Teaching for PROWESS Vision and Change Rubrics Summaries

The Teaching for PROWESS (TfP) Vision & Change Catalyst Tool is a diagnostic tool designed to be used in a self-study to evaluate the implementation of the recommendations of the AMATYC Standards (referring to *Crossroads in Mathematics*, *Beyond Crossroads*, and *IMPACT*) in mathematics departments. The work is based on the extensive work of Partnership for Undergraduate Life Science Education (PULSE)* which was focused on Biology in 4-year institutions. They have been modified based on the features expected in a 2-year college math department that has fully implemented all of the AMATYC recommendations. They are meant as tools to highlight the areas where departments stand out and areas where departments have made less progress.

The complete Teaching for PROWESS Vision & Change Catalyst Tool contains 7 rubrics**:**
1) Student Learning and the Learning Environment, 2) Instruction, 3) Curriculum and Program Development, 4) Assessment of Student Learning, 5) Diversity, Equity, and Inclusion, 6) Professionalism, and 7) Climate for Change.

Terminology: The rubrics can be used to evaluate individual departments or a division composed of mathematics faculty (either full-time or part-time) which will be referred to as 'departments' in this document. The use of the term 'faculty' throughout the rubrics is meant as a generic term for the range of possible titles for all those who are instructors in any course that is part of the department being evaluated.

*An initiative launched by the National Science Foundation (NSF), the Howard Hughes Medical Institute (HHMI), and the National Institute for General Medical Sciences (NIGMS/NIH).

The TfP Rubrics are to be used to report *consensus scores*, not average scores, which result in skewed scores, particularly in small departments. Many departments develop consensus by completing the rubrics during department meetings to discuss differences in scores and come to agreement among department members.

This summary document is intended to give members of a department a basic understanding of each of the rubrics to aid in determining which rubrics the department would like to use. Each rubric section begins with a summary of the intent of the rubric (click on the arrow to expand) and is followed by 8-16 criteria. Further explanation (Context) for each criterion is available by clicking on the criterion. Each rubric is rated on a 0-4 scale. For complete details of each rating, please see the full rubric documents.

Rubric I – Student Learning and the Learning Environment (8 criteria)

Summary

This rubric assesses the extent to which mathematics faculty and their institutions create an environment that optimizes the learning of mathematics for all students. Two-year colleges serve a student body with varied characteristics and academic needs. Each student is entitled to the best educational experiences and opportunities available regardless of age, gender, sexual orientation, race and cultural differences, socio-economic factors, physical and cognitive abilities, or pre-college experiences. Creating a learning environment that maximizes student learning in mathematics and responds to the needs of all students requires the active involvement of every faculty member and each component of the institution. The latest educational research should be used in designing the learning environment. Categories include: A) Learning Environment and B) Resources and Support.

Part A – Learning Environment

Criterion A1: Classroom accommodations

CONTEXT*:* This criterion is focused on providing access to learning opportunities for students with physical, learning, and mental disabilities. When estimating the percentage of accessible classrooms, for the denominator, use the classrooms that are generally assigned to your department for teaching; for the numerator, use the subset that are accessible to students with diverse needs. Also, estimate the extent to which accommodations allow students with disabilities to engage in all learning activities.

Criterion A2: Teaching spaces that support active learning

CONTEXT*:* This criterion is related to the quality of the actual teaching space. The teaching space should be large enough that every small group can work on vertical non-permanent surfaces (VNPS) such as whiteboards. Also, the teaching space should be flexible and reconfigurable with furniture that can be easily (and quickly) rearranged to accommodate student groups of different sizes. When estimating the percentage of classrooms, for the denominator, use the classrooms that are generally assigned to the department for teaching; for the numerator, use the subset that supports active learning. Single level classrooms are generally more conducive to active learning than tiered rooms. An example of a classroom that does not support active learning would be a lecture hall with multiple tiers and fixed seating and minimal whiteboard space.

Criterion A3: Classroom IT infrastructure and active-learning practices

CONTEXT*:* This criterion pertains to technological infrastructure rather than physical infrastructure. At many institutions, classrooms are not controlled at the departmental level, but are instead controlled centrally. Thus, the department often cannot control the classrooms in which they teach. When estimating the percentage of classrooms, for the denominator use the classrooms that are generally assigned to your department for

teaching; for the numerator, use the subset that possesses IT infrastructure that promotes active learning. Examples of IT infrastructure that encourage active learning include flat panel screens, interactive white boards, the ability to project student computer screens to share with groups or the whole class, infrastructure or licensing technology that enables the use of student response devices (i.e. clicker technology), and video and audio lecture capturing capabilities.

