

UNIVERSITY SYSTEM
OF GEORGIA:
TRANSFORMING
COLLEGE
MATHEMATICS
JULY 2013

How to dramatically increase success rates in mathematics gateway courses
without compromising the integrity of the mathematical content

The University System of Georgia Mathematics Task Force: Report and Recommendations

Introduction

In January 2013, the University System of Georgia (USG) established a System-wide Task Force on the Role of Mathematics in College Completion. The task force was charged with determining how the System's colleges could dramatically improve success rates in gateway mathematics courses without compromising the disciplinary integrity of these courses. The task force was charged with developing its recommendations by July 31, 2013.

The System Executive Vice Chancellor and Chief Academic Officer appointed eight distinguished Georgia mathematics leaders to serve as members of the task force and engaged two senior consultants to support their deliberations. (See Appendix for task force membership.) The work was carried out under the leadership of Teresa Betkowski, Interim Assistant Vice Chancellor for Transitional and General Education, and Virginia Michelich, Associate Vice Chancellor for Student Achievement.

Background

*Complete College Georgia, Georgia's Higher Education Completion Plan 2012*¹ presents a compelling vision and strategy for developing a state workforce that will ensure a prosperous future for Georgia residents. Among its key planks is the commitment to increase the proportion of young adults with postsecondary degrees and certificates from 42 percent to 60 percent by 2020. Achieving this commitment will require fundamental changes in the ways in which higher

¹ Retrieved from http://www.usg.edu/educational_access/documents/GaHigherEducationCompletionPlan2012.pdf.

education supports its students in completing key gateway course sequences.

Complete College Georgia is a gubernatorial effort aligned with federal objectives that are outlined in the 2012 report from the President's Council of Advisors on Science and Technology (PCAST), *Engage to Excel*.² The report presents the challenge that the United States needs to produce one million more graduates in Science, Technology, Engineering and Mathematics (STEM) fields over the next decade in order to meet its projected industrial needs. In order to achieve that goal, the nation's higher education institutions must address the reality that less than 40 percent of students who begin postsecondary education intending to major in a STEM discipline actually complete a degree in a STEM field. PCAST charged the President with launching a national experiment in postsecondary mathematics, and Georgia is in the vanguard of states responding to the federal challenge.

Currently, approximately 1 in 5 of all students in the University System of Georgia colleges and approximately 2 in 5 of all students in the System's access colleges begin their studies in remedial (learning support) classes, which neither award college credit nor require mastery of college-level course content.³ Less than one-sixth of these students complete a degree within six years.⁴ Moreover, for many of these students, mathematics is a nearly insurmountable barrier to their hopes of attaining a certificate or degree and, more broadly, to their hopes of establishing an economically rewarding career. However, it is not only in learning support courses that students flounder. Failure rates (D, F, W) in College Algebra typically exceed 40 percent.⁵ Thus, the improvement of lower division mathematics courses and instruction, and the establishment of suitable, focused student support mechanisms must be a priority for the University System of Georgia. The call for the redesign of lower division mathematics comes at a time

² Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf.

³ Source: The University System of Georgia Research and Policy Analysis.

⁴ Source: The University System of Georgia Research and Policy Analysis.

⁵ Source: The University System of Georgia Research and Policy Analysis.

of growing recognition among labor economists that mathematical knowledge and skills are increasingly vital to an individual's upward economic and social mobility. This finding follows in part from dramatic advances in mathematics and its increasing centrality to an expanding number of academic and professional fields.⁶ A modernization of the mathematics curriculum, therefore, will serve to increase access for students with limited prior success in the discipline. Given the high attrition rate among more accomplished students who begin college with the intention of pursuing mathematics-intensive academic majors and professions, modernization of the mathematics curriculum is also vital to keeping students in STEM fields.⁷

A half century ago, most students who took college mathematics were preparing for careers in engineering or the sciences, and calculus was the clear entry point for these STEM programs of study. Today, almost all students need a deeper understanding of basic mathematics and how to apply it in unfamiliar settings. They also need sufficient knowledge of statistics and data analysis to make sense of and to manage the inescapable reality of uncertainty in both physical systems and human affairs. Thus, many more students need to study mathematics, especially in courses that teach them how to use mathematics to make sense of the world around them, to prepare them for responsible citizenship, and to prepare them for success in an increasing diversity of majors.

Recommendations

The following recommendations reflect the consensus of the Mathematics Task Force for highest priority action. These recommendations are intended to apply to all campuses in the University System of Georgia. The task force believes strongly that pilot projects, which typically affect small numbers of students on individual

⁶ National Research Council. (2013). *The mathematical sciences in 2025*. Washington, DC: The National Academies Press.

