Streamlining Math Pathways in Florida

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We will discuss the following recommendations:

Recommendation #1: Create common mathematics pathways by aligning mathematics courses to programs, meta-majors and careers in Florida.

Recommendation #3: Ensure mathematics prerequisites align with mathematics pathways.

Recommendation #5: Encourage colleges and universities to implement instructional models (such as the co-requisite model) that place students, when appropriate, directly into college-level mathematics courses carrying general education credit.

Key Ideas

Alignment:

- Mathematics course requirements are aligned to programs of study (Recommendation #1).
- Support course content is aligned with the content of gateway courses (Recommendation #3).

Acceleration:

- Place students, when appropriate, directly into college-level mathematics courses carrying general education credit, and
- Implement co-requisite instruction to improve academic outcomes in the gateway course (Recommendation #5).

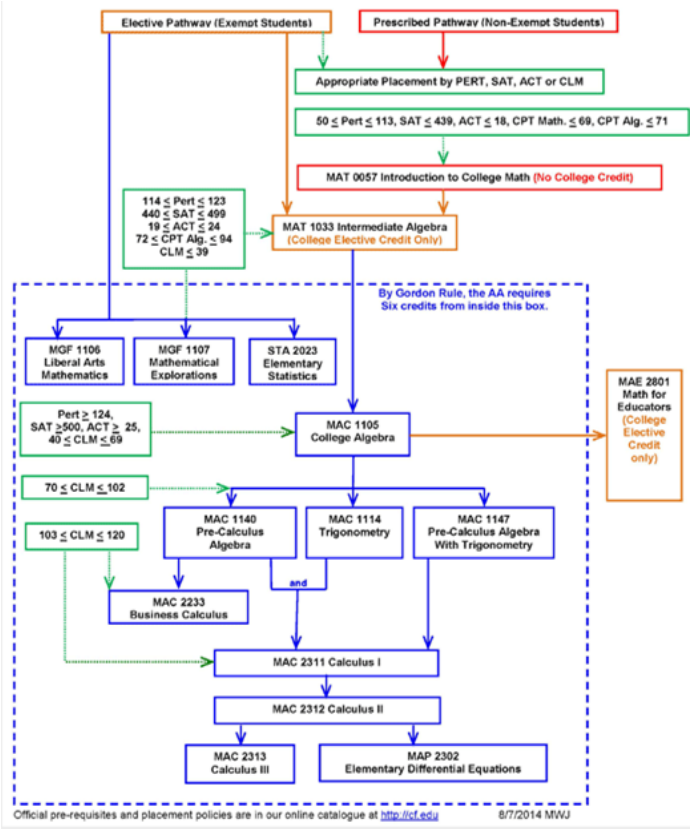
Recommendation #1: Create common mathematics pathways by aligning mathematics courses to programs, meta-majors and careers in Florida.

What is the definition of Math Pathways?

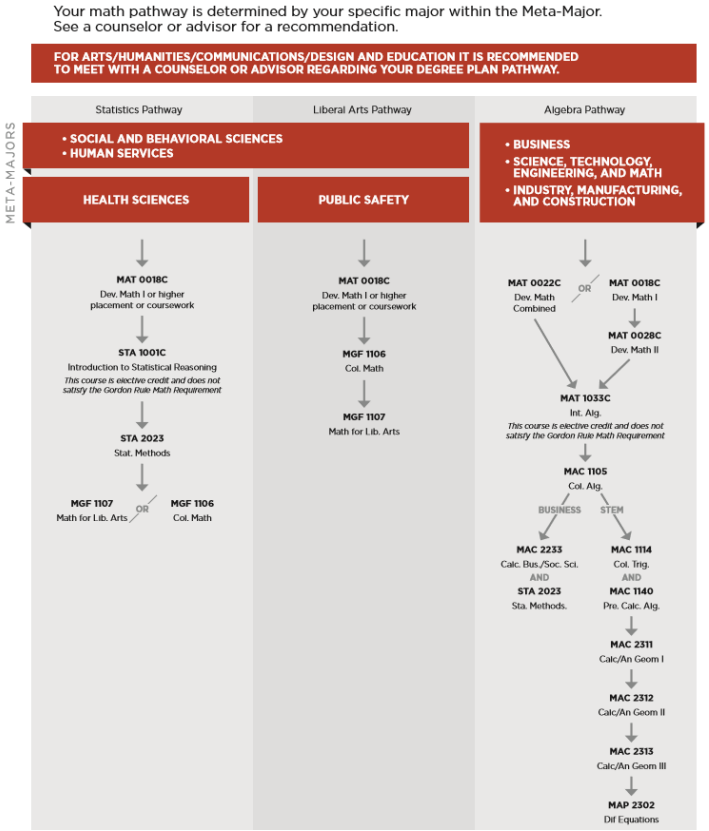
Math pathways enable students to take different paths through the math curriculum, depending on their course of study, so the math they learn is relevant and aligned to their goals (Ganga & Mazzariello, 2018).

Math Pathways...