Criterion A4: Informal gathering spaces (in person and virtual) that encourage collaboration

CONTEXT*:* This criterion speaks to the importance of space in creating community around learning. Informal gathering spaces include lounges, lunchrooms and eating areas with seating, libraries, open access computer stations, and study rooms.

Criterion A5: Learning center facilities for students

CONTEXT: This criterion is focused on the importance of formal support for student learning and success outside the classroom. Examples of spaces include college-wide writing, math, and reading centers. The key point here is having a learning center that is accessible and welcoming to STEM students. Other issues to consider include 1) Is the facility staffed? If so, is it staffed by trained educators?; 2) Are tutors available?; 3) Are the hours restricted? In other words, is the facility open during hours when students are available to take advantage of it? For example, a learning center that is open 9-5 weekdays may not serve the needs of many students who have time to study only in the evening or on weekends; 4) Is online tutoring available when the learning center is closed?; 5) Does the learning center have the necessary resources such as computers and software used in classrooms or for homework?; 6) Is the writing center open and welcoming to mathematics students?

Part B – Resources and Support

Criterion B1: IT support for teaching

CONTEXT: This criterion addresses the degree to which the institution provides IT support for innovative teaching. Many student-centered classroom activities rely on technology, such as computers and computer projectors, web access, student response systems, video/audio lecture capture, etc. Is there support at your institution to ensure that these technologies function and are reliable? If there is a crisis in the classroom where one of these technologies fails, is there IT support available that will immediately address the problem? Another issue to consider is the degree to which the IT group provides adequate training to

instructors in the use of the technology. Does IT ask instructors for recommendations for improving IT support, software to purchase, upgrades needed, etc.? At the highest level of achievement, the IT staff will also be proactive in presenting emerging technologies to the faculty that can be used to enhance pedagogy including the support for online teaching.

Criterion B2: Support staff for student learning

CONTEXT*:* This criterion is focused on the importance of adequate teaching and teacher support. How well does your institution support the teaching mission with support staff? Examples include 1) administrative/office staff support, 2) a curriculum development or learning specialist who works with STEM faculty members, 3) a faculty member in your department whose scholarship includes discipline based educational research (DBER) and 4) support for Supplemental Instruction when requested by instructors.

Criterion B3: Institutional support for electronic information resources

CONTEXT*:* This criterion addresses the importance of access to scholarly resources for enhancing and improving teaching. Issues to consider include accessibility of electronic resources for faculty and students and assignment of resource costs to the institution or to faculty and students. Electronic resources include online journal subscriptions and licenses to key software packages, etc.

Rubric II – Instruction (14 criteria)

Summary

This rubric assesses the extent to which mathematics faculty use a variety of instructional strategies that reflect the results of research to enhance student learning. Effective mathematics instruction requires a variety of resources, materials, technology, and delivery systems that take into account students' different learning styles and instructors' different teaching styles. Using multiple strategies in the classroom will increase the level of engagement of students and open opportunities for more students to be actively involved in the learning of mathematics. Categories include: A) Pedagogy, B) Student Higher Level Learning, and C) Learning Activities Beyond the Classroom.

Part A – Pedagogy

The Standards for Pedagogy presented in the *Crossroads in Mathematics* are compatible with the constructivist point of view. They recommend the use of instructional strategies that provide for student activity and student-constructed knowledge. Furthermore, the standards are in agreement with the instructional recommendations contained in *Professional Standards for Teaching Mathematics* (NCTM, 1991).

Sentences and phrases in italics show changes based on new knowledge since *Crossroads* was published in 1995. More detail can be found in Chapter 2 of the document.

Criterion A1: Teaching and Technology

CONTEXT*:* Mathematics faculty will model the appropriate use of technology in the teaching of mathematics so that students can benefit from the opportunities it presents as a medium of instruction.

Criterion A2: Active and Collaborative Learning

CONTEXT*:* Mathematics faculty will foster interactive learning through student writing, reading, speaking, and collaborative activities so that students can learn to work effectively in groups and communicate about mathematics both orally and in writing. *Active learning is defined by the following guiding principles: (1) students' deep engagement in mathematical thinking (PRoficiency), (2) instructors' interest in and use of student thinking (OWnership), (3) student-to-student interaction (Engagement), and (4) instructors' attention to equitable and inclusive practices (Student Success).*

Criterion A3: Connecting with Other Experiences

CONTEXT*:* Mathematics faculty will actively involve students in meaningful mathematics problems that build upon their experiences, focus on broad mathematical themes, and build connections within branches of mathematics and between mathematics and other disciplines so that the students will view mathematics as a connected whole relevant to their lives.