⁷ Carnevale, A. P., & Desrochers, D. M. (2003). The democratization of mathematics. In B. L. Madison & L. A. Steen (Eds.), *Quantitative literacy: Why numeracy matters in schools and colleges* (pp. 21-31). Princeton, NJ: The National Council on Education and the Disciplines. Retrieved July 27, 2013, from <http://www.maa.org/sites/default/files/pdf/QL/WhyNumeracyMatters.pdf>.

campuses and small numbers of campuses within the System, cannot bring about the outcomes of Georgia's Higher Education Completion Plan. It is time to innovate at scale, and the **Task Force Recommendations** are offered as a blueprint for this innovation. We therefore recommend the following System policies and College practices:

1. Focus on supporting success in college credit-bearing, gateway mathematics courses for *all* students.
2. Align gateway mathematics course sequences with academic programs of study. In particular, College Algebra should not be the default class for non-STEM majors.
3. Implement a co-requisite approach to support student success in gateway mathematics courses.
4. Develop year-long mathematics pathways for students with significant gaps in preparation.
5. Use multiple measures to place students in gateway courses and appropriate supports.
6. Terminate use of COMPASS as an exit examination.
7. Align the outcomes of gateway mathematics courses with the Common Core Georgia Performance Standards (CCGPS) for Mathematics.
8. Develop advising systems and protocols for placing students in gateway mathematics courses and co-requisite supports that align with their intended programs of study.

Recommendation 1: Focus on supporting success in college credit-bearing, gateway mathematics courses for all students.

Students attend college to learn college-level material. The focus of lower division mathematics education should be on enabling students to master the material in gateway courses (Quantitative Skills and Reasoning, Introduction to Mathematical Modeling, and College Algebra). Learning support and remediation strategies should be designed to further this aim, not to reteach high school material unless essential to college course success. In brief, learning support should be a vehicle to support learning of college-level material, not an end in itself.

We recommend that many more students be advised to begin their programs of study in college-level, credit-bearing gateway courses. Well-prepared students should begin their study of college mathematics in gateway courses.

Underprepared students should also study college-level material with integrated, just-in-time support either in a single semester or over one year (see Recommendations 3 and 4).

Recommendation 2: Align gateway mathematics course sequences with academic programs of study. In particular, College Algebra should not be the default class for non-STEM majors.

System institutions should ensure the alignment of pathways for Area A mathematics to programs of study so that students learn the mathematical content necessary for success in their majors. There are currently two primary mathematics pathways: for STEM majors, through College Algebra⁸ and Precalculus,⁹ and for non-STEM majors, through Quantitative Skills and Reasoning¹⁰ or Introduction to Mathematical Modeling.¹¹

Most students in System colleges now take College Algebra as their entry-level mathematics course. College Algebra was designed explicitly to meet the needs of students who are preparing to take Precalculus and Calculus. Most students in non-STEM majors would be better served by enrolling in Quantitative Skills and Reasoning or Introduction to Mathematical Modeling, possibly followed by a statistics course in Area D (Natural Science, Mathematics, and Technology) of the core curriculum. Quantitative Skills and Reasoning and Introduction to Mathematical Modeling were designed to meet the needs of non-STEM majors and include significant real-world applications. They are appropriate, rigorous

⁸ For College Algebra course description, see

http://www.usg.edu/academic_planning/documents/Math_1111_College_Algebra_-_Outline.pdf.

⁹ For Precalculus course description, see

http://www.usg.edu/academic_planning/documents/Math_1113_Precalculus_-_acceptable_Outline.pdf.

¹⁰ For Quantitative Skills and Reasoning course description, see

http://www.usg.edu/academic_planning/documents/Math_1001_Quantitative_Skills_and_Reasoning_-_Outline_.pdf.

¹¹ For Introduction to Mathematical Modeling course description, see

http://www.usg.edu/academic_planning/documents/Math_1101_Introduction_to_Mathematical_Modeling_-_Outline.pdf

mathematics courses for a broad array of non-STEM programs of study in which deep knowledge of and facility with basic mathematics are essential to prepare students for responsible citizenship.

