covered during class instruction. Just-in-time instruction on prerequisite competencies is designed so that students will use the concepts during the following class session, which in turn will help them see the value of the workshops and motivate them to do the exercises.

The redesigned courses will encourage active learning. They will enhance each student's learning experience by removing deficiencies in mathematical competencies required for success in the core courses. Students will receive prompt feedback on all of the learning activities as well as individualized support. Consistency across all sections will be provided through

standardization of small group activities and instruction. APSU expects the redesigned courses to increase the student success rates in mathematics, increase student retention at the university and decrease the amount of time required to complete the baccalaureate degree.

Student learning will be assessed by comparing baseline data with data from redesigned sections in both the pilot and full implementation phases. Comparison data will include: the percentage of students completing developmental requirements as well as the core mathematics requirements; student retention rates; mean and standard deviation of final grades in core mathematics courses; student performance on common content items on final exams; pre- and post-test results on prerequisite competencies; and the correlation between workshop attendance and course grade.

The redesigned courses will decrease instructional costs from $402,804 to $193,556, a 52% reduction. These savings will be achieved by eliminating the Elementary Algebra and Intermediate Algebra courses, reducing the number of developmental sections from 52 to 0. Thirteen enhanced sections of Fundamentals of Math and 21 enhanced sections of Elements of Statistics will replace the developmental sections. The cost of the redesigned courses includes only half of the 34 enhanced sections (since half of these sections would have been offered in the traditional format for the 50% of developmental students who previously enrolled in these two courses) plus the cost of the SLA workshops for 17 of the 34 sections. In addition, 70 classrooms will become available each week when the supplemental workshops replace full sections. The savings will be used to expand the mathematics department, improve academic advising, and improve the collection of data about student retention initiatives.

Final Report (as of 6/1/09)

Impact on Students

Prior to the redesign, students were required to complete one or more developmental courses before enrolling in a core mathematics course. The success rates for the developmental courses were 53% for Elementary Algebra and 51% for Intermediate Algebra.

Because Austin Peay's redesign eliminated developmental math courses completely, the team did not have comparable data on student learning outcomes for the traditional and redesigned courses. Instead, they were able to compare how well developmental math students performed in two subsequent college-level courses both before and after the redesign. To do this, the team calculated a success rate for what percentage of the entire developmental math population was successful in the two core courses, taking into account that a significant portion of them never enrolled in a college -level math course.

This calculation showed that the percentage of students who succeeded (grade of D or better and completed the requirements for removing deficiencies in the SLA format) in the redesigned mathematics courses, enhanced Mathematical Thought and Practice or enhanced Elements of Statistics, was significantly higher than the success rates that occurred when students were required to complete developmental mathematics (Elementary Algebra and/or Intermediate Algebra) before enrolling in the college-level courses.

	Traditional		Redesign		
Mathematical Thought and Practice	**2005-2007**	**Fall 2007**	**Spring 2008**	**Fall 2008**	**Spring 2009**
# of students		271	232	221	202
Success rate	33%	74%	65%	72%	71%
Elements of Statistics		**Fall 2007**	**Spring 2008**	**Fall 2008**	**Spring 2009**
# of students		237	191	245	290
Success rate	23%	52%	56%	49%	57%

Prior to the redesign, 33% of developmental students who enrolled in Mathematical Thought and Practice successfully completed the course. After the redesign, that rate averaged 71%. Prior to the redesign, 23% of developmental students who enrolled in Elements of Statistics successfully completed the course. After the redesign, that rate averaged 54%.

Students were considered successful only if they removed mathematics deficiencies (determined by post-testing) and earned core course credit. Students who achieved a grade of A in the core course were considered to have removed their mathematics deficiencies without demonstrating deficiency removal on the post-test.

The success rate in Mathematical Thought and Practice of those students who completed the traditional Intermediate Algebra was 85% compared with the success rate of students who removed mathematics deficiencies by enrolling in enhanced Mathematical Thought and Practice, which averaged 71%. The success rate in Elements of Statistics of students who completed the traditional Intermediate Algebra was 56% compared with the success rate of students who removed mathematics deficiencies by enrolling in enhanced Elements of Statistics, which averaged 54%. However, as noted in fall-to-fall retention data shown below, almost half of the students who were required to enroll in developmental courses in the traditional format did not return the following fall. Thus, many students who were required to enroll in six hours of developmental courses or who were unsuccessful in the first attempt never attempted a core course.