Criterion A4: Multiple Approaches and Representations

CONTEXT: Mathematics faculty will model the use of multiple approaches *and representations* - numerical, graphical, symbolic, and verbal - to help students learn a variety of techniques for solving problems.

Criterion A5: Experiencing Mathematics

CONTEXT*:* Mathematics faculty will provide learning activities, including projects, *research opportunities*, and apprenticeships, that promote independent thinking and require sustained effort and time so that students will have the confidence to access and use needed mathematics and other technical information independently, to form conjectures from an array of specific examples, and draw conclusions from principles.

Part B – Student higher Level Learning

Part B – Student Higher Level Learning

Criterion B1: Opportunities for inquiry, exploration, and generalization in courses

CONTEXT: This criterion is focused on the degree to which inquiry-based learning is incorporated into courses. In other words, to what degree do students have the opportunity to do inductive and deductive reasoning, analyze data, craft and test hypotheses, and create mathematical models. Another key point here is that class time should not be dedicated solely to presentation of facts, but instead should expose students to mathematical and statistical reasoning, namely data collection, hypothesis generation, model generation, hypothesis testing, data analysis, and drawing conclusions based on probability.

Criterion B2: Student metacognitive development

CONTEXT: This criterion addresses the degree to which instructors encourage students to reflect on their own learning or metacognition. Metacognition is defined as the process of setting challenging goals, identifying strategies to meet them, and monitoring progress toward them. For scores of 3 or 4, instructors integrate the practice of effective learning strategies supported by cognitive research and reflection on learning into course assignments and assessments. An example of a metacognitive assignment is asking students to review returned exams and correct their answers. For departments seeking Teaching for PROWESS Recognition, examples of metacognitive assignments or assessments requiring metacognition should be included in the Additional Materials to justify a score of 3 or 4.

Criterion B3: Student metacognitive knowledge

CONTEXT: This criterion pertains to the degree to which students reflect on their own learning preferences, tendencies, or strengths in the context of the course or course assignments. For programs seeking Recognition, some information about the measurement of students' understanding of and use of learning strategies that are supported by cognitive research and their ability to reflect on their own learning strategies should be provided in the rubric justification to support the scores indicated. For example, explaining how students' metacognitive knowledge is evaluated and providing quantitative information about the frequency and prevalence of the practice of metacognition by students would support scores of 3 and 4.

Criterion B4: Student higher-order cognitive processes

CONTEXT: This criterion is focused on the type of thinking required of students and whether assignments and assessments are designed to give students adequate practice, particularly in developing higher order cognitive skills. The

lowest order cognitive processes focus on knowledge and comprehension and require students to memorize, name, label, define, arrange, classify, identify, restate, and select. The process of application requires students to apply, demonstrate, interpret, use, or solve. Higher order cognitive processes include analysis (requiring students to analyze, categorize, compare, contrast, differentiate, and test), synthesis (requiring students to compose, create, design, organize, and propose), creation (requiring student to arrange, assemble, build, collect, combine, compile, compose, constitute, construct, create, design, develop, devise, formulate, generate, hypothesize, integrate, invent, make, manage, modify, organize, perform, plan, prepare, produce, propose, rearrange, reconstruct, reorganize, revise, rewrite, specify, synthesize, and write.) and evaluation (requiring students to appraise, assess, defend, evaluate, judge, and predict).

Part C – Learning Activities Beyond the Classroom

Criterion C1: Instructor disposition and availability

CONTEXT: This criterion addresses the need for student-faculty interaction. One aspect to consider is whether faculty members offer regularly scheduled office hours. Preferably, office hours should be held multiple hours per week and at different times of day to accommodate variation in student schedules. Are faculty members willing to meet with students one-on-one if office hours are impossible for them to attend, or if they wish to discuss a confidential matter that is not appropriate to discuss in public office hours? A second example is sessions/review sessions scheduled outside of normal class hours. Thirdly, are faculty members responsive to student questions and concerns via email and/or course online discussion board? It is more difficult to quantify the degree to which the program faculty is interested in student success. Important criteria might include the degree to which faculty members are willing to re-explain basic concepts, or to patiently work with students near the bottom of the class who may be underprepared, to ensure that they progress with their learning and do not become discouraged. Student course evaluations that indicate the degree to which faculty are available and perceived as interested in student success would provide some evidence in support of scores of 3 or 4 on this criterion.

