Mathematics Course Placement
How? Why? For whom?

Recommended Guidelines
for an
Effective Placement Process for the First College Mathematics Course

Broader Context

How is the placement process situated in the broader context of mathematics pedagogy, curriculum, equity, teacher professional learning, and a modern view of mathematics? For example (adapted from Huey and Hart 2020):

- Earlier Transitions: *As we think about placement processes to support an effective mathematics transition from high school to college, how can we learn from and build upon student's earlier educational transitions?*
- Disparate Opportunities to Learn: *In what ways do mathematics placement processes replicate these educational disparities?*
- Tracking: *In what ways are we replicating the negative impacts of tracking through college placement processes and associated courses?*
- Beliefs about Students' Ability to Learn Mathematics: *Do these beliefs translate into tangible actions in terms of course placement, the learning environment, and culturally-responsive teaching?*
- Testing versus Knowing and Doing: *How do placement tests potentially under-represent what students know and how do they privilege "good test takers" versus those who can reason, communicate, and make sense of mathematics? By focusing on test results generally, how are we narrowing the mathematics being taught and learned in ways that don't prepare students for STEM fields, modern careers, and citizenship?*
- Robust Curricula: *Given the limited success of traditional high school and college mathematics curricula (e.g., less than a quarter of high school seniors are proficient on NAEP 2019, and "[college] mathematical sciences curricula need new courses, new majors, new programs" as per the National Research Council's 2013 report), how can placement processes help support needed curriculum reform?*
- Teacher Professional Learning: *What changes are needed in pre-service and in-service teacher education to meet the challenges of effective pedagogy, a more modern view of mathematics curricula, teacher tracking, and culturally-responsive teaching?*

In summary:

As we think about effective mathematics placement processes, how do we ensure that we also take into account the broader issues of mathematics education and research?

Guiding Principles for Effective Mathematics Course Placement

An effective placement process should ...

- Promote student success, equity, and access to mathematics for all students.
- Empower the student as the primary decision maker.
- Realistically assess students' readiness, but not be a barrier.
- Help students become college-ready, and help colleges become student-ready.
- Support robust mathematics teaching, learning, and content.
- Bring high schools and colleges together with regard to mathematics teaching, learning, and content, through a clearly articulated and proactively compatible process.

Recommendations for Effective Mathematics Course Placement

1. **Use multiple measures**: Use a multiple-measures placement process, designed to ascertain the student's whole mathematics story, for example by using all sources below when available:
    - An initial automated flow-chart survey that gathers information about and assesses a student's background (including date of last course taken), plans, and dispositions.
    - High school math GPA and overall GPA (e.g., utilizing the forthcoming statewide e-transcript system).
    - Non-cognitive factors (such as, effort, commitment, growth mindset, math anxiety)
    - External test scores such as ACT and SAT as supplemental sources of information.
    - An appropriate skills test compatible with the Guiding Principles above.
2. **Use judicious minimal testing**: Test only the minimum necessary number of students. Not everyone needs a placement test. For example, if a student has four years of successful mathematics in high school, or if a student has recently passed a concurrent enrollment course in high school, then they should automatically be eligible to enroll in a credit-bearing college mathematics course.
3. **Increase transparency and reduce placement test anxiety**: Clearly specify what topics will be on placement tests, to students, high schools, and colleges, so that students can study and prepare for the experience. When possible, provide non-proctored, non-binding practice tests ahead of time to reduce test anxiety.
4. **Maintain mathematical and pedagogical integrity**: For any test used, ensure that it assesses the mathematical methods, skills, concepts, processes, and dispositions that we value.
5. **Allow appropriate use of technology**: Allow appropriate use of mathematically-rich technology tools on placement tests.
6. **Avoid unnecessary placement in developmental coursework**: Students should be offered alternatives beyond previously taken courses unless the mathematical content is required and essential for their major. Non-STEM majors in particular should be provided with mathematically rich courses that will meet their needs for future coursework.