Improved Retention

Prior to the redesign, the percentage of Elementary Algebra students who received a grade of D or higher was 53%. For Intermediate Algebra, it was 51%. After the redesign, the percentage of students in Mathematical Thought and Practice who received a grade of D or higher (thus successfully removing the mathematics deficiency by completing the core course) was 69%, In Elements of Statistics, it was 54%

The fall-to-fall student retention rate for students who enrolled in the developmental math courses under the traditional format never exceeded 59%; thus, 41% of those students (approximately 200 students) never attempted a core math course. During AY 2006-07, 57% of students who had been enrolled in a traditional developmental math course returned to the university the following fall. During AY 2007-08, 66% of developmental math students returned to the university the following fall after completing the enhanced mathematics courses.

Impact on Cost Savings

APSU saved approximately $209,248, a 52% reduction. The university realized the savings by:

- **Eliminating 52 developmental math sections each year, which previously cost $402,804 ($384,500 for the instructors and $18,304 for the tutors who supported the courses.)**

- **Adding 32 enhanced sections of the two core courses, six of Mathematical Thought and Practice and 10 of Elements of Statistics. (The cost of the redesign includes only half of these enhanced sections since half of these sections would have been offered in the traditional format for the 50% of developmental students who previously enrolled in these two courses.) The cost of six enhanced MT&P sections and 10 enhanced Statistics sections was $121,956.**

- **Adding 32 student-led SLA workshops required as a co-requisite with a core mathematics course, which cost $71,600.**

- **The total cost of the redesign was $193,556.**

The computer labs in which the SLA instruction took place were previously used for computer-based developmental courses. Thus, no additional expense was incurred.

In addition, reducing the number of sections offered saved classroom space. Estimates indicate that the university saved 70 classroom hours per week with the redesign.

Of equal importance is the cost savings to students. Students no longer spend one or two semesters (or more, if they needed to repeat the course, which many of them did) in non-university level courses that do not count toward a degree. Thus, students are saving both time and money with the redesign.

These savings enabled the mathematics department to add five Ph.D. level faculty positions and to eliminate temporary and adjunct positions. In addition, APSU added one position to its institutional research office, a supervisor of Structured Learning Assistance and three academic advisors in the schools of nursing, education and business.

Lessons Learned

Pedagogical Improvement Techniques

- ***Structured Learning Assistance*. Rather than requiring students with math deficiencies to enroll in developmental courses which did not count toward a degree, APSU's redesign placed students in core mathematics courses needed to complete a baccalaureate degree and provided support to help them succeed in those courses. The support, Structured Learning Assistance (SLA ,) was a co-requisite for the core course. Students were able to remove their deficiencies while completing the core mathematics course. The required participation in SLA permitted students to address the mathematics competencies in which they were deficient when it was covered in the core course meeting. SLA workshops were facilitated by students who had excelled in mathematics and had been recommended by mathematics faculty. Each SLA leader was assigned to one enhanced mathematics section and attended each class meeting with the students enrolled in the SLA workshop. During the workshop, the SLA leader reviewed the more difficult concepts as covered during class instruction. One hour each week was set aside for collaboration between the faculty member teaching the course and the SLA leader. During the pilot for Mathematical Thought and Practice, the professor realized that the SLA leader could also serve very effectively as a peer-tutor inside the classroom. Thus, the SLA leader began routinely moving between groups and providing assistance. Students felt very comfortable asking the SLA leader for help in the classroom as well as in the workshop. During training conducted prior to the beginning of each semester and during monthly in-service training, SLA leaders learned to use instructional material appropriately during their workshops.**

- ***Modularization.* The APSU mathematics faculty determined the prerequisite competencies that were required in order for students to successfully complete each of the two core mathematics courses and developed a prerequisite competency test for each course. During the initial meeting of the workshop, students took an assessment to determine their proficiency in the prerequisite competencies. Students then received a printout indicating their scores in each competency group and were assigned modules in *MyMathLab* based on assessed needs. Students received individualized computer-based instruction on a "just-in-time" basis so that they were prepared to use the math skills required by the course topic. While each student was provided an individual list of modules to complete, all of the modules were available to every student so that they could review concepts if they felt the need for further assistance.**