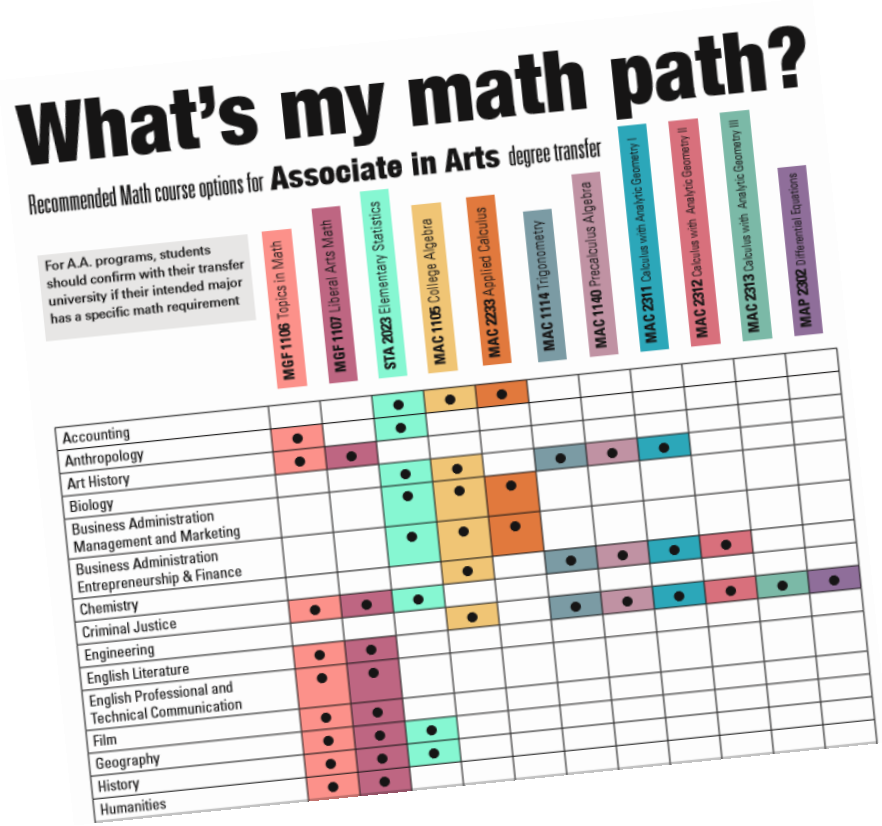
...are more than sequences of math courses



...they are also aligned to meta-majors & programs of study



Create **common** math pathways in Florida

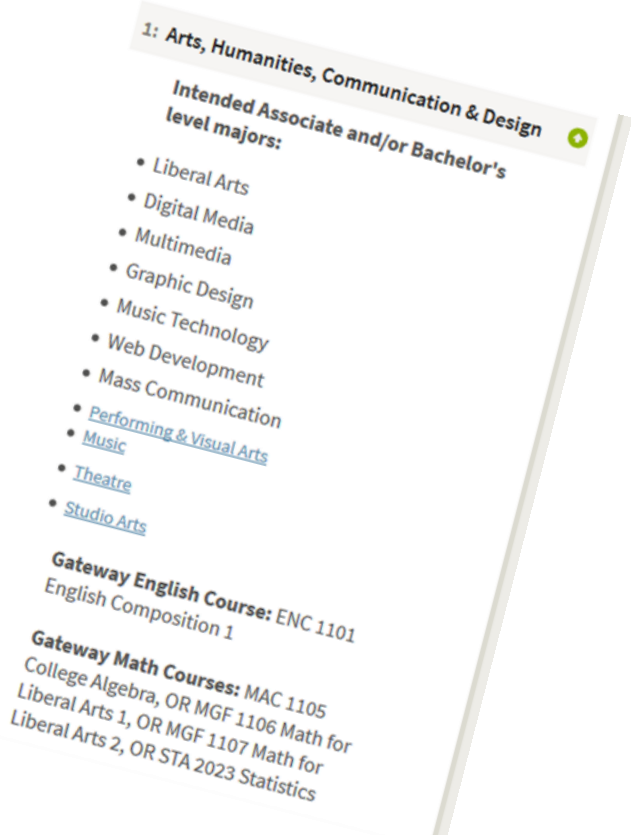


What's my math path?

Recommended Math course options for **Associate in Arts** degree transfer

For A.A. programs, students should confirm with their transfer university if their intended major has a specific math requirement

	MGF 1106 Topics in Math	MGF 1107 Liberal Arts Math	STA 2023 Elementary Statistics	MAC 1105 College Algebra	MAC 2239 Applied Calculus	MAC 1114 Trigonometry	MAC 1140 Precalculus Algebra	MAC 2311 Calculus with Analytic Geometry I	MAC 2312 Calculus with Analytic Geometry II	MAC 2313 Calculus with Analytic Geometry III	MAP 2302 Differential Equations
Accounting			●	●	●						
Anthropology	●		●								
Art History	●	●				●	●	●			
Biology			●	●							
Business Administration Management and Marketing			●	●	●						
Business Administration Entrepreneurship & Finance			●	●	●						
Chemistry				●		●	●	●	●		
Criminal Justice	●	●	●			●	●	●	●	●	●
Engineering				●							
English Literature	●	●									
English Professional and Technical Communication	●	●									
Film	●	●									
Geography	●	●	●								
History	●	●	●								
Humanities	●	●									



1: Arts, Humanities, Communication & Design

Intended Associate and/or Bachelor's level majors:

- Liberal Arts
- Digital Media
- Multimedia
- Graphic Design
- Music Technology
- Web Development
- Mass Communication
- Performing & Visual Arts
- Music
- Theatre
- Studio Arts

Gateway English Course: ENC 1101 English Composition 1

Gateway Math Courses: MAC 1105 College Algebra, OR MGF 1106 Math for Liberal Arts 1, OR MGF 1107 Math for Liberal Arts 2, OR STA 2023 Statistics

Creating common math pathways in Florida:

- Focusing on academic disciplines using a survey
  - Example: Arkansas Mathematics Task Force

- Focusing on mathematics course sequencing
  - Example: North Carolina’s Brunswick Community College

Focusing on academic disciplines

- Identify mathematics competencies needed for specific programs of study, relying on upper-division discipline-specific faculty to identify the competencies.