These two courses are currently underutilized for a number of reasons including: (1) the longstanding use of College Algebra as a barrier to entry for many selective, non-math-intensive majors; (2) the risk aversion among advisors who are concerned that non-STEM students might change their mind and seek to pursue STEM majors; and (3) the misperception that Quantitative Skills and Reasoning and Introduction to Mathematical Modeling lack mathematical rigor. The practice of using College Algebra as a proxy for general quantitative ability or to ensure that students can later transfer to a STEM major must end. System data suggest that placement in College Algebra for the above reasons is a major contributor to student failure. Furthermore, the broad audience in College Algebra makes it challenging to organize this important course as a true stepping stone to Calculus.¹²

The task force recognizes that new strategies will need to be developed to support the relatively small number of students who begin their college studies in non-STEM major and who then wish to change to a STEM major. Advice on this matter should be sought from the Academic Committee on Mathematical Subjects (ACMS). However, normative mathematics pathways should be designed to serve the vast majority of students in their pursuit of a clear program of study.

Recommendation 3: Implement a co-requisite approach to support student success in gateway mathematics courses.

The traditional approach to learning support in the University System of Georgia colleges has been to enroll underprepared students in special non-credit courses,

¹² In a representative sample of USG colleges, only 5 percent of students completing Calculus I have taken College Algebra, which suggests that very small numbers of students who complete College Algebra eventually pursue STEM majors. Just 7 percent of students who begin in non-STEM majors eventually transfer to a more math-intensive major. The task force recognizes that more research needs to be done on the role that College Algebra plays as a pathway to STEM majors.

which were designed to allow them to learn, or most often relearn, key prerequisites for college-level introductory courses. These learning support classes in mathematics include a wide variety of topics typically taught in middle school and high school, are not specifically targeted to the learning needs of individual students, and are not tied to the content of the college-level class.

As documented in *Complete College Georgia, Georgia's Higher Education Completion Plan 2012*, the traditional approach to learning support has not led to degree or certificate attainment by the great majority of students it was designed to help.¹³ It is time to rethink the support systems for student success in gateway mathematics courses without reducing our System's commitment to success for all students.

The task force recommends that a new set of co-requisite support courses and course support structures be developed System-wide. The central idea is to provide students in standard gateway college-credit courses with more learning time and intensive instruction explicitly designed to support mastery of college material as the need arises—in essence, just-in-time support.

There are several models of co-requisite support, which include one- to two-credit linked learning labs, which show special promise for emulation and refinement in the University System of Georgia. The common features of co-requisite models are: (1) whatever the co-requisite format, students will complete a gateway college-credit course in one semester, saving students time and money while increasing their likelihood of success; and (2) the content of the co-requisite support is integrated with the college content of the gateway college-credit course. In other words, students will start their college mathematics experience learning college-level material, although perhaps with very different levels of support.

Experience with co-requisite approaches at other postsecondary systems and campuses suggests that many students with only moderate academic deficiencies

¹³ See Complete College America (2011, September). *Time is the enemy*. Washington, DC: Author. Retrieved from http://www.completecollege.org/resources_and_reports/time_is_the_enemy.

can succeed in gateway courses if they are enrolled in a linked lab that enables them to master the key course content without falling behind. Important examples include efforts at Austin Peay State University, the Community College of Baltimore County, the University of Maryland, the University of Texas, and the University of Michigan, which have all demonstrated impressive gains in student achievement with a linked lab approach.

ACMS should collaborate with members of the Mathematics Task Force in making recommendations for mathematics course pathways for students who are admitted to System colleges with substantial mathematical deficiencies to successfully complete a gateway college-credit math course in one semester. An ad hoc committee of the ACMS should be charged with developing a framework and set of guiding principles for USG co-requisite math courses and support structures. System colleges should be supported in developing co-requisite courses and supports that reflect the needs of their campus populations and reflect the design principles set forth by the ACMS.

Recommendation 4: Develop year-long mathematics pathways for students with significant gaps in preparation.

While low to moderate need students will benefit from the co-requisite strategy, significantly underprepared students or non-traditional students may need a more comprehensive support model. The task force recommends developing year-long pathways that would enable these high-need students to complete gateway math course content within one academic year. The pathways will be designed for student completion in two, back-to-back semesters and might consist of a foundations course followed by an appropriate gateway course. The foundation course will include college-level material with significant supports to master concepts. Initially, two year-long pathways should be established, STEM and non-STEM.

The Statway™ and Quantway™ projects developed by the Carnegie Foundation for the Advancement of Teaching and the New Mathways Project (NMP) have demonstrated on many campuses dramatic improvements in the success of

students with major academic deficiencies in one-year, co-requisite versions of gateway mathematics courses. The University of Texas, Dana Center's New Mathways Project, a one-year co-requisite model designed for use at scale in postsecondary systems, is worthy of consideration as a model for the University System of Georgia.