- ***Using instructional software to promote active Learning*. Instructional software, including *MyMathLab*,*Minitab* and *Fathom*, was used in the redesign to increase active participation by students.*MyMathLab* software is web-based and therefore is available to students from any computer with internet access. Students were excited about the opportunity to access *MyMathLab* from their home computers and to work on math at home as well as in the workshops. In addition, students often sought more opportunities to work on math by working in the lab beyond the required participation. Elements of Statistics workshops used *Fathom*, in addition to *MyMathLab*, to provide learning opportunities. *Fathom* software allows students to explore statistical concepts and use charts and graphs to visualize statistical information. In addition to using software to provide active-learning experiences, small-group activities in the SLA workshops allowed students to work with math concepts. Only a limited amount of time in each workshop was allowed for question and answer periods; the majority of the time was allocated for active engagement with mathematics.**

- ***Providing students with individualized assistance*. The redesign used computer-based instruction coupled with peer support to provide students with individualized assistance in the classroom and in the workshop. During the workshops, students received immediate computer-based feedback on each exercise worked in *MyMathLab*. If the computer did not adequately answer their questions, the SLA leader was available to work with students. The SLA leader also provided feedback to the students during small-group activities. Some of these activities were designed to produce disequilibrium in the students as they struggled with a mathematical concept. The SLA leaders did not provide answers but rather provided prompts to guide students who became bogged down on an exercise.**

Cost Savings Techniques

APSU eliminated 52 developmental math sections per year. Rather than requiring students to enroll in developmental courses which did not count toward a degree, the APSU redesign placed students in the core mathematics course required for their major with a co-requirement of Structured Learning Assistance (SLA) workshops. Students were able to remove their deficiencies while completing the core mathematics course. Successful removal of the deficiency required students to pass the core course in which they were enrolled as well as all the workshop requirements including a post-test.

Implementation Issues

- ***Creating course-specific assessments*. After mathematics faculty identified the competencies and requisite skills for core courses, an assessment had to be designed to identify the skills that each student lacked. This was more specific than the ACT score that placed them in developmental math courses.**

- ***Developing SLA workshop materials.*** **Developing workshop materials was a critical implementation issue to be sure that students received appropriate instruction on course pre-requisite competencies on a just-in-time basis.**

- ***Building faculty consensus*****. Bringing all groups affected to the table to implement the redesign was an ongoing implementation issue.**

- ***Registration issues*****. Since students needed to enroll in an SLA workshop when they enrolled in the enhanced section of the core course, the registrar had to develop measures to direct students to the appropriate course sections, based on mathematics placement scores, and to properly record student performance within Banner.**

- ***Staffing issues*****. There are now an increased number of students who are able to enroll in college-level mathematics during any semester. Identifying qualified students to serve as SLA leaders at the rate of pay APSU could offer proved difficult. Competent mathematics students often have other more lucrative work opportunities.**

- ***Facilities*****. Computer labs were equipped in 2005 when the traditional developmental math courses attempted an initial redesign. When an older building was renovated, two classrooms were converted into high tech classrooms and assigned for use for SLA workshops. The equipment previously used in developmental math courses was moved to the newly renovated building.**

Sustainability

The TBR Strategic Plan placed developmental studies in the community college; the closest TBR community colleges are in Nashville , more than 50 miles from Clarksville , where APSU is located. Retaining a way to address mathematics deficiencies at the university level provides higher education access for students who are time and place bound and most likely would not be able to attend the nearest community college. At this point, the university has no plans to change the way mathematics deficiencies are addressed.

Student success rates have improved as has the quality of instruction. The fall-to-fall retention rate of students with mathematics deficiencies is higher for students enrolling in enhanced core courses than it was for students who were required to enroll in developmental mathematics courses. Removing the requirement for non-university credit courses provided students the opportunity to enroll in a core mathematics course that is required for the baccalaureate degree and thus complete degree requirements in four years. Greater consistency has been achieved in multiple sections of courses as indicated by the use of common writing prompts in Mathematical Thought and Practice and common activities in Elements of Statistics. Common questions embedded in exams for both the enhanced and regular sections of the two core courses suggest that the same rigor is being maintained in both formats. Anecdotal comments from students suggest that the support they receive from SLA workshops has made a difference and enabled a higher level of success. Instructional considerations that must be addressed in the future have been identified.