Note: Long developmental math sequences do not work. Students should be offered alternatives beyond previously taken courses unless the mathematical content is required and essential for their major. Non-credit bearing developmental courses should be limited to one semester. Developmental math should be made as efficient as possible. [Citation needed]

7. **Allow for just-in-time review and co-requisite models**: Acknowledge the applicability of just-in-time review and broader co-requisite models to advance students into higher level courses rather than necessarily placing them into lower courses.
8. **Coordinate with multiple pathways:** Tailor the placement process so that it flexibly adapts to different mathematics pathways at high school and college. For instance, non-calculus pathways, such as statistics and data science, and non-STEM pathways are becoming more common, and placement processes must accommodate these pathways.
9. **Strive for consistent placement processes statewide, while recognizing differences and the need for flexibility:** Recognize that different institutions have different needs and constraints so that a single placement process may not be universally applied statewide, yet strive for consistency, coordination, and clear communication of placement processes across institutions that reflects best-practices and recommendations of national organizations and professional communities.
10. **Ensure clear communication of course expectations:** Recognize that not all similarly-titled high school and college courses address the exact same content, mathematical practices, or rigor, and therefore provide students, high schools, and colleges with ample information about course expectations to facilitate the best course placement decisions.
11. **Provide effective advising:** Effective course placement requires effective advising. With careful and knowledgeable advising, remedial no-credit courses and placement tests can be offered but need not be required. With appropriate advising students will be empowered to choose their own placement to best suit their needs. This requires well-informed advice from school counselors, college student support staff, and faculty.
12. **Consider when as well as what for the first college mathematics course:** Generally speaking, students should take their first mathematics course in college during the first year in order to retain previously learned skills and understandings. At times, it may be beneficial to delay the first course until the second semester (e.g. biology, chemistry, and business) in order to develop independent study skills, and some majors require mathematics upon entry to college (e.g. engineering, physics, mathematics).

Case Studies

The Guiding Principles and Recommendations above are illustrated in the following case studies. The four cases provided are certainly not comprehensive in nature, but were purposefully selected to highlight potentially complex circumstances and a range of student readiness. The cases are common in terms of how the principles and recommendations are applied and provide a sense of the intentions and spirit of the mathematics placement process.

Case 1: Consider a high school student who expects to be a non-STEM major in college and has successfully completed three years of high school mathematics with no mathematics in his senior year. What is an effective mathematics course placement process for his first college mathematics course?

- Before considering the placement process, it is important to note that a recommendation complementary to the course placement process is that every college-intending student should take 4 years of mathematics in high school, including in the senior year. Advising to this effect should be provided to this student early in high school.
- To begin the placement process, and with regard to the Multiple Measures recommendation, this student's placement process could begin with an initial automated flow-chart survey that gathers information about and assesses the student's background (including date of last course taken), plans, and dispositions. In addition, his high school math and overall high school GPAs should be noted.
- If this survey confirms him as a non-STEM major and his GPAs are satisfactory (e.g., see Iowa e-transcript math GPA policy), then, with reference to the Judicious Minimal Testing and Multiple Pathways recommendations, no placement test or further measures are needed for this student.
- This student can be immediately placed in a credit-bearing "contemporary mathematical literacy" course (the creation of such courses at colleges and universities is a recommendation complementary to these placement process recommendations).
- If the student wants to be placed in a course similar to his last successfully completed high school course, then, consistent with the Avoid Unnecessary Placement recommendation, he should be allowed to do so since he is a non-STEM major. (Note that he did not successfully complete a course within the last year because he did not take math as a senior, so automatically placing him into a course similar to his last high school course, if he wants to do this, is only recommended since he is a non-STEM major. Otherwise, other measures such as a placement test may be warranted.)
- With regard to the Just-in-Time and Co-Requisite Models recommendation, if the student chooses the "contemporary mathematical literacy" course, then it may be that the institution and/or instructor will include some just-in-time skill review as needed in that course. If the student chooses a college course similar to his last high school course, then either just-in-time review or a co-requisite model may be available. (If the student wants to take a course higher than his last successfully completed high school course, then further measures may be needed, but keep in mind the potential of just-in-time review and/or co-requisite models to avoid unnecessarily requiring a placement test.

Other information from the survey or from other measures such as GPA or ACT may be sufficient for this decision without a placement test.)