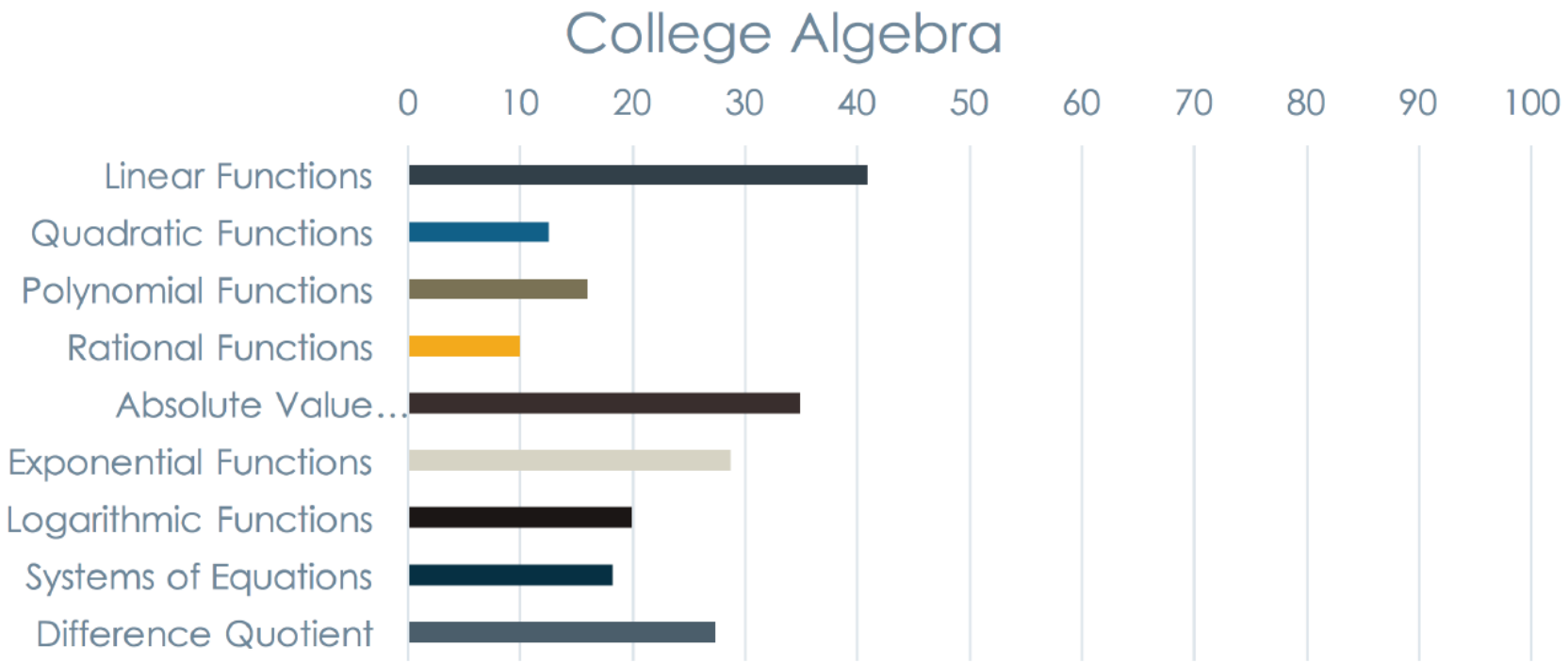
- Use the identified mathematics competencies to recommend common transferable mathematics course requirements for each program of study and corresponding meta-major.