In response to the redesign successes, the university applied for and received a $2 million Title III Grant, which will provide funding over the next five years to support course redesign. The focus of the redesign effort is on core courses which have D-F-W rates of 30 percent or more. Workshops on course redesign were provided for all faculty by Dr. Tristan Denley , Provost and Vice President for Academic Affairs and an NCAT scholar. Following the workshops, 11 faculty members submitted proposals to redesign courses. Five were accepted and will be piloted during the 2009-10 academic year. These courses include Elements of Statistics, Fundamentals of Public Speaking, General Chemistry, Human Anatomy and Physiology and Wellness Concepts and Practices. These redesigns are expected to achieve similar results as the math redesign: improved student learning and cost savings that will permit a redirection of funds to other academic initiatives.

NEW DEVELOPMENTAL MATHEMATICS PROGRAM AT THE UNIVERSITY OF MARYLAND, COLLEGE PARK

by William W. Adams

(http://www.maa.org/features/112103devmath.html)

We begin with a familiar story. A student, we call him Tom, arrives at the University, happy to begin his college adventure. Almost immediately he is confronted with the Mathematics Placement Exam, designed to see if he is ready to enroll in a general education mathematics course (or in a credit-bearing course required by his major). The results of the Placement Exam unfortunately indicate that Tom is not prepared for the course he wants, and he must instead take a Developmental Mathematics Course. The results: he faces a delay in completing the needed Mathematics course, he must take a course (for no credit) he feels he has already taken, and to add insult to injury, he must pay an extra fee for the developmental course. Unhappiness, frustration and despair set in, the course is treated as a lowest priority (and often failed because of it), and an angry and frustrated student emerges.

But what is the University to do? Without the procedure outlined above, Tom would register for a course he appears to be unprepared for. Data show that the result is frequently failure in the course, which would slow his matriculation and perhaps lead to his dropping out of the college. Like numerous other institutions in the nation, the University of Maryland, College Park (UMCP), has been faced with this problem for many years. The student frustrations often seem most acute for majors in the College of Arts and Humanities, whose majors often have no specific mathematics requirements other than the general education requirement. But it is also a common problem all over the campus of UMCP, as students are placed in courses below their expectations.

In the Fall of 2000 the University formed a campus committee to investigate, among other things, the issue of remediation in mathematics. Chaired by the dean of the college in which the Mathematics Department resides, the members included faculty, advising staff, and students from around the campus, including several mathematicians. The goal was to devise a plan that could be implemented for a large number of students, that would reduce the extra semester of developmental mathematics for many of these students, would be reasonably cost effective, and would not compromise teaching effectiveness in preparing the students for the course(s) they needed.

What emerged from committee discussion was a radical solution that completely cast aside the old Developmental Math program. It gained immediate strong support from the campus administrators both bureaucratically and monetarily. With great effort (including building a new computer laboratory, creating a new curriculum, training mathematics teachers and training advisors campus wide), the new program was put into place in Fall 2001. Now in Fall 2003 we see that the program has been very effective; this article is designed to describe the various features of the program, and include data substantiating the claims of success.

DESCRIPTION OF THE NEW PROGRAM

As before, all entering students are given the Placement Examination during orientation. About 20-25% of the entering freshman class (about 1000 students) are judged deficient in mathematics preparation for a general education math course. In the new program, of these students, roughly the lowest 40% are given a one full semester of Developmental Mathematics, which has been altered and which is called

MATH 003. The remaining approximately 60% of the students judged deficient are advised to go into one of four courses, MATH 010, 011, 013, or 015 (collectively labeled MATH 01X in this article) corresponding to the required credit courses listed below. Now we will describe these two components of the new program instituted in Fall 2001.

MATH 003: Rather than having a two-level Developmental Mathematics curriculum for the lower 40% of those students who were judged deficient by the Placement Examination, a single self-paced course with a computer platform was created. The students began their program and progress according to their own needs and abilities, under guidance of a professional mathematician and a cadre of assistants. The course was labeled MATH 003 and met for 6 hours per week in a computer laboratory.

