



**MONTANA UNIVERSITY SYSTEM**  
OFFICE OF THE COMMISSIONER OF HIGHER EDUCATION

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**Report and Recommendations of the**  
**Montana Math Pathways**  
**Task Force**  
**October 2015 Report**

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## Introduction

In May 2014, Clayton T. Christian, the Commissioner of Higher Education, convened over 50 math faculty, campus leaders, and regents from across the Montana University System (MUS) to a 1-day Math Pathways meeting featuring keynote speaker Uri Treisman. Representatives included the MUS leadership (the commissioner and the two presidents of the system), provosts and academic affairs representatives, key academic deans, the Developmental Education Council, the Developmental Education Math Discipline Council, the Math Placement Council, and K-12 leaders in Montana.

The result of the May 2014 Math Pathways meeting was the commissioner's decision to join the Complete College America (CCA) Math Pathways Initiative and to create a faculty-led Math Pathways Task force comprising faculty across MUS to make recommendations to the commissioner and the Montana Board of Regents (BOR) regarding math pathways. CCA is a national nonprofit whose mission is to help states improve the number of Americans with career certificates or college degrees. CCA has determined that difficulty with mathematics is a contributor to low college completion rates. In 2014 they started a Math Pathways Initiative to solve this problem.

### **The Montana University System – Building Math Pathways into Programs of Study**

MUS is well-placed to actively participate in the CCA Math Pathways initiative. There is strong support from the governor's office to reach the goals of the completion agenda, from the BOR and MUS leaders for developmental education reform, and from the faculty to align math requirements to degrees. Other initiatives, such as performance-based funding, have had strong faculty participation to support developmental education on the campuses.

MUS has initiated many of the requirements for successful selection and agrees to the following:

- Convene a math pathways task force of math faculty.
- Participate in the annual college completion metrics data submission process.
- Gather the necessary data to inform the work of the math task force.
- Audit program requirements across disciplines.
- Work across disciplines to encourage appropriate math requirements in a systematic way.
- Adjust institutional articulation agreements to ensure transferability of math courses.
- Design corequisite math courses to support student success in the new math pathways.

## Background

MUS comprises 16 public universities and colleges, enrolling more than 45,000 students each semester (MUS Student Warehouse, 2015). MUS includes two flagship universities: Montana State University (MSU) and the University of Montana (UM). Under each flagship university are affiliated regional comprehensive universities and 2-year campuses. Academic programs include baccalaureate, masters, and doctoral programs at the flagship universities; associate, baccalaureate, and masters programs at the regional comprehensive universities; and certificate, associate of applied science, and associate-level degrees at the 2-year campuses. Within universities, students have access to a broad variety of degrees: business, arts, humanities, sciences, engineering, architecture, forestry, allied health, nursing, and many others. The 2-year campuses provide a diverse array of career and technical programs, allied health, nursing, and business-to-university transfer opportunities through associate of arts and associate of science degrees.

The governance and administration of MUS is vested with BOR, which has full power, responsibility, and authority to supervise, coordinate, manage and control MUS, and supervise and coordinate other public educational institutions assigned by law. BOR consists of seven members appointed by the governor and confirmed by the Senate to 7-year overlapping terms. One member is a full-time student at an MSU school. The student member's term is 1 year, with the possibility of reappointment to successive terms. The governor, superintendent of public instruction, and commissioner of higher education are ex-officio members of BOR. BOR also supervises the three community college districts in Montana, which each have locally elected Boards of Trustees. This supervision includes approving all academic programs for the community colleges, establishing minimum entrance requirements and faculty qualifications, and approving budgets for each of the community college districts.

The Montana Governor's Office, Office of the Commissioner for Higher Education, and Office for Public Instruction share a sense of urgency to improve student success in college mathematics. Montana Governor Steve Bullock joined the CCA Alliance of States in 2013 and, in partnership with MUS, set new priorities for higher education in Montana, reaffirming the completion agenda he set the year before to collect baseline data for common measures of success and to identify and develop system- and campus-level action plans to meet those completion goals.

## State Urgency

For Montana to compete in an increasingly global economy, more emphasis must be placed on removing barriers to success in higher education. As part of a national effort to increase educational attainment, Governor Bullock has set a goal that by 2020, 60% of Montana's adults have a postsecondary credential (State of Montana, 2013), which would be a 20% increase (Office of the Commissioner of Higher Education, 2014). Montana joins other states that are concerned about the impact of low postsecondary credential attainment. Data collected by CCA and other respected researchers have shown a direct impact of college graduation on productivity and employment. There are four factors that highlight the critical need for additional college graduates in Montana:

1. In the next 10 years, a disproportionate population of retirees and youth will cause a 24,000-person workforce shortage (Montana Department of Labor and Industry, 2015).
2. Montana's population is aging; the state now has the fifth-oldest population per capita in the nation (Montana Department of Labor and Industry, 2015).
3. An aging population and a changing economy are exacerbating Montana's workforce shortage.
4. A widening skills gap will be detrimental to Montana's ability to sustain recent economic and wage growth. Optimizing production is part of the solution to this imminent crisis. A catalyst for this optimization is moving people into and through MUS so they acquire the knowledge and skills to move the state forward during the challenging times ahead.