Focusing on academic disciplines: ex. Arkansas

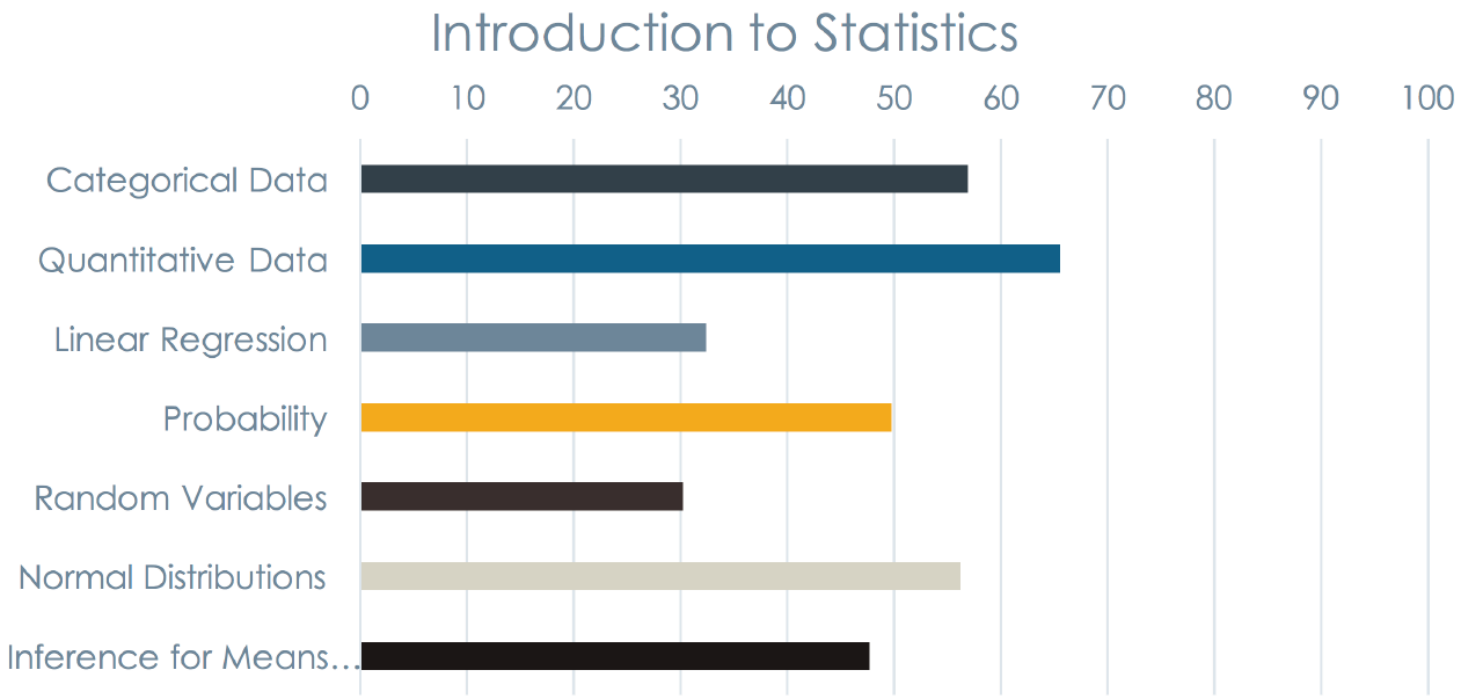
- *Survey of Departmental Leadership at 2-Year and 4-Year Colleges in Arkansas to Identify Mathematics Competencies Necessary for Student Success in Non-STEM Disciplines* administered using Survey Monkey.
- The survey presented a comprehensive list of mathematics skills and sub-skills asking the respondent to check the main topics or mathematical skills they felt were important for students in their majors to comprehend.

https://dcmathpathways.org/resources/forging-relevant-mathematics-pathways-arkansas

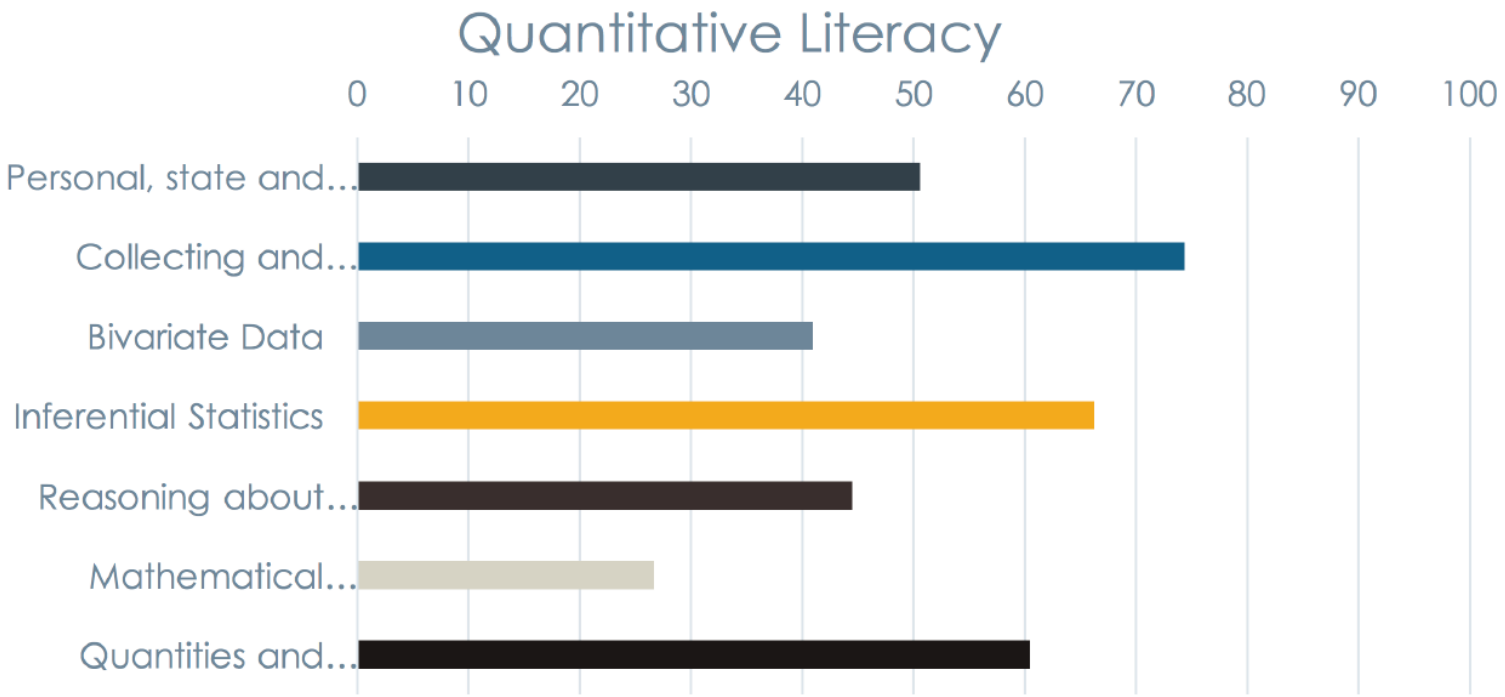
The graph shows the percentage of respondents from non-STEM degree programs who chose required topics that are traditionally associated with and taught in a College Algebra course.