When the students entered MATH 003, they were placed into one of five modules, depending on the general education course they were headed for. There are four of these courses:

MATH 110 (Elementary Modeling): generally a terminal general education course

MATH 111 (Probability): prepares a student for a Statistics course in the student's major

MATH 113 (College Algebra and Applications): prepares a student for elementary calculus

MATH 115 (Precalculus): prepares a student for engineering calculus

Four of the five modules were designed to prepare the students for one of these four courses. The fifth module was designed for those students as yet unprepared to succeed in the other four modules. In any case, the course grade (pass/fail) was based on written examinations, written (graded) homework, and attendance, in addition to success on the computer modules. It should be emphasized that the self-paced format of this course is critical for the implementation of the program for the other group of students to be discussed next. The success of this course is documented in data presented below.

MATH 01X: The remaining approximately 60% of those students not passing the Placement Examination were placed into a combination course we designated MATH 01X/11X, where the X represents 0, 1, 3, or 5. (Thus MATH 010/110 was a combination of a developmental mathematics course with MATH 110, etc.). The courses met 5 days a week, rather than the usual 3 days a week. The first 5 weeks of the course constituted MATH 01X, which reviewed the developmental mathematics topics (especially algebra) necessary for success in MATH 11X. Since the students enrolled in MATH 01X were in the upper 60% of the students with deficient placement test scores, we felt that there was a good chance that an intense 5-week abbreviated form of the Developmental Mathematics course would suffice. However, to be sure, and to be legitimate about allowing the students to transfer to a credit-bearing course after 5 weeks, they were required to take the Placement Examination again at the end of 5 weeks. The same cut-off scores were required for a student to move into the MATH 11X course as were required to enroll in MATH 11X during orientation. If the student did not achieve such a score, then the student was placed back in the self-paced MATH 003, with the good prospect of completing MATH 003 by the end of the semester.

To our surprise and delight, about 89% of the students passed the Placement Exam at the required level after 5 weeks of MATH 01X, so were allowed to proceed into the appropriate MATH 11X course at the beginning of the 6th week. By continuing to meet 5 days a week until the end of the semester, the MATH 11X course had approximately 45 sessions, which is about the number of sessions for the ordinary MATH 110 or 111 or 113 or 115 course during the full semester. Moreover, the students in

MATH 11X continued in the same room with the same teacher as before; the re-registration from MATH 01X to MATH 11X was handled by the department (and the course MATH 01X was erased from the student's record and was substituted by MATH 11X). As far as the student was concerned, he/she had one 5 day a week course that met for the entire semester. At the end of the term the student was given exactly the same uniform final examination taken by the regular MATH 11X students. As a result, our department could directly compare the results of the students who had to start with remediation with those who did not. And those who completed MATH 11X successfully had completed their Math requirement in one semester rather than two, as would have happened under the earlier regime!

Observation: A side benefit of the new program was the flexibility of choices for students. For example, if a student in MATH 015 was preparing for the Engineering Calculus, but either decided he/she did not want to go into Engineering or did not place into MATH 115 at the 5 week point, but did place into the MATH 113 course, the student could shift to the 5-day-a-week MATH 113. Similarly a student might move "up" from MATH 010 to MATH 113 if the 5-week placement score merited it. Also, a few students in MATH 003 finished their self-paced course by the 5 week point, and were allowed to move into the appropriate MATH 11X course beginning in the sixth week.

RESULTS AFTER TWO YEARS

First we record the scope of the new Developmental Mathematics Program in the academic year 2001/02:

Number of Students

Course	003	010	013	015	Total
Fall 2001	391	140	259	177	967
Spring 2002	214	92	92	57	455

(Note that the MATH 011 is not in the table since it was not included in the program until Fall 2002). The percentage of students who moved from MATH 01X into MATH 11X in Fall 2001 was 89%, and in Spring 2002 was 95%. These numbers were substantially higher than we had expected.

Second, in Fall 2001 both groups of students (those starting in MATH 01X and those starting in MATH 11X) took the same final examination, and were given course grades prepared from comparable bases. As the table below indicates, both groups had similar course

grades:

Table of ABC rates for Fall 2001

	finishing in 110	113	115	all 11X
starting in 01X	73%	69%	53%	65%
starting in 11X	57%	78%	54%	66%

More particularly, on the Fall 2001 final examination we obtained the following results: Those starting in MATH 013 got a median score of 76%, whereas those who started in MATH 113 got a median score of 77%. Similarly, those who started in MATH 015 got a median score of 66%, whereas those who started in MATH 115 got a median score of 68%. Also in MATH 110 the median scores on the final

were at least as high in the sections starting with MATH 010, and often better, than the median scores of those who went directly into MATH 110.