As we look at factors affecting graduation, it is clear that mathematics plays an important role in student success and completion. This role begins with high school math. In 2015, the Montana ACT Profile Report stated that 8% of high school students who took fewer than 3 years of math met the college readiness benchmark for college mathematics, compared to a 34% college readiness rate for those taking 3 to 3 1/2 years of math. That readiness benchmark increases to 64% when students compete 4 or more years of high school math (ACT, 2015).

Enrollment in college math also has a strong impact on success. From Fall 2009 to Spring 2015, only 49.6% of MUS students enrolled in at least one math course (MUS Student Warehouse, 2015). Failure to enroll in and subsequently pass a math course affects a student's ability to earn a postsecondary credential. It is imperative that issues such as math aversion, placement tests, developmental success rates, and course appropriateness are thoroughly investigated in Montana. To begin addressing this issue, MUS BOR adopted a policy requiring students who are placed in developmental math to successfully complete math in their first 30 credits of study. This policy was approved by BOR in September 2014 and implemented in January 2015. The effects of the policy will be studied in the year ahead.

Mathematics is a broad field, and most college and university math departments offer a variety of courses. A pathway as defined in this document is a sequence of courses required for a college degree. Some mathematics sequences lead to careers in science, engineering, and technology. Other sequences lead to fields that use statistics. Some develop quantitative literacy for a liberal

arts education. The career that a student chooses should determine his or her pathway through mathematics.

From the task force's perspective, mathematics itself is not the problem. Problems with college completion related to mathematics may originate in the following:

- Alignment of mathematical content with programs
- Placement and advising
- Availability of appropriate pathways (secondary and postsecondary)

The 2004 CUPM Curriculum Guide published by the Mathematical Association of America mirrors the concerns stated above and informs the recommendations that follow (Committee on the Undergraduate Program in Mathematics, 2004). Research on mathematics in higher education in Montana has led to the recommendations in this document, which should contribute to statewide improvement.

## Recommendations

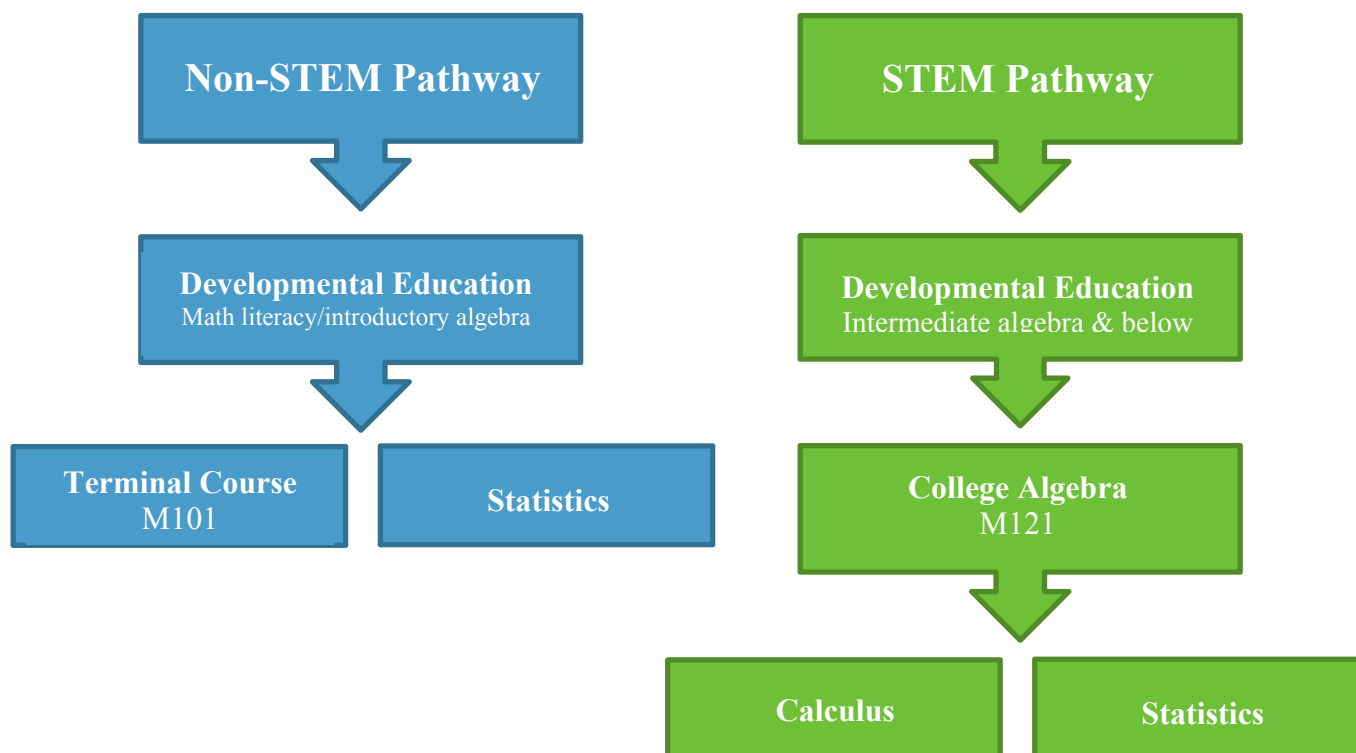


Figure 2. Proposed STEM and Non-STEM pathways in mathematics.

### Process Leading to Recommendations

In September 2014, Commissioner Clayton Christian called for the creation of a statewide task force to begin work on the Montana Math Pathways Initiative.