The graph shows the percentage of respondents from non-STEM degree programs who chose required topics that are traditionally associated with and taught in an Introduction to Statistics course.



The graph shows the percentage of respondents from non-STEM degree programs who chose required topics that are traditionally associated with and taught in a Quantitative Literacy course.



Arkansas Math Pathways Task Force recommendations based on the survey results

- Programs of study that do not require Calculus should not require students to take College Algebra.
- Instead, students should be expected to take Quantitative Literacy or Introduction to Statistics, which are courses more relevant to their degree programs, future careers, and civic responsibilities.

Focusing on mathematics course sequencing

- STEM: College Algebra, Calculus and Beyond according to major
- Business: College Algebra, Statistics, Business Calculus according to major
  - Integration of business skills into lower-division mathematics courses for business majors.
- Statistics/Liberal Arts Pathway
  - Broaden access to STA2023 through new placement and prerequisite policies.
- Liberal Arts Pathway
- Quantitative Reasoning/Literacy Pathway
  - Broad learning outcomes: Argumentation/Communication, Proportional reasoning, Probability & Statistics, Modeling, Application

Brunswick Community College, NC - An Example

They have two main pathways...

- **Quant/Stat pathway**, and
- **STEM Calculus pathway** with prerequisite courses labeled “Precalculus Algebra”, rather than “Intermediate/College Algebra”:

  MAT 001P - Math Skills Support
  MAT 143 - Quantitative Literacy
  MAT 152 - Statistical Methods I
  MAT 171 - Precalculus Algebra
  MAT 172 - Precalculus Trigonometry
  MAT 263 - Brief Calculus (Prerequisite: MAT 171)
  MAT 271 - Calculus I (Prerequisites: MAT 171 and 172)
  MAT 272 - Calculus II

Brunswick Community College, NC - An Example

The benefits of this system…

- “Intermediate/College Algebra” courses are labeled “Precalculus”.
- The “Precalculus Algebra” label, rather than “College Algebra”, more accurately describes for advisors, students, and program directors, the roles these courses play in the system – preparation for calculus.
- In my opinion, MAC1105 could just as well be called “High School Algebra”, since so much of it overlaps with what is being taught in Algebra 2, a high school level course.

Brunswick Community College, NC - An Example

Labels matter…

- Leaders of programs of study that do not require calculus will conclude that a "Precalculus" pathway is not best suited for them.
- Quant/Stat pathway would address more relevant real-world mathematics, including dimensional analysis, finance, modeling, problems solving, etc.
- This could help with over reliance on MAC1105:

Gateway Enrollment

Course	2014-15	2015-16	2016-17
MAC1105	90,986	104,135	100,041
MGF1106 or MGF2106	25,688	35,446	35,725
MGF1107 or MGF2107	11,500	15,337	16,225
STA2023	53,344	69,375	68,883

~45% of students

Fitting this system into Florida's system…

Two main pathways...

- STEM Calculus
- non-STEM with Quant/Stat/MGF

Developmental Mathematics

MGF 1106 – Explorations in Mathematics I

MGF 1107 – Explorations in Mathematics II

MAT 11xx – Quantitative Reasoning

STA 2023 – Statistics

MAT 1033 – Precalculus Algebra I

MAC 1105 – Precalculus Algebra II

MAC 1147 – Precalculus Algebra III with Trigonometry

MAC 2233 – Survey/Business Calculus (Prerequisite: MAC 1105)

MAC 2311 – Calculus I (Prerequisites: MAT 1147)

Recommendation #3: Ensure mathematics prerequisites align with mathematics pathways.

Key Assumptions:

- Prerequisite course must improve students’ success rate in a gateway course.
- Prerequisite course content must align with the content of a gateway course.

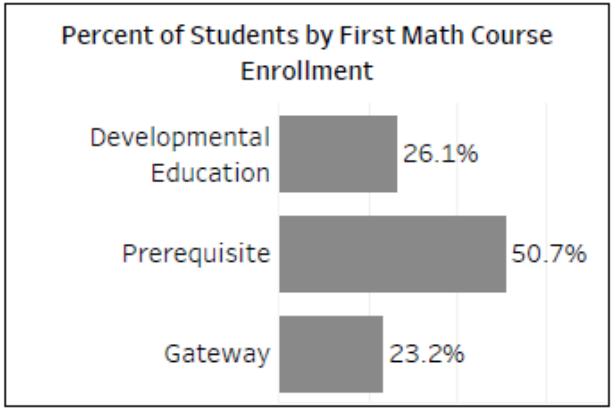
FCS Prerequisite course enrollment in Fall 2014

Students Included in Analysis:

* First-Time, Full-Time (FTIC) in Fall 2014
* Enrolled in Associates in Arts Program
* Enrolled in Developmental Education, Prerequisite, or Gateway Mathematics Course in Fall 2014

Note: Students who participated in dual enrollment in high school or who enrolled in math courses at more than one institution were excluded.