Recommendation 5: Use multiple measures to place students in gateway courses and appropriate supports.

Extensive data collected on student success rates in College Algebra suggest that high school grade point average (HSGPA), in combination with test scores, provides a better predictor of student success than test scores alone. For example, a student with a COMPASS score of 41 has a probability of success in College Algebra that varies from 25 percent for a student with a 2.0 high school GPA to 68 percent for a student with a 3.5 high school GPA.¹⁴ Currently, high school GPA is not used in placing students.

The task force recommends that the University System develop a uniform placement index based on a student's probability of success in a gateway course. The index should take into account both test scores (SAT/ACT or COMPASS) and high school GPA. The choice of index and the cut-offs used for placement will need to be informed by System data analysis and in consultation with stakeholders in mathematics and other disciplines. Key concerns for a committee of experts to address include:

- Establishing system-level cutoff ranges for gateway, co-requisite, and year-long strategies based on the probability of success in a gateway course.
- Identifying a timeline for regular review and revision of system cutoffs.
- Determining whether probability of success should be based on data from the entire system, a sector of the system, or an individual college.
- Determining whether very low success rates at a particular institution should trigger a review of institutional support systems.

¹⁴ Source: The University System of Georgia Research and Policy Analysis.

- Developing a policy on which tests should be used for placement and whether students should be required to submit SAT or ACT scores for placement purposes.

The task force recognizes that measures appropriate for recent high school graduates might not be appropriate for non-traditional students. For non-traditional students, in order to ensure that the placement index reflects current information, it might be appropriate to give relatively greater weight to a recent placement test and less weight to high school GPA.

Recommendation 6: Terminate use of COMPASS as an exit examination.

The task force strongly recommends the elimination of the COMPASS as an exit exam.

As we shift our focus on learning support towards completion of the college-level gateway courses, the COMPASS exit exam creates an unnecessary hurdle to college completion for students who have already demonstrated proficiency by passing learning support courses. Learning support must not be a barrier locking students out of gateway material; it must be an integrated support system for helping students develop the skills they need to be successful in gateway courses.

Furthermore, the COMPASS exit exam is misaligned to the skills needed for the Quantitative Skills and Reasoning and Introduction to Mathematical Modeling courses. It therefore stifles innovation among institutions that want to develop alternate mathematics pathways leading to these courses.

Recommendation 7: Align the outcomes of gateway mathematics courses with the Common Core Georgia Performance Standards (CCGPS) for Mathematics.

At present, the ACMS-approved learning outcomes for Area A mathematics courses delineate student learning outcomes in terms of content knowledge. The lists of learning outcomes should be updated to articulate standards of practice such as problem solving, abstract reasoning, construction of viable arguments, and modeling with mathematics at the college level. Reflecting advances in the

learning sciences, these dimensions of mathematical skills and knowledge are clearly articulated in Georgia's K–12 Common Core Georgia Performance Standards (CCGPS) for Mathematics.¹⁵ The ACMS should revise its learning outcomes accordingly.

Revision of learning outcomes for gateway mathematics courses would send a powerful signal to K–12 about the importance of the Common Core curriculum to college readiness. Explicit alignment of the expectations of USG gateway courses with the secondary mathematics performance standards will facilitate a smoother transition for students from high school to college. Such alignment would also promote student understanding and success at the college level.

Recommendation 8: Develop advising systems and protocols for placing students in gateway mathematics courses and co-requisite supports that align with their intended programs of study.

Transitioning to the new system of gateway mathematics courses and course support systems demands significant change in long-established traditions of college advising by both faculty and professional staff. At the most basic level, faculty members, professional advisors, and administrators responsible for course planning and scheduling will need to understand new system guidelines and the rationale for them. Advisors will need tools and knowledge to: (1) support students in the selection of an appropriate mathematics pathway for their desired programs of study; (2) match student needs to new support structures including co-requisite and year-long models; and (3) understand a new placement index based on multiple measures that predict the probability of student success in gateway courses. Without intensive support for advisors, the dramatic improvements in student success which we seek through these recommendations will not be realized.

¹⁵ See the Common Core Standards for Mathematical Practice at www.corestandards.org/Math/Practice.

Infrastructure for Implementation of Recommendations

The Mathematics Task Force recommends the development of an infrastructure to implement its recommendations.