Observations: We emphasize a significant point: The students starting in MATH 01X had lower MATH Placement scores than the other MATH 11X students and so started with weaker math skills, and still performed similarly to the other MATH 11X students. For the spring semester 2002 the corresponding table of course grades is as follows:

Table of ABC rates for Spring 2002

	finishing in			
	110	113	115	all 11X
starting in 01X	48%	42%	37%	43%
starting in 11X	39%	46%	33%	40%

The fact that success in the Spring goes down is a familiar fact of university life. This spring group of students includes several mathematically weaker populations: the students who delay taking their Math requirements for one semester, the large group of students who had to begin in Math 003, and the freshmen and transfer students who begin at the university in the spring semester.

For Fall 2002 (the second year) the results were comparable to those in Fall 2001:

Table of ABC rates for Fall 2002

	finishing in			
	110	113	115	all 11X
starting in 01X	78%	65%	72%	72%
starting in 11X	72%	73%	51%	73%

What happened to students when they completed the MATH 01X/11X course successfully? The students who began in MATH 010 and completed MATH 110 fulfilled their Mathematics requirement in one semester instead of two and went away very happy with the new program. For most of the students who succeeded with the MATH 013/113 course, the elementary calculus course MATH 220 awaited them; similarly, for most of the students who succeeded with the MATH 015/115 course, the engineering calculus course MATH 140 awaited them. We gathered follow-up data on these two groups, both in terms of the percent of students who enrolled in MATH 220 (MATH 140) after completing MATH 113 (MATH 115), and the percentage of those who received an A, B, or C in the successor course:

Success of 013/113 vs 113 Students

	Percent who took Math 220	Percent with ABC in Math 220
F01 to Sp02 013/113	61%	65%
113	67%	54%
Sp02 to F02 013/113	49%	51%
113	37%	45%

Success of 015/153 vs 115 Students

	Percent who took Math 140	Percent with ABC in Math 140
F01 to Sp02 015/153	78%	55%
115	50%	72%
Sp02 to F02 015/115	54%	36%
115	37%	37%

Observation: Of those students starting in MATH 013 who took MATH 220, a higher percentage performed better than those students who started in MATH 113. This is in contrast with the students who started in MATH 015: one semester they performed much worse than those who had started in MATH 115, and the other semester the results were about the same. We note that the MATH 115 course is much more demanding than the MATH 113 course, and the low success rates in MATH 140 reflect the difficulty of catching up in a science/engineering track after inadequate high school preparation. We also note that the table indicates that the students who started in MATH 015 were much more devoted to pursuing their Engineering Calculus than the regular MATH 115 students.

Now we consider the results of the MATH 003 students. In the table, MATH 001 was comparable to high school Algebra I, and MATH 002 was comparable to high school Algebra II. In 2001 these two courses were supplanted by MATH 003.

Math 003 Follow-up

Math Course	Year	Percent with ABC Next Semester in Some Math Course
001	Fall 99 & 00	30%
002	Fall 99 & 00	47%
003	Fall 01	35%
003	Spring 02	38%

We recall that the students measured in the 003 rows are those who scored in the lowest 40% of those not successful in placing into a credit bearing course on Placement Examination, while the students measured on the top two rows include the higher 60%.

Comment: We also conducted surveys of the students. The students were generally positive about the new program. Those in the MATH 01X courses were especially pleased with the possibility of obtaining academic credit in one semester for the combined courses. Moreover, in general those in MATH 003 liked the "module" approach of the course, which was a feature they felt gave them more control over the pace of the course and the outcomes for the course. We also heard from many of the advisors around the campus who reported a large decrease in frustration levels for students forced into Developmental Math.