First Math Course Enrollment	
Developmental Education	5,586
Prerequisite	10,855
Gateway	4,976
Grand Total	**21,417**



Students were organized into three groups based on their first math course:

(1) Developmental Education (MAT0012, 18, 19, 22, 23, 27, 28, 29, 54, 55, 56, 57, 58, 157);
(2) Prerequisite Level (MAT1033, MAT1100, STA1001, MAT1032, MGF1100, or STA1021); or
(3) Gateway Level (MAC1105, MGF1016, MGF2106, MGF1107, MGF2107, or STA2023).

MAT1033 Intermediate Algebra enrollment in FCS

About 92% of FCS students, who enrolled in one of the three prerequisite courses in 2016-17 school year, enrolled in MAT1033 course:

Prerequisite Enrollment

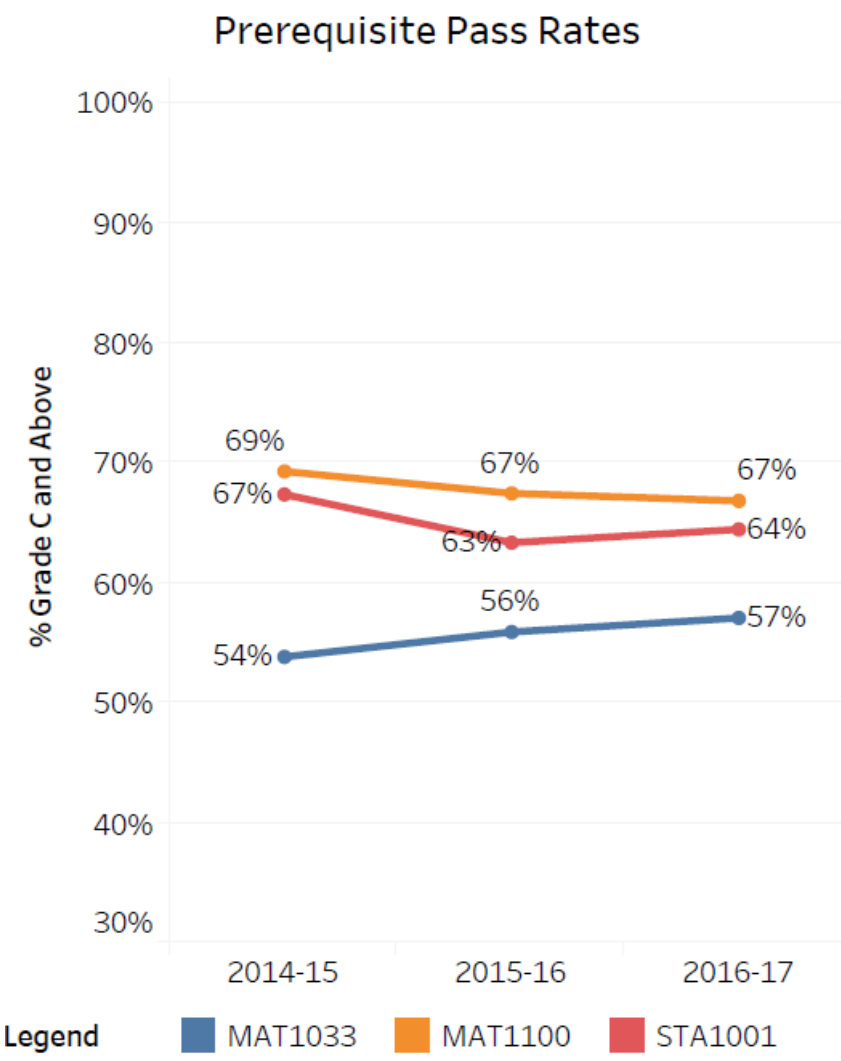
Course	2014-15	2015-16	2016-17
MAT1033	112,513	102,992	95,112
MAT1100	1,501	2,901	4,291
STA1001	711	4,101	4,333

~92% of students

MAT1033 as a common prerequisite in the Florida State Coursewide Numbering System

State Math Gateway Courses	MAC 1105 College Algebra	MGF 1106 Liberal Arts Math I	MGF 1107 Liberal Arts Math II	STA 2023 Statistics
Course Prerequisite as Listed in the State Coursewide Numbering System	MAT 1033 or Placement	MAT 1033 or Placement	MAT 1033 or Placement	MAT 1033

MAT1033 Intermediate Algebra pass rates in FCS



Examine the use of MAT1033 as a prerequisite for STA and MGF courses

- “Prerequisite courses other than Intermediate Algebra can adequately prepare students for courses of study that do not lead to Calculus” (AMATYC, 2014).
    - Thus, MAT1033 may not be the best prerequisite course for STA and MGF courses.
- In the Florida Statewide Course Numbering System, we recommend to reconsider the use of MAT1033 as a prerequisite for STA and MGF courses.