- In summary, for this non-STEM major with three years of successful high school mathematics, he can be immediately placed into a credit-bearing college math course; either into a "contemporary math literacy" course or, possibly with just-in-time review support, into a course similar to the last course he successfully completed in high school. He does not need a placement test and he should not be placed into a lower course or a non-credit bearing math course. If he wants to take a course higher than his last high school math course or if he switches to being a STEM major, then a different placement process would apply. See other case studies.

Case 2: Consider a high school student who desires to enter a STEM major in college, took four years of high school math, but struggled in the last course due to a family situation that created turmoil in the students' life for most of the academic year. The student's grades for all previous mathematics courses were either A's or B's, but she earned a low C in the final year of precalculus. The student also has some testing anxiety, and she is from an under-represented population within STEM fields. What is an effective mathematics course placement process for a first college mathematics course?

- To begin the placement process, and with regard to the Multiple Measures recommendation, this student's placement process ideally would begin with an initial automated flow-chart survey that gathers information about and assesses the student's background (including date of last course taken), which will reflect some test anxiety, plans for a STEM major, and an acceptable math and overall high school GPA (e.g., see Iowa e-transcript math GPA policy).
- Given the four years of high school mathematics coursework with passing grades, this student automatically qualifies for credit-bearing college mathematics. Based upon the survey results, the student should be given the opportunity to enroll into a precalculus path automatically based upon the recommendation to avoid backwards placement. If the students' precalculus class was college-credit bearing, the student should also be given the option to enroll in Calculus 1 automatically.
- In order for the student to make an informed decision, the student should be given an opportunity to self-assess their readiness for Calculus 1 via a placement test that addresses needed math knowledge specific to the course. The topics on the placement test should be communicated to the student in advance, so that she can refresh her knowledge and prepare for the experience. If possible, a practice exam should be provided to again reduce anxiety related to the test. These recommendations align with the goals of transparency and reducing test anxiety.
- Once an official score has been generated, the student should be provided with feedback regarding areas of success and areas that require further work. When possible, self-remediation should be an option for students as well as multiple attempts on mathematics placement exams supported by tutoring services within the community college or four-year institutions.

- Depending on the scores earned on the placement test, the initial survey, the highschool GPA and other scores such as ACT and SAT, the advice to this student will vary. Given that the student comes from an under-represented population in STEM fields, ACT/SAT and math placement scores may not reflect what the student knows and can do in relation to math due to known systemic bias within testing platforms. The consistent performance of the student in math classes leading up to her last year in high school should be weighted as the strongest source of evidence, as with all students, filtered by the school district performance within the state. ACT/SAT scores should be used as additional sources of information, and the placement test (assuming well designed and managed) should be the second strongest source of information.
- In summary, this STEM student should be placed into Calculus 1 if her performance on the placement test is reasonably good with consideration given to inherent bias in testing systems. If the student does not earn a reasonable score and did not obtain college-credit for the precalculus course taken in high school, detailed feedback on areas that require attention should be provided with opportunities to self-remediate with support, and then reassess. At that point the student should be allowed to decide for herself if she wants to enroll in Calculus 1. Many STEM majors require students to start with Calculus 1 during the first semester of college, which raises the stakes related to this initial placement. Ultimately, the student should know what mathematics is needed for a successful entry to Calculus 1, and be provided with ample feedback regarding readiness.

Case 3: A student joined the military immediately upon high school graduation and served in a technical field. After four years of service, the student decides to attend a community college pursuing a degree in a STEM related area with the intention of transferring to a four-year university.

The student will take the initial flow-chart survey and report a four year gap in formal mathematics instruction. However, the student has served in a technical role in the military and utilized mathematics as part of their daily activities. Of note, most schools do not recognize or accept credit from military courses for credit due to differing course outcomes, as the military courses tend to be more focused and applied in nature. Therefore, a mathematics placement test should be used to determine the student's current skill set.