The overarching goal of the project is to dramatically improve the success of students in developmental and gateway mathematics courses.

The commissioner selected five delegates from MUS units to attend a Math Pathways Institute in Dallas, TX, in September 2014. The purpose of the institute was to introduce participating states to resources that will facilitate implementation of the commitments CCA has promoted. These included templates for selecting and meeting with the task force, developing a public statement, designing alternative courses, and coordinating math courses with other programs of study.

When the group returned from the institute, Jim Hirstein, former chair of the Mathematical Sciences Department at the University of Montana, was selected to chair the task force. The University of Montana assigned Alicia Heckel, budget analyst in the Provost's Office, as

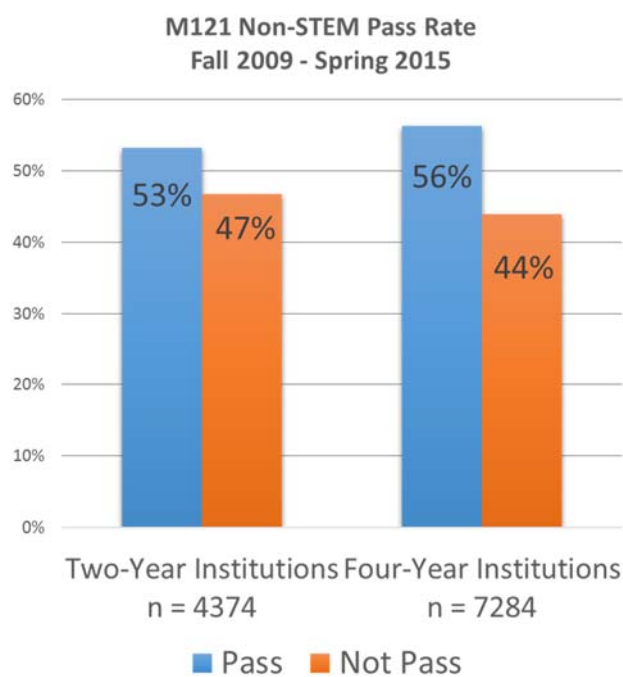
facilitator for the group. Over the next 2 months, the task force Math Pathways–Montana was formed.

From January through August 2015, the task force met several times in Helena, Montana, and via conference calls. They examined data from across the state and formulated a set of draft solutions, which were discussed in a statewide Math Pathways Summit held in Helena on September 8, 2015. The summit drew 65 participants: mathematics department chairs, math faculty, student services professionals, student advisors, deans, and provosts. It began with messages from the commissioner and the two flagship presidents.

Following the summit, the task force met at MSU on September 24, 2015. They formulated five recommendations:

### **Recommendation 1: Provide a clear pathway for non-STEM students**

Across MUS, College Algebra has been the primary gateway mathematics course for students in both 2-year and 4-year institutions. College Algebra is recognized as a clear path to calculus, yet few students, particularly at 2-year colleges, intend to continue to Calculus. MUS data indicate that College Algebra has the highest enrollment of gateway courses and also has highest failure rate. Of 11,658 enrollments in College Algebra from Fall 2009 to Spring 2015, 5,262 students (45%) failed the course (MUS Student Warehouse, 2015). The task force believes directing students to a gateway mathematics course that is appropriate for their program of study and providing a clear path to those alternative courses is essential for students to complete their degree programs and develop mathematics literacy applicable to their future endeavors.

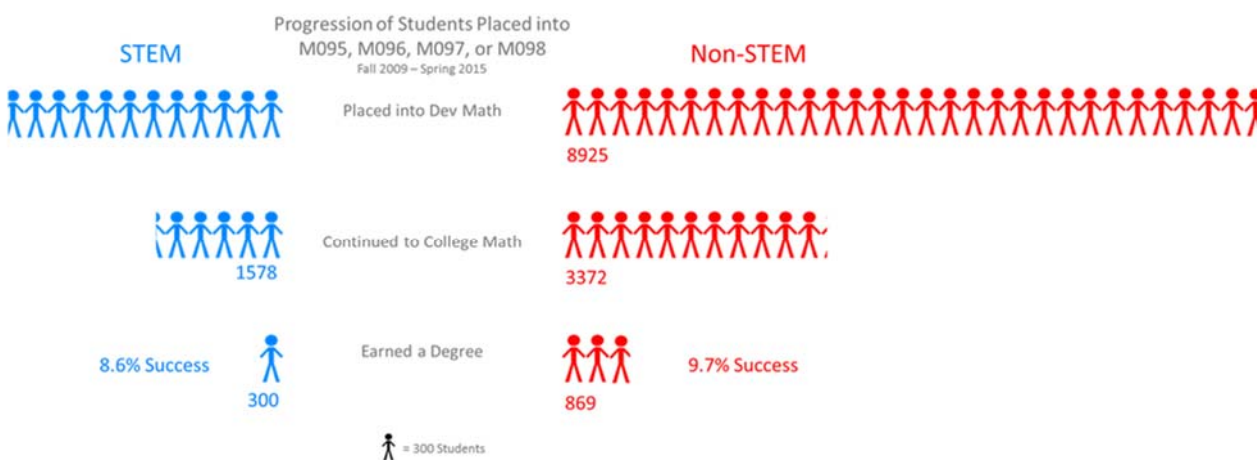


*Figure 2. Difference in pass rate between 2- and 4-year institutions, 53% and 56% respectively (MUS Student Warehouse, 2015).*