- The USG Office of Educational Access and Success, with advice from the ACMS Executive Committee, should be tasked with forming an Ad Hoc Steering Committee of mathematics faculty to direct the implementation of the recommendations. Financial support must be provided to support the intensive work of the steering committee.
- The Mathematics Task Force recommendations should be a top priority of the Office of the Executive Vice Chancellor and Chief Academic Officer, with dedicated time secured from staff of the Office of Educational Access and Success and the Office of Research and Policy Analysis.
- The Office of Research and Policy Analysis should continue to develop a longstanding relationship with the ACMS and individual mathematics department heads so that System mathematics leaders have current and relevant data for monitoring and recognizing successes and problem areas as they arise.
- Task force members should attend the Complete College America meeting in August 2013.

Steps for Specific Recommendations

Recommendation 1: Focus on supporting success in college credit-bearing, gateway mathematics courses for all students.

Recommendation 2: Align gateway mathematics course sequences with academic programs of study. In particular, College Algebra should not be the default class for non-STEM majors.

The Mathematics Task Force will develop descriptions of gateway courses that include information about how course content is used in and aligns to high enrollment majors.

ACMS will work with subject area advisory committees to recommend the mathematics course or course sequences appropriate to disciplines.

An ACMS Ad Hoc Steering Committee will develop resources and materials for advisors, explaining mathematics pathways and alignment to programs of study.

Recommendation 3: Implement a co-requisite approach to support student success in gateway

<i>mathematics courses.</i>
The University System of Georgia will seek ACMS endorsement of the co-requisite strategy.
An ACMS Ad Hoc Steering Committee will begin working immediately to: <ol style="list-style-type: none"> (1) Review co-requisite models in Georgia and in other states to identify a small number of recommended models, including information about the number and type of credits offered, staffing, student population, and financing. (2) Build co-requisite curricular materials to provide just-in-time support to students. (3) Identify common course numbers for support courses/lab components. (4) Develop resources for advisors for placing students in co-requisite support models.
<i>Recommendation 4: Develop year-long mathematics pathways for students with significant gaps in preparation.</i>
An ACMS Ad Hoc Steering Committee will begin working immediately to: <ol style="list-style-type: none"> (1) Examine national year-long pathway curricular models such as the New Mathways Project, Statway™/Quantway™, New Life Project, etc. (2) Recommend one or a small number of year-long courses/curricular options. (3) Provide guidance for implementation, including course numbers, number and type of credits, who enrolls in courses, etc. (4) Develop resources for advisors about year-long models.
<i>Recommendation 5: Use multiple measures to place students in gateway courses and appropriate supports.</i>
The USG will create a committee with representation from the Mathematics Task Force, Learning Support Directors, and University System office to establish System-wide cut-off ranges for gateway, co-requisite, and year-long models based on data provided by the USG Office of Research Policy Analysis.
The committee will develop a uniform placement index based on standardized test scores and high school grade point average (HSGPA) and evaluates the key considerations described above (Recommendation 5).
<i>Recommendation 6: Terminate use of COMPASS as an exit examination.</i>
The University System office will terminate the use of COMPASS for the purposes of exit.
<i>Recommendation 7: Align the outcomes of gateway mathematics courses to the Common Core Georgia Performance Standards (CCGPS) for Mathematics.</i>
An ACMS Ad Hoc Steering Committee will review and revise current course descriptions of all current gateway courses for submission to the full ACMS for approval.
The University System office will provide grant opportunities to support colleges in pilot efforts to

incorporate the CCGPS performance standards in college-level courses.

Recommendation 8: Develop advising systems and protocols for placing students in gateway mathematics courses and co-requisite supports that align with their intended programs of study.

The University System office will establish an Administrative Committee for Advisors with a point of contact on every campus that will:

- (1) Lead institutions in ensuring that System-wide recommendations for changes in remediation and recommendations concerning new math pathways are communicated to all advisors at their institutions.
- (2) Develop strategies for enabling students to choose as early as possible a coherent program of study and for enrolling them in the relevant mathematics gateway course.
- (3) Support the use of “Degree Works” in directing students to the correct pathway for their majors.
- (4) Communicate the role that “GAtracs” can play in the advisement of transfer students.

The University System office should provide extensive regional direct training workshops for all advisors that enable them to properly and efficiently guide students in the selection of gateway mathematics courses relevant to the students’ programs of study.

Appendix

Membership

The task force consists of eight experts in the field of mathematics, representing each institutional sector (research, regional, state university, and state college). The task force was supported by consultants from The Charles A. Dana Center and Complete College America as well as staff from the University System of Georgia.

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