Criterion C2: Availability of supplemental assistance for student success

CONTEXT: This criterion addresses whether the institution offers supplemental student engagement opportunities. These opportunities include 1) availability of tutoring (Are tutors available? Are there sufficient tutors to satisfy student demand? Are the tutors free for students or at least free for students on financial aid?), 2) Peer mentoring (Are there formal peer mentoring programs set up by the institution? These could be one-on-one programs or programs where a peer mentor works with multiple students.), 3) Supplemental instruction (This would

include formal peer-led study groups that are associated with the class or extra class sections for students that need help mastering fundamentals.), 4) Academic advisors (Are academic advisors available for students? Are there sufficient academic advisors to meet student demand? Do students meet with academic advisors frequently enough to establish an effective and beneficial relationship?), 5) Learning communities (Are there opportunities for mathematics students to live/socialize together?), 'Institutionalized,' for a score of 4, refers to permanent funding for these opportunities

Criterion C3: Student participation in supplemental assistance opportunities

CONTEXT: This criterion assesses the percentage of students that actually utilize the supplemental assistance opportunities outlined in C2.

Criterion C4: Student opportunities for activities outside of the classroom

CONTEXT: This criterion addresses whether the institution offers activities for the students to engage in outside of the classroom to enhance their mathematics education. These opportunities may include, but are not limited to: 1) interest-based or career oriented clubs (clubs organized around STEM and/or mathematics specifically) with multiple events throughout the year; 2) internships or service learning including a presentation about the experience; 3) competitions related to STEM and/or mathematics specifically (such as the Student Mathematics League and Student Research League); 4) undergraduate research.

Criterion C5: Student participation in activities outside of the classroom

CONTEXT: This criterion assesses the percentage of students that actually utilize the opportunities to engage in activities outside of the classroom outlined in C4

Rubric III – Curriculum and Program Development (14 criteria)

Summary

This rubric assesses the extent to which mathematics departments develop, implement, evaluate, assess, and revise courses, course sequences, and programs to help students attain a higher level of quantitative literacy, better quantitative reasoning skills, and achieve their academic and career goals. Mathematics departments, in collaboration with appropriate stakeholders, should regularly engage in course and program review and evaluation to assure that the mathematics curricula 1) prepare students to be numerate citizens and productive employees who have an appreciation for mathematics and lifelong learning and 2) meet the mathematical needs of client disciplines. These course and program reviews and the subsequent revisions should reflect the department's own analysis of student achievement and the informed practice

of the mathematics community. Categories include: A) Standards for Content and B) Standards for Intellectual Development.

Part A – Standards for Content

The Standards for Content presented in *Crossroads in Mathematics* provide guidelines for the selection of core concepts that will be taught throughout the first two years of college mathematics. The mathematics needed in the workplace and to be a good citizen has evolved since the publication of *Crossroads in Mathematics* in 1995. The italicized portions of each description were added to address these changes. For specific expectations regarding the seven Standards for Content please refer to Chapters 2 and 3 in *Crossroads in Mathematics.*

Criterion A1: Integration of number sense into the curriculum

CONTEXT*:* Students will perform arithmetic operations, as well as reason and draw conclusions from numerical information. Number sense includes the ability to perform arithmetic operations, to estimate reliably, to judge the reasonableness of numerical results, to understand orders of magnitude, to think proportionally, *and to manipulate data (especially large data sets) in order to visualize patterns.* Topics may include pattern recognition, data representation and interpretation, estimation, proportionality, and comparison.

Criterion A2: Integration of symbolism and algebra into the curriculum

CONTEXT*:* Students will translate problem situations into their symbolic representations and use those representations to solve problems. Students will move beyond concrete numerical operations to use abstract concepts and symbols to solve problems. Students will represent mathematical situations symbolically and use a combination of appropriate algebraic, graphical, and numerical methods to form conjectures about the problems. Topics may include derivation of formulas, translation of realistic problems into mathematical statements, *converting between different representations,* and the solution of equations by appropriate graphical, numerical, and algebraic methods.