Non-STEM students deserve a mathematics experience that pertains to their future careers. In recognition of the national movement to create non-STEM gateway mathematics alternatives, such as the American Mathematical Association of Two-Year Colleges recommendation that mathematics departments offer a terminal course that satisfies general education requirements, the task force recommends using the title Quantitative Literacy to describe college courses that are less algebraically intensive than is College Algebra. These courses could include quantitative reasoning and basic statistics. For example, topics in a Quantitative Literacy course might vary among “arithmetic, measurement, data representation, number sense, variables, geometric shapes, spatial visualization, and chance”

that can be applied to a student's life, as well as statistical reasoning skills and "knowledge of the power and utility of mathematics and how it has shaped civilization" (Beyond Crossroads Writing Team, 2006). Although several courses across MUS exist that are similar to this intended course (M105 and M145), they carry a variety of course numbers and outcomes. The task force recommends moving these courses to a common number and developing a list of shared learning outcomes. This new course would meet general education core requirements for all MUS campuses. Quantitative Literacy is a course title that has been accepted as transferable in many states.

A Quantitative Literacy course would solve just one part of the problem. Many colleges that offer alternative gateway courses for non-STEM students continue to require algebra-based prerequisites for these courses. Discussions nationwide have revealed that the algebra-intensive preparation required for non-STEM students often creates a barrier that prevents them from completing a degree. The task force therefore recommends that the prerequisite for the Quantitative Literacy course include skills no higher than those contained in an introductory algebra course. Alternative prerequisites, such as M088 Mathematics Literacy at Gallatin College, could serve as a model across MUS.



*Figure 3. Progression of students in M095, M096, M097, and M098, Fall 2009-Spring 2015.*

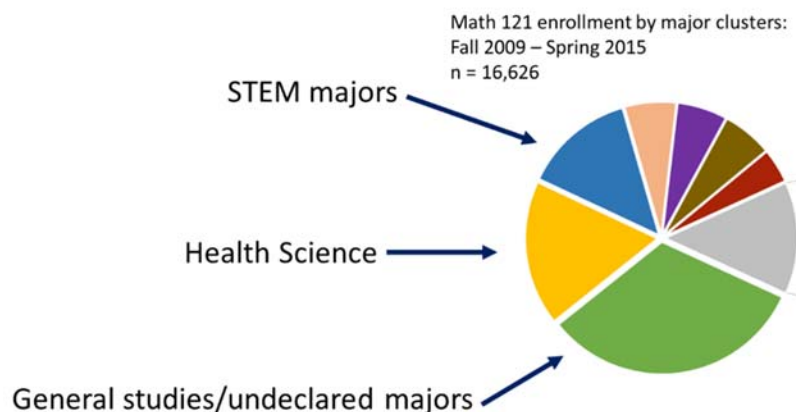
*Note. Of all students placed into developmental math, 8.6% of STEM majors and 9.7% of non-STEM majors completed a degree (MUS Student Warehouse, 2015).*

Some campuses have begun a pilot developmental education class as a prerequisite for statistics. If this proves successful, we recommend further implementation. Future work may be needed for a statistics pathway.



## Recommendation 2: Evaluate curricular requirements involving College Algebra

An inventory of all programs requiring College Algebra should be undertaken to determine if algebra is the most appropriate mathematics course for each program. If algebraic manipulation is not an essential skill in the program, then a nonalgebraic-intensive course such as quantitative reasoning or basic statistics is recommended. Initial data show that algebra is required in some majors where students might be better served by statistics or other math requirements such as Quantitative Literacy. In these cases, more appropriate pathways and gateway courses should be developed with the possibility of creating new courses or redesigning current ones to provide students with the most appropriate mathematics course for their programs.



*Figure 4. Proportion of Math 121 enrollments by major (MUS Student Warehouse, 2015).*

The Mathematical Association of America recommends that “mathematical sciences departments should determine the extent to which the goals of courses and programs offered are aligned with the needs of students as well as the extent to which these goals are achieved.” They also recommend that schools examine the effectiveness of College Algebra. These recommendations are in line with those of the task force (Committee on the Undergraduate Program in Mathematics, 2004).

Pathways that would not use Quantitative Literacy as a gateway course include health care, statistics, and elementary education. In addition, many career and technical education pathways in the state’s 2-year and community colleges could benefit from a gateway math course designed for technical studies. Campuses should await conclusions developed by statewide task forces, such as the TAACCCT IV Healthcare Montana grant, which is working to realign allied health and nursing curricula in Montana’s 2-year and community colleges with industry needs, and improve students’ ability to transfer between programs. The task force views this as an opportunity to intersect with grant-funded statewide curriculum committees and engage in math pathway discussions. The variety of pathways offered across MUS intensifies the need for cross-campus collaborations so credits will transfer across the system.