Non-MAT1033 prerequisites for **STA2023** across FCS

None	Dev. Ed.	STA1001	MAT1100	MGF1106 or MGF1107 (2106 or 2107)
College of Central Florida	Gulf Coast State College	Broward College	Florida SW State College	Chipola College
	Hillsborough CC	State College of Florida, M-S	Pasco Hernando State College	Daytona State College
	North Florida CC	Valencia College	Seminole State College	Florida State College at Jax
			St. Petersburg College	St. Johns River State College

MAT1100->MGF1106->STA	MGF1100->MGF1106->STA
Indian River State College	Santa Fe College
Lake Sumter State College	
Palm Beach State College	
Polk State College	

Evidence of Success: MGF1106 & 1107 courses

In 2016-17 school year, St. Johns River State College changed the prerequisite for MGF1106 and MGF1107 courses from MAT1033 to developmental education exemption.

- Success rate for MGF1106 decreased from 76% in 2014-15 to 71% in 2016-17. However, since enrollment increased from 285 to 508, more students were successful.
- Success rate for MGF1107 increased from 61% in 2014-15 to 69% in 2016-17. Enrollment has also increased from 77 to 216.

Evidence of Success: Introductory Statistics course

Based on data from randomized controlled experiment, there is evidence to suggest that many students directed into developmental mathematics can pass the college-level statistics course **without** full remediation (Logue, Watanabe-Rose & Douglas, 2016).

- 56% of students assigned to the college-level statistics with a two-hour workshop support passed the course.
- 39% of students assigned to traditional developmental algebra course prior to taking statistics passed the course.
- 44% of students assigned to traditional developmental algebra course with a two-hour workshop support prior to taking statistics passed the course.

Examine the use of MAT1033 as a prerequisite for MAC1105 course

Recent study suggests that MAT1033 may not increase the likelihood of successful completion of MAC1105 (Center for Postsecondary Success, 2018).

- Within the sample of Fall 2014 FTIC, AA degree-seeking students, researchers identified a group of students with a PERT score range that would have placed them into MAT1033. Within this group, some students took MAT1033 and others enrolled into MAC1105 (possibly due to other placement measures [SAT scores, etc.])

Recommendation #5: Encourage colleges and universities to implement instructional models (such as the co-requisite model) that place students, when appropriate, directly into college-level mathematics courses carrying general education credit.

What is the definition of a Co-Requisite?

Co-requisite developmental instruction or tutoring that supplements credit instruction while a student is concurrently enrolled in a credit-bearing course. (FL Statute 1008.02)

Working definition: ...the placement of students who have been designated as underprepared directly into college-level courses and providing additional supports. (Charles A. Dana Center 2019)

Investigation of Math Pathways in the Florida College System by the Center for Postsecondary Education (CPS) at FSU

Table 4: Predicted Probability of Earning a Degree within Two Years and Exposure to MAT1033 as a Prerequisite

	No Pre-req.	Took/Passed MAT1033	Took/Failed MAT1033
Earned Degree	7.67%	5.52%***	4.52%***

*Note. Stars indicate whether changes in MAT1033 exposure are statistically significant compared to taking no prerequisites. *** $p < .001$.*

Investigation of Math Pathways in the Florida College System by the Center for Postsecondary Education (CPS) at FSU

Table 2: Predicted Probability of Passing MAC1105

	No Pre-req.	Took/Passed MAT1033	Took/Failed MAT1033
All students	62.92%	58.21%***	41.38%***
Students below gateway placement	53.88%	n/a	38.31%***
Students placing into MAT1033	62.52%	n/a	44.15%***

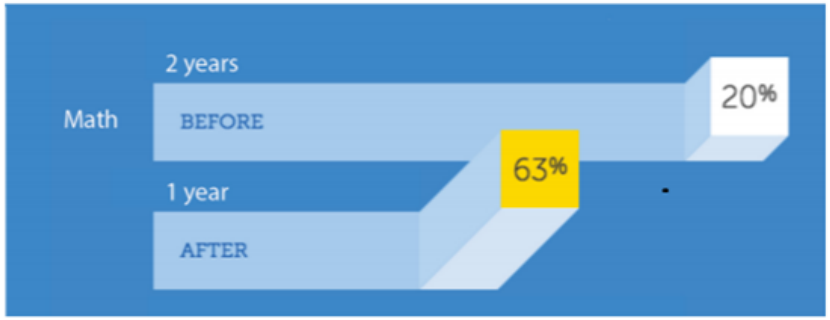
*Note. Stars indicate whether changes in MAT1033 exposure are statistically significant compared to taking no prerequisites. *** $p < .001$.*

Three Main Objectives of a College Algebra Co-Requisite Course:

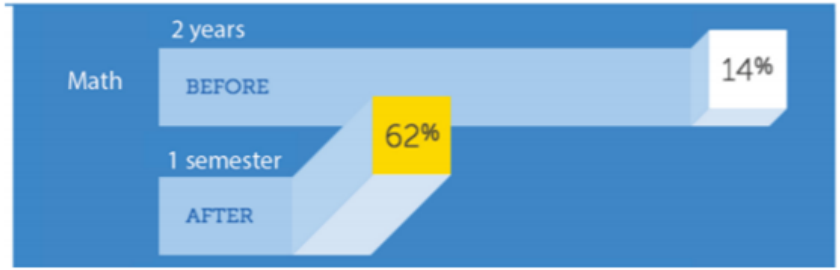
1. Remediate - Students will learn the material that is needed for College Algebra.
2. Reinforce - Students will reinforce the material that is learned in College Algebra.
3. Practice - Students will apply the material that is learned to real life problems.