RESOURCES FOR THE NEW PROGRAM

The main expense in setting up the new program was in building two new dedicated computer labs for MATH 003. We obtained two rooms from the University and purchased 70 computers and the necessary furniture in order to outfit these rooms. We also had to purshase the computer program for the self-paced MATH 003 course. The remaining costs were relatively small and mainly involved developing the curriculum for the new courses. As for the ongoing costs, they were comparable to the costs for running

the old program. It should be noted that previously the students paid a fee for taking Developmental Mathematics, and that remained true for either MATH 003 or MATH 01X (and the fees were the same as before).

CONCLUSIONS

The main conclusion is that the new program prepared the students at least comparably well to the old one. But with the new program hundreds of students (373 students in Fall 2001 alone!) had completed their basic Math Requirement in one semester, rather than the two that all of these students would have needed under the old program. As a second measure of success of the new program, at the end of the Fall 2001 semester, 80% of the students placed in Developmental Math had either completed or were prepared to complete their Math requirement at the beginning of Spring 2002. By contrast in Fall 1999 only 64% of these students were even prepared to move on to their Math requirement in Spring 2000 (and, of course, none had completed it). This is also a dramatic improvement.

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Elizabeth Shearn is the person who developed the teaching materials for the MATH 003 course and has done studies on its effectiveness. Debra Franklin is the person who created the teaching materials for the MATH 01X courses. Mike Boyle and Bill Schildknecht were responsible for overseeing the program during its first semesters. One must also acknowledge the very creative committee and administrators, led by Dean Steve Halperin, for putting together this program. I would also like to thank Denny Gulick for invaluable help in preparing this report.

Developmental education has the mission of enabling underprepared students to acquire the capabilities necessary for college success; however, a growing number of research studies document its failure. Specifically, two thirds of community college students referred to a developmental mathematics sequence do not complete it.

In response to these findings, The Carnegie Foundation for the Advancement of Teaching, with the Dana Center as a principle design partner, has launched a comprehensive initiative to create two new pathways, the **Statway** and the **Quantway**, to enable developmental mathematics students to complete a credit-bearing, transferable mathematics course in one academic year while simultaneously building skills for long-term college success.

The Charles A. Dana Center
The University at Texas Austin
(http://www.utdanacenter.org/pathways/index.php)

PATHWAYS

Statway

The Statway is designed as a one-year sequence of college-level statistics melded with the necessary mathematics topics to support the learning of statistics. The pathway is designed for non-STEM students seeking a college-level statistics course who place into a beginning course in algebra. The outcomes in Statway have been designed to be as rigorous as those in a first course in college-level statistics. Statway includes transferrable, college-level content that meets the requirements of various academic programs and careers.

The Statway content focuses on an in-depth exploration of a critical set of core topics essential for understanding statistics. The mathematics learning outcomes in the Statway have been developed based on the mathematics needed in statistics and the mathematics students need broadly in college for success as productive citizens and in their academic programs.

The essential mathematics concepts are presented in the context of statistics or other appropriate contexts and integrated throughout in an order that differs from traditional courses. The fundamental mathematical ideas are established within statistical situations that adult students can relate to. One goal of Statway is to provide a mathematical experience that emphasizes the internal connections of mathematics to statistics, as opposed to a numerous, discrete set of procedures and memorization tasks.

Statway Course Design

The design of Statway was guided by evidence-driven processes, based on educational research findings and hypotheses, and informed by the experiences of seasoned developmental education and statistics educators. The foundation of Statway is based on several types of critical learning experiences: Productive Struggle, Explicit Connections to Concepts, and Deliberate Practice. The following set of Statway Design Principles facilitates the formation of these learning experiences:

- Statistics will be the focus of curriculum materials, with mathematics topics addressed as students need them to understand statistics.
- Instruction in statistics will make use of authentic contexts and real data.
- Specialized terminology, when it supports discussion, will be modeled by the teacher.
- Statway will require that students have access to technology.

The Joyful Conspiracy

The Charles A. Dana Center at the University of Texas at Austin and The Carnegie Foundation for the Advancement of Teaching are the founding partners for the project. They are joined in this work by 19 Statway and 8 Quantway collaboratory campuses in 8 states who have co-developed curricular materials and piloted lessons.

The Pathways initiative has worked to engage campus leaders, mathematics faculty, professional associations, state policymakers, and national research and advocacy organizations in the problems we seek to address and to organize ourselves to innovate at scale.