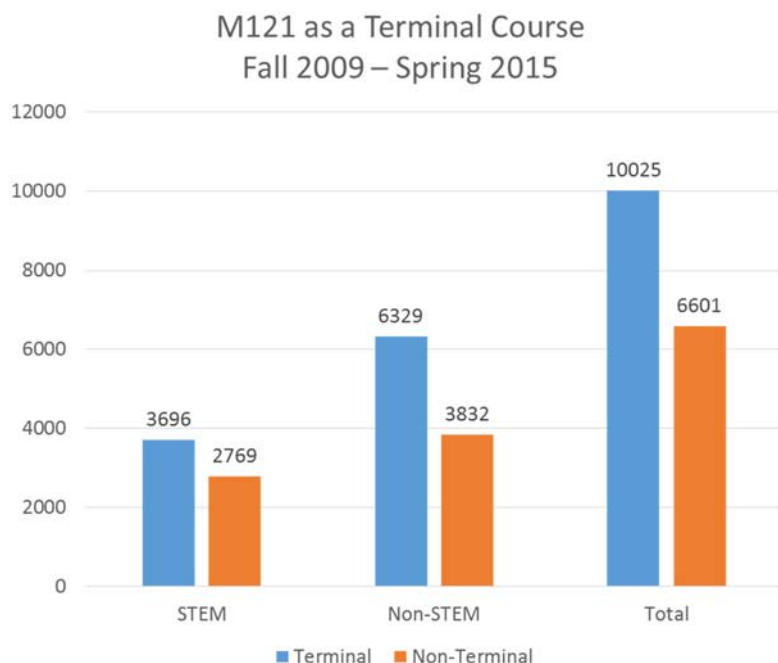
Once program math alignment has been completed, an inventory of all programs requiring College Algebra and those with alternative pathways or math requirements should be widely distributed to students, high schools, faculty, and advisors.

### Recommendation 3: Strengthen advising processes for math

Developing and implementing appropriate mathematics pathways for STEM and non-STEM students cannot succeed without clear communication to students, advisors, and faculty. As statewide data reveal, College Algebra has the highest enrollment of any 100-level math course, with 1,763 enrollments in Fall 2015, or nearly 5% of the system's student population. This indicates that students are not taking advantage of alternative courses to satisfy their program requirements (MUS Student Warehouse, 2015). The task force recommends that colleges improve training and communication to support improved math advising.

Faculty, advising professionals, and students need clear and accurate information. For students, this is of particular importance early in their college career. Relevant information should be widely distributed to high school partners as well. To strengthen intake and new student advising, first-semester advisors can ask, "Do you see yourself taking calculus?" If the answer is yes, then College Algebra is the appropriate course. If the answer is no, additional questions will help reveal the most appropriate mathematics course and pathway. For students who are not succeeding in their current program and want to change their major, faculty should refer them to professional advisors who are equipped to provide guidance on alternative programs. For faculty and advisors to be effective, resources and training should be provided.

The task force frequently received comments that well-intentioned advisors recommend that undecided students take College Algebra because "it opens the most doors." However, for many students, that course is closing doors based on the large number who do not pass the course on their first attempt. The task force recommends that advisors be trained to counsel undecided students to take courses that are not algebraically intensive, such as Quantitative Literacy. This strategy would provide both educational and motivational benefits by affording students who have previously had negative experiences in math an opportunity to start from a point of success.



*Figure 5. M121 as a terminal course. Note. Shows the number of students who did not enroll in another math course after taking M121. From Fall 2009 to Spring 2015, M121 was often used as a terminal math course (MUS Student Warehouse, 2015).*

#### **Recommendation 4: Stronger communication between secondary schools and college**

The task force recommends three key areas to strengthen communication between secondary school partners and MUS colleges and universities:

1. Encourage high school advisors, teachers, and counselors to provide clear recommendations for mathematics coursework in the junior and senior year of high school.
2. Create a joint task force to address issues affecting both partners.
3. Create a MUS-wide mathematics placement document that clearly communicates standardized test score expectations for enrollment in college credit-bearing mathematics courses.

Whereas Montana requires at least 2 years of mathematics for all high school students, most colleges and universities require 3 years of mathematics for full admission. This misalignment means students can arrive at the university without having been in a math class for 18 months or more. Recognizing that mathematical knowledge decays when not put to use, the task force recommends that high school students intending to pursue postsecondary education take mathematics in their junior and senior year. Studies such as *The Consequences of Delayed Enrollment in Developmental Mathematics* have shown that GPA, retention, and completion are adversely affected by deferred developmental math enrollment. With that knowledge in mind, MUS requires that all students not placed in college math take developmental math during their first year (Fike & Fike, 2012).

Montana is fortunate in that all high school juniors can take the ACT free of charge (funded for 6 years by a federal grant administered by the Office of the Commissioner of Higher Education). To close the gap between the high school exit requirements and college entrance requirements for mathematics, it is important that high school juniors understand how their placement test scores affect their ability to enroll in credit-bearing college mathematics courses. It is also important that high school students, their parents, teachers, and advisors understand the implications of taking developmental coursework and its negative correlation to college graduation rates.

The commissioner created a statewide Placement Task Force in September 2015 to develop recommendations for creating a statewide approach for placement in both math and writing. The Placement Task Force will provide recommendations for review by December 2015. The Math Pathways Task Force will coordinate its work with the Placement Task Force.

A document should be created for high school students and college counselors that translates standardized test score results into MUS mathematics placement (Committee on the Undergraduate Program in Mathematics, 2004). Such a document will clearly communicate the “costs” associated with low achievement in high school mathematics and with taking developmental courses in college. The document should also make clear the “mathematical demand” for different areas of study so that students can set their “mathematical trajectory” before arriving at the university.