Placement testing along with non-cognitive factors suggests that the student is ready to take Calculus from a prerequisite skills perspective, despite the fact that the student only completed the minimum math requirements of Algebra 1 and 2 and Geometry in high school. The flow chart survey of non-cognitive factors confirms that the student is prepared to manage their time effectively as a student who also works part-time outside of college. The recommendation provided from the placement process based on the flow chart survey of non-cognitive factors and mathematics placement test is to allow the student to enroll in Calculus and have access to just-in-time remediation to address gaps in skills and knowledge as needed, despite not having a trigonometry class in high school. In all cases, adequate information must be provided to the student to explain course expectations as academic expectations can differ

from military courses. This information is critical for the student to make a fully informed decision as all placement processes are fallible in nature.

Case 4: A student withdrew from high school during her last semester and earned her high school equivalency diploma. She performed well overall in high school and is eager to enroll in college and continue her education.

A student, who performed well in high school, took classes assuming that she would attend college upon graduating. She earned passing grades in Algebra I, Geometry, and Algebra II and enrolled in Statistics her senior year. During her senior year, personal issues became overwhelming, and she made the tough decision to drop out of high school in January. She was able to deal with her personal issues during that spring and summer and obtained her high school equivalency diploma. She is eager to enroll into college for the following fall semester.

The initial flowchart survey data, GPA (overall and math) prior to dropping out of high school indicate that the student was a strong math student. She took mathematics her senior year and earned a B+ first semester. In a non-cognitive factor examination, the student reports that she has addressed the issues that caused her to drop out of high school and that she is doing well mentally. If she is pursuing a non-STEM degree, then further testing is not needed, she should be allowed to enroll in a non-STEM mathematics course (she took mathematics within one year of enrollment). If she is pursuing a STEM degree, then a placement test is warranted. Statistics is not an algebra-based course, so due to the algebra gap, it would be wise to share resources for her to study for the placement test. If she scores well, she should be placed into pre-calculus or calculus coursework. If her placement score indicates she needs additional support, then she may be placed into no lower than an Algebra II type course (avoid backwards placement) or possibly a precalculus with co-requisite support course.

These case studies are meant to start conversations, and we note that every student situation is unique. We recommend that placement decisions be made according to the Guiding Principles and Recommendations above in this document.

Resources and References

POSITION STATEMENT
INITIAL PLACEMENT OF TWO-YEAR COLLEGE STUDENTS INTO THE MATHEMATICS CURRICULUM
https://amatyc.org/page/PositionInitialPlace

AMATYC (2014). Position Statement of the American Mathematical Association of Two-year Colleges:The Appropriate Use of Intermediate Algebra as a Prerequisite Course. Available at : https://amatyc.org/page/PositionInterAlg

Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus states that placement tests should provide a measure of students' abilities not only to show mastery of algorithmic skills but also to think critically and solve problems (AMATYC, 1995).

Developmental Education: Recommendations to Improve Postsecondary Student Success (Iowa DOE, 2019)
https://educateiowa.gov/documents/publications/2021/05/developmental-education-recommendations-improve-postsecondary-student

College Transitions: Ensuring High School Graduates are College Ready through Partnerships with the Community College (Iowa DOE, 2018)

https://educateiowa.gov/documents/boards-commissions-committees-councils-and-task-forces/2021/05/college-transitions

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Huey, Maryann and Eric Hart (2020). Objectives and Broader Educational Context for Iowa's Planned Work on the Mathematics Transition from High School through College. Available at:

Research for Action. (2021). *Multiple measures placement assessments: Benefits and challenges to consider*. Benefits and challenges of the measures commonly found across the eight campuses included in Research for Action's spring 2016 field work on multiple measures implementation.
https://ordj93404cx3hdh7vxlhkvz0-wpengine.netdna-ssl.com/wp-content/uploads/2017/05/Multiple-Measures-Assessment-Pros-and-Cons-Final.pdf

Transitional Math Course like Illinois https://pearson.wistia.com/medias/mjio1900eh

Zachry Rutschow, Elizabeth (2019). *The National Academies of Sciences, Engineering, and Medicine Workshop on Understanding Success and Failure of Students in Developmental Mathematics: Developmental Mathematics Reforms*. Available at: Microsoft Word - Zachry Rutschow_The Current Landscape of Developmental Mathematics Reform Efforts.doc (nationalacademies.org)