We know this ambitious task requires coordinated action at all levels of the system. Collectively, this strategy is known as the "joyful conspiracy," designed to help community colleges fulfill what they see as their most important mission: providing a reliable pathway to upward social and economic mobility for all who seek to improve their lives through education.

We invite you to join our joyful conspiracy.

- Each topic will be designed to help students make progress toward clearly stated learning goals.
- Statway materials will be designed to allow for local flexibility.

Consistent with the American Statistical Association's Guidelines for Assessment and Instruction in Statistics Education, the Statway learning outcomes center around providing students with a firm conceptual understanding that will allow them to use statistical tools intelligently and to be sophisticated consumers of information from studies that contain conclusions based on data.

Students completing the Statway course will understand that data analysis is a process that begins with formulation of a question that can be addressed with appropriate data, followed by the development of a thoughtful plan for identifying and collecting the necessary data. Students will know how data can be displayed and summarized in informative ways, and they will understand how the data can be used to draw conclusions in the presence of uncertainty.

Quantway

For the past two decades, a growing consensus in the mathematics community has developed around the need for an educational focus on **quantitative literacy**. We are now poised at a time in which there is a need for a national standard for quantitative literacy at the college level, both in developmental and college-credit mathematics courses. Quantway will fill that role as the first quantitative literacy course designed for large-scale implementation across a wide variety of institutions.

As a foundation for the Quantway project, the Carnegie Foundation and the Dana Center held a convening of leaders in the field representing community colleges, four-year institutions, and professional organizations to write a set of learning outcomes for quantitative literacy. Quantway will be the first quantitative literacy curriculum based on outcomes written and vetted by such a broad coalition. The outcomes detail skills and concepts under three main objectives:

1. **Students will demonstrate quantitative reasoning to** analyze problems**,**critique arguments**, and** draw and justify conclusions**.**
2. **Students will communicate quantitative results both in writing and orally using appropriate language, symbolism, data and graphs.**
3. **Students will use technology appropriately as a tool.**

The first version of Quantway, referred to as Quantway 1, is a one-semester course being piloted in eight colleges in Georgia, New York, and Ohio in January 2012. Quantway 1 is designed to replace the traditional developmental math sequence of Beginning Algebra/Intermediate Algebra. It has a strong focus on proportional reasoning and also covers algebraic topics such as linear and exponential functions. The algebra is presented through the "quantitative literacy lens" with an emphasis on using and interpreting the functions and less emphasis on algebraic manipulation of equations. Quantway 1 uses contexts from three themes: Citizenship, Personal Finance, and Medical Fluency. The Quantway 1 curriculum will be ready for public dissemination in August 2012.

Quantway will eventually be expanded into a two-semester "to-and-through" course that will take students from the Beginning Algebra level through a college-level quantitative literacy course. Quantway is appropriate for students in programs that require a general education math course such as Math for Liberal Arts or program-specific math courses. It may also be an appropriate

alternative for programs that currently require College Algebra but would prefer a course with less focus on formal algebra and more on critical thinking and communication skills.

What is [Quantitative] Literacy?

The concept of quantitative literacy was born from the growing realization that the modern world demands on ability to use mathematics in ways that both build upon and transcend the traditional mathematical topics of algebra, geometry, and statistics. This ability has been variously labeled as quantitative literacy, quantitative reasoning, numeracy, and mathematics in use among other things.

It is a field of mathematics that uses estimation skills, proportional reasoning, modeling and statistical reasoning in service of interpreting, evaluating and making decisions and arguments based on authentic quantitative information. Quantitative literacy uses contexts that are important to an educated citizen of modern society including personal finance, consumer information, governmental and social issues and quantitative information commonly presented in media.

The Quantitative Literacy Design Team formed by the National Council on Education and the Disciplines states that despite overlaps in topics, quantitative literacy is neither statistics nor mathematics.

> *Quantitative literacy is more a habit of mind, an approach to problems that employs and enhances both statistics and mathematics. Unlike statistics, which is primarily about uncertainty, numeracy is often about the logic of certainty. Unlike mathematics, which is primarily about a Platonic realm of abstract structures, numeracy is often anchored in data derived from and attached to the empirical world. (2001, p. 5)*
>
> Steen, L.A. (2001). *Mathematics and Democracy: The Case for Quantitative Literacy*. Princeton, NJ: National Council on Education and the Disciplines, pages 1-22.