The task force recognizes that concerns about college completion are shared by both MUS and secondary school partners and that recent developments have blurred the distinction between high school and college curricula. Dual-credit courses, a universal MUS placement exam for mathematics, the role of the Smarter Balance Assessment in MUS mathematics placement, EdReady, and the best use of the Montana Digital Academy are just a few examples of why a joint task force is necessary to facilitate the high-school-to-college transition by discussing issues such as college preparation and dual-credit opportunities.

#### **Recommendation 5: Strengthen communication through MUS system**

MUS's 16 institutions reflect three distinct missions: research universities, comprehensive regional universities, and 2-year/community colleges. All of them provide students with an opportunity to develop mathematics skills that apply to their academic and career goals. To implement a cohesive statewide approach to mathematics education, the task force recommends creating a Mathematics Advisory Council to discuss ongoing math initiatives and their effect on each campus. The group would include members of the Math Pathways Task Force and the Statewide Placement Workgroup, as well as campus representatives from across MUS. Discussions would take place annually and would include data analysis, course requirements, advising, and other issues facing math departments.

## What MUS is Doing Now

The Math Learning Center at MSU, the Math Emporium at UM, and statewide scaling of EdReady are current efforts in MUS that are consistent with task force recommendations, as is the Student Success Coordinator (SSC) program at MSU and its technology-enhanced active learning (TEAL) classrooms.

Last year, 4,249 students enrolled in MSU gateway math courses and benefited from support provided by the SSC that was spearheaded by the Department of Mathematical Sciences (MUS Student Warehouse, 2015). Outcome assessments indicate that SSC and TEAL improve learning and enhance success in gateway math courses. For example, average success rates in MSU's largest multisection freshman and sophomore math and statistics courses increased from 8% to 17% compared to the 3-year period prior to SSC. After instituting SSC,

- in College Algebra (M121), the success rate increased from 61.9% to **75.5%** ( $n = 1,088$ ).
- in Calculus I (M171), the success rate increased from 51.5% to **68.7%** ( $n = 954$ ).
- in Calculus II (M172), the success rate increased from 67.5% to **75.9%** ( $n = 780$ ).
- in Introduction to Statistics (STAT216), the success rate increased from 63.0% to **75.4%** ( $n = 1,427$ ).

Clearly, these initiatives are effective in helping students learn the material and prepare for success in subsequent courses. In just one year, 555 additional students succeeded in gateway math courses at MSU as a result of SSC and TEAL. Funding is necessary to ensure that successful programs like these are sustained and enhanced.

Traditional lectures leave little room for individualized problem solving, and data clearly show that this approach is ineffective for underprepared students in mathematics. Technologically enhanced active-learning approaches and flipped classrooms transform rows of note-taking students into groups of collaborative, interactive problem solvers. There are no generic lectures in these courses; rather, students spend class time solving problems on paper or computers, with the instructor providing individualized assistance and encouraging peer-to-peer support. In this environment, students are active learners and the instructor is transformed from a “sage on the stage” to the “guide on the side.”

### Common Course Numbering and Transfer

In 2007, MUS was directed by BOR to develop a common course numbering (CCN) system. The CCN policy ensures that equivalent courses at different campuses have the same title, number, and prefix, and that all such equivalent courses be accepted for transfer as if they had been taken at the receiving campus. This policy makes it easy to know which courses taken at one campus have equivalents at other campuses, and thus which courses will transfer without the need for further transcript review. Courses with common numbers indicate that they are considered 80-100% similar in the outcomes students should be able to demonstrate by the end of the course. Because equivalency is determined based on projected learning outcomes (not grading rubrics, course structure, catalog descriptions, textbooks, individual instructors, or facilities), how and where the course is taught are not used as a basis of comparison.

## EdReady

EdReady Montana is an online integrated technology curriculum from the National Repository of Online Courses for all students from middle school through college who want to prepare for math classes, supplement their skills while taking a math class, improve general math skills, become better prepared for college math, practice math skills needed for a desired career path, or prepare for a standardized test. Students can sign up through their secondary school, college campus, or adult basic education center—or on their own.

EdReady Montana is facilitated by the Montana Digital Academy (MTDA) and funded by a generous gift from the Dennis and Phyllis Washington Foundation. Montana was the first state in the country to deploy EdReady, having begun in early 2014.

During Summer 2013, UM pilot tested EdReady and found that students who were not satisfied with their math placement scores benefitted from using EdReady to shore up weaknesses and engage in personalized study. The pilot study revealed that 86% of students increased their test scores and qualified to enroll in higher level courses. The majority were able to reach their target score with less than 16 hours of EdReady use.

In MUS, EdReady Montana has resulted in three tools to support math instruction throughout the system:

- **Placement test preparation tool:** Students who have received a low score on their college placement use EdReady to prepare for a retest. Both UM and MSU (through Gallatin College) have used the system in this way over the past two summer sessions.
- **Companion classroom instruction tool:** All students in the class use EdReady in conjunction with traditional materials to prepare for quizzes and tests, enabling the teacher to work individually with students in their areas of identified need. This model has been used the longest at Highlands College and UM Western. At UM, all students in 100-level classes have access to EdReady, and a mentorship program is being piloted in Fall of 2015 to provide targeted support for M115 students at UM.
- **Pathway and nonmath class preparation:** Efforts related to the HealthCARE Montana grant and in partnership with statewide ABLE leaders will provide EdReady resources for students to acquire foundational math skills needed for any given pathway. Over 100 discreet pathway preparation goals have been created in a nationwide collaborative effort that Montana representatives helped form.