Criterion A3: Integration of geometry into the curriculum

CONTEXT*:* Students will develop a spatial and measurement sense *in both Euclidean and analytic (coordinate) geometry*. Students will demonstrate their abilities to visualize, compare, and transform objects. Students will develop a spatial sense *and spatial reasoning* including the ability to draw one, two-, and three-dimensional *shapes from different perspectives and extend a concept, such as vectors, to higher dimensions.* Their knowledge of geometry will enable them to determine *the dimension of a shape and the* area, perimeter, and volume *of common* plane and solid figures. Topics may include comparison of geometric objects (including congruence and similarity), graphing, prediction for graphs, measurement, and vectors.

Criterion A4: Integration of functions into the curriculum

CONTEXT*:* Students will demonstrate understanding of the concept of function by several means (verbally, numerically, graphically, and symbolically) and incorporate it as a central theme into their use of mathematics. *Students will know when a relation is a function.* Students will interpret functional relationships between two or more variables, formulate such relationships when presented in data sets, and transform function information from one representation to another. *Students can use function notation, define recursive functions, and perform operations on functions.* Topics may include generalization about families of functions, *transformations of functions,* use of functions to model realistic problems, and the behavior of functions.

Criterion A5: Integration of discrete mathematics into the curriculum

CONTEXT*:* Students will use discrete mathematical algorithms and develop combinatorial abilities in order to solve problems of finite character and enumerate sets without direct counting. The conceptual framework of discrete mathematics should be integrated throughout the curriculum in order to improve students' problem-solving skills and prepare them for the study of higher levels of mathematics as well as for their careers. Topics may include sequences, series, permutations, combinations, recursion, difference equations, linear programming, finite graphs, voting systems, and matrices.

Criterion A6: Integration of probability and statistics into the curriculum

CONTEXT*:* Students will analyze data and use probability and statistical models to make inferences about real-world situations. The basic concepts of probability and descriptive and inferential statistics should be integrated throughout the mathematics curriculum at an intuitive level. Students will gather, organize, display, and summarize data. They will draw conclusions or make predictions from the data and assess the relative chances for certain events happening. *Students should be introduced to data science techniques for dealing with data sets.* Suggested topics may include basic sampling techniques, tabulation techniques, creating and interpreting charts and graphs, data transformation, curve fitting, measure of center and dispersion, simulations, probability laws, and sample distributions.

Criterion A7: Integration of deductive proof into the curriculum

CONTEXT*:* Students will appreciate the deductive nature of mathematics as an identifying characteristic of the discipline, recognize the roles of definitions, axioms, and theorems, and identify and construct valid deductive arguments. While not being the main focus of instruction in introductory mathematics, mathematical proofs, including indirect proofs and mathematical induction, will be introduced where they will enhance student understanding of mathematical concepts. Students will engage in exploratory activities that will lead them to

form statements of conjecture, test them by seeking counterexamples, and identify and, in some instances, construct arguments verifying or disproving the statements. *Informal proofs (such as proofs using diagrams and pictures instead of words or symbols) should be encouraged.*

Part B – Standards for Intellectual Development

The Standards for Intellectual Development presented in the Crossroads in Mathematics address desired modes of student thinking and represent goals for student outcomes referred to as competencies. Sentences and phrases in italicsshow changes based on new knowledge since Crossroads in Mathematics was published in 1995. More detail can be found in Chapter 2 of the document.

Criterion B1: Inclusion of problem solving throughout the curriculum

CONTEXT: Students will engage in substantial problem solving. *Students should use a heuristic approach such as Pólya's four-step process. Problem solving means the ability to solve problems the student has not previously seen.* Students will use problem-solving strategies that require persistence, the ability to recognize inappropriate assumptions, *the collection of data needed to solve the problem,* and intellectual risk taking rather than simpler procedural approaches. These strategies should include posing questions; organizing information; drawing diagrams; *solving similar, simpler problems*; analyzing situations through trial and error, graphing and modeling; and drawing conclusions by translating, illustrating, and verifying results. The students should be able to communicate and interpret their results.

Criterion B2: Inclusion of modeling throughout the curriculum

CONTEXT: Students will learn mathematics through modeling real-world situations. Students will participate in the mathematical modeling of situations from the world around them and use the models to make predictions and informed decisions. In some cases, faculty may select problem situations and ask students to collaborate on the development of models. In other cases, students may be asked to evaluate previously developed models. Whether students develop their own models or evaluate models that are given to them, they should look beyond how well a proposed model fits a set of data and attempt to provide mathematical or scientific reasons for why the model