Co-Requisite Successes

Georgia



West Virginia



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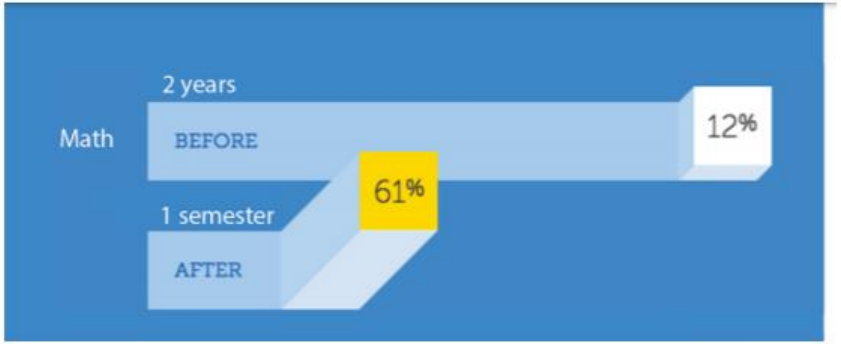
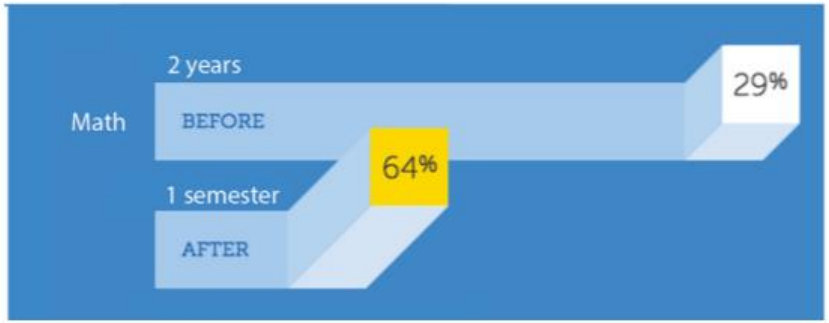
Co-Requisite Successes

Tennessee



Indiana



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Dana Center Mathematics Pathways: Co-Requisite Supports Narrowing the Gap Between Instruction and Support

Consideration 1: Existing campus supports

- Are there other initiatives on campus, such as guided pathways work, examining content, pedagogy, alignment, enrollment, persistence, etc.? What other on-campus resources can be accessed?

Consideration 2: Co-requisite model (placement, credit hours, financing)

- **Placement:** What information is used to determine the default enrollment for students into their mathematics courses?
  - How will you determine which students are best served by a one-semester co-requisite structure or by a yearlong sequence?
  - Consider giving students information about support options and allowing them to choose.

- **Student structures**
  - **Co-mingling:** Mixing college-ready and underprepared students in the same class. Underprepared students are provided additional supports.
  - **Cohorting:** Designating certain sections of college-level courses exclusively for underprepared students. Additional supports may be embedded or separate.

- **Calendar structures**

Just-in-time supports

- **Support courses:** Separate, structured support courses that run before, after, or on opposite days to the college-level courses; completed within one semester
- **Embedded supports:** College-level classes with the developmental content embedded
- **Mandatory tutoring:** Required attendance in a tutoring lab for a specified number of hours per week

Prerequisite supports + college-level; one semester

- **Boot camp:** First 3-5 weeks of the semester are remediation, followed by the college-level content (classes meet for extra hours each week throughout the semester in order to equal the two classes or class + lab)
- **Compressed courses:** Developmental prerequisite class is compressed into 8 weeks, and then the college-level class is compressed into 8 weeks, so that both classes are completed in one semester (classes meet for extra hours each week throughout the semester in order to equal the two classes).

Just-in-time supports; two semesters

- **Stretch courses:** College-level classes with the developmental content embedded, and stretched over two semesters (e.g., Statway model)

- **Grades:** Whether to give one grade or separate grades for the two portions
- **Staffing:** Determining whether the college-level instructor will also teach the support/developmental portion
    - If separate instructors, what mechanisms will be in place to foster coordination between instructors?
- **Credit hours and financing**
    - How many hours do students attend the college-level portion?
    - How many hours do students attend the support/developmental portion?
    - How many hours do students pay for?
    - How do the hours count in the instructor's teaching load?

Consideration 3: Co-requisite content

- What are the essential foundational concepts that students need to know in order to be successful in the college-level course?

Consideration 4: Cultural shifts

Cultural shifts in both the college-level and the support classrooms can contribute to the narrowing of the gap between instruction and supports.

- **Collaborative work** can contribute to the formation of peer support groups.
- **Early referral** can increase success and decrease withdrawals.
- **Explicit instruction** in goal-setting, self-regulation, and the value of struggle can increase persistence.
- **Ongoing formative assessment** can result in early intervention and increased success.

Example of Schools in Florida implementing a Co-requisite Model with MAC1105

Five faculty at MDC are piloting a MAC1105 College Algebra co-requisite course in the Fall of 2019. Students who are exempt and have been placed into MAT1033 will have a choice to go directly into MAC1105 as long as they decide to enroll into a co-requisite lab that meets two hours a week. Also, students only pay for 3 credits. The extra co-requisite hour is not pass or fail.

Each professor will pilot 1 Intervention (experimental) class and 1 Control class. Students have the co-requisite part after the course where the students meet with the Learning Assistant (Not Professor) to facilitate the dialogue about the topics learned in class. The class is worksheet based/ active learning.

Critical Takeaways

- Students should engage in a mathematic pathway that directly relates to their academic and career goals.
- Students should complete their first transferable mathematics course within their first year of study.