Beginning in Spring 2014, there were 42 EdReady users in Montana. By Fall 2015, that figure had grown to over 20,000 (see Figure 9). This growth represented users at all postsecondary institutions (flagship universities, regional colleges, 2-year/community colleges, and tribal colleges) as well as high schools, adult basic education programs, and individual users.

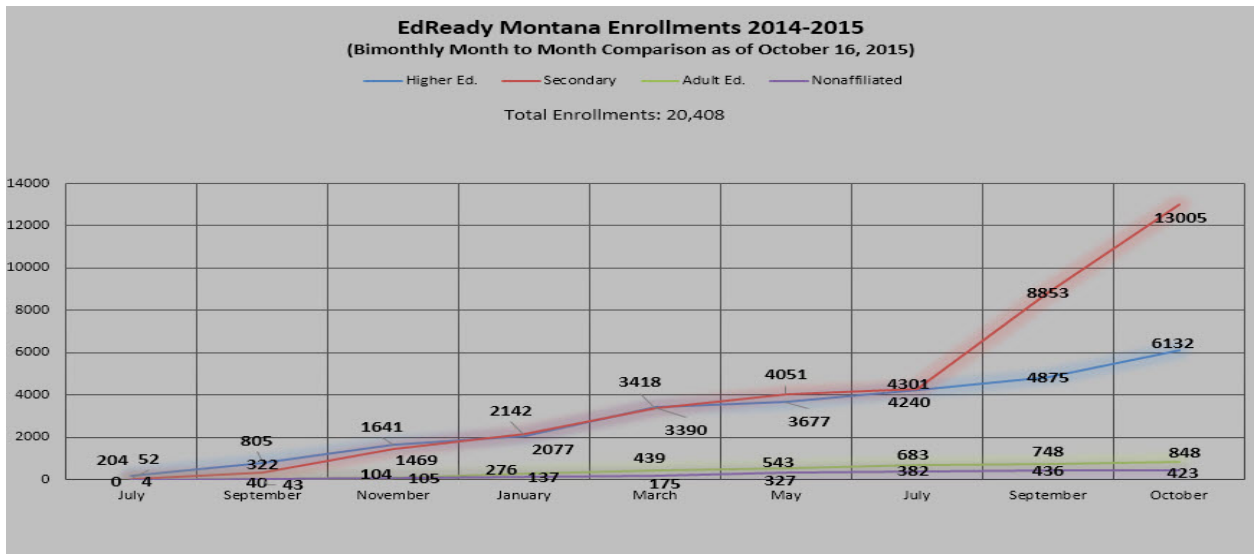


Figure 6. EdReady Montana enrollments, 2014-2015.

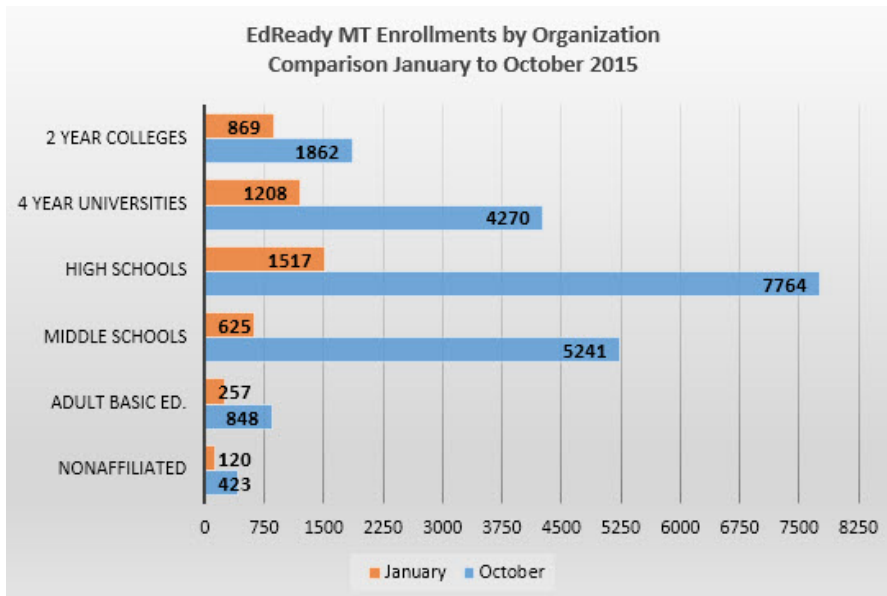


Figure 7. EdReady Montana enrollments by organization, January-October, 2015.

Early analysis from EdReady shows that students who use EdReady are able either to move directly into college-level math courses or shorten the time needed in remedial math. This tool is changing MUS's approach to remedial math education. In addition to improving academic performance, EdReady can create cost savings by reducing the need for traditional remedial courses and increasing student retention and graduation rates.

UM-Missoula has taken a number of steps over the last 20 years to create appropriate math pathways and increase student success:

- In Fall 1997, we introduced a new course, Contemporary Mathematics (originally numbered 107, now 105), intended for students whose majors had no specific math requirement beyond general education (humanities, arts, etc.). This has been a very successful course, with total enrollment of 400 or more every year.
- In Fall 2008, we introduced a two-semester sequence, College Algebra (originally 111, now 121) and College Trigonometry (originally 112, now 122) for students intending to take Applied Calculus (M 162) or Calculus I (M 171) but for whom the one-semester Precalculus course (M 151) was too fast-paced.
- Starting in Fall 2010, the M 121/122/151 course coordinator introduced a series of changes in those courses that have increased student success by around 10%. These include online homework systems that give immediate feedback to students and the opportunity for extra practice.

The enrollment figures and pass rates for 2012-13 reflect the success of these initiatives. Only 15.3% (333/2171) of UM-Missoula students and 21.6% (130/603) of Missoula College students taking one of the courses between M 105 and M 151 took College Algebra. This indicates that students are not generally taking M 121 as a general education math course but as a prerequisite for other math courses, such as calculus.

#### **2012-2013 Enrollments & Pass Rates in 100-level Math Courses Numbered 151 and Below**

<b>Course</b>	<b>UM-Missoula</b>		<b>Missoula College</b>	
	<b>Enrolled</b>	<b>%Pass</b>	<b>Enrolled</b>	<b>%Pass</b>
M 105: Contemporary Math.	411	86.6	124	71.0
M 115: Prob. & Linear Math	942	78.9	320	78.1
M 121: College Algebra	333	81.7	130	82.3
M 122: College Trigonometry	122	91.8	25	76.0
M 135-6: Math for K-8 Teachers	227	92.1	0	
M 151: Precalculus	136	81.6	4	100.0
<b>Total: 151 and below</b>	<b>2171</b>		<b>603</b>	

**Table 1. Note: These figures exclude students who withdrawal.**



## Statewide Placement Workgroup

The Math Pathways Task Force supports the Statewide Placement Workgroup in its effort to create a consistent and effective approach to mathematics placement across MUS. The workgroup's efforts to reevaluate current placement policies; consider "cut ranges" rather than "cut scores;" and implement additional placement metrics such as class rank, GPA, and time since last math course will be closely followed. The task force will also support additional efforts including investigating correlations between math placement and gateway success and the effect of initial math placement on student success and degree completion.

## Conclusion

Over the past year, the Montana Math Pathways task force has done the following:

- Examined national data and pathways research from CCA and the Dana Center at the University of Texas at Austin as well as recommendations from the Mathematical Association of America to determine how research can assist Montana students.
- Evaluated statewide student success data with an emphasis on math to see where students are getting caught in a "math spin cycle" or experiencing math avoidance.
- Found College Algebra to be one of the biggest barriers to success, often creating a spin cycle where students retake the course
- Discussed reasons why this phenomenon is occurring across the state. Most campuses had similar reasoning, but colleges with nursing programs noted that students try to get better grades in M121 for their competitive entry process.
- Agreed that advisors need better information about the math sequence and the confusion created by out-of-order numbering.
- Recommended better communication between math and other faculty to assess math course outcomes that pertain to their program/degree.
- Debated the proper pathway through developmental education for STEM and non-STEM majors.
- Confirmed that Introductory Algebra is an effective mathematical prerequisite for some gateway math courses.
- Encouraged each campus to look at its current math sequence for STEM and non-STEM majors and discuss its relevance to the program

While we acknowledge that mathematics is seen as a roadblock to success, the Montana Math Pathways Task Force has worked hard to identify the root of this perceived roadblock: the misconception that College Algebra should be the default course for all students. We have addressed the barriers stemming from that misconception and have a plan to help remove those roadblocks.

The task force is committed to helping all students be successful in mathematics. We will work on this in the second year by making sure that mathematics courses are more appropriately aligned with various majors. Key strategies include the following:

- Distribute a report to educational and industry stakeholders.

- Develop timelines and determine responsible entities for implementing the recommendations in the report.
- Encourage full adoption of our recommendations rather than small pilots.
- Develop a plan to track results and measure improvement in math, retention, progression, and graduation outcomes.
- Provide BOR with evidence regarding implementation of Math Pathways.
- Make recommendations to improve advising across MUS via clear, ongoing communication with advisors regarding Math Pathways and by staying informed on best practices.
- Leverage successful pilots already underway in Montana to incorporate corequisite design for students placed in remedial math. Montana was selected by CCA to participate in its corequisite initiative to provide math and writing support for students enrolled in a gateway course. Montana will join several other states with this effort in March 2016.

The task force will conclude its work in Fall 2016, when it presents its final recommendations to BOR. It is considering recommending creation of a statewide Math Council charged with overseeing implementation of task force recommendations. The task force is also considering recommending that BOR require regular updates from the Math Council regarding the status of recommendations implementation.

## Task Force Members

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## References

- Beyond Crossroads Writing Team. (2006). *Beyond crossroads*. American Mathematical Association.
- Committee on the Undergraduate Program in Mathematics. (2004). *CUPM curriculum guide*. Mathematical Association of America.
- Fike, D., & Fike, R. (2012). The consequences of delayed enrollment in developmental mathematics. *Journal of Developmental Education*.
- Montana Department of Labor and Industry. (2015). *Labor Day report*. Helena, MT: State of Montana.
- MUS Student Warehouse. (2015).
- Office of the Commissioner of Higher Education. (2014). *Educational attainment*. Helena, MT: Montana University System.
- State of Montana. (2013). *Bullock announces complete college Montana initiative*. Helena, MT.
- The ACT. (2015). *Profile Report - Montana*. ACT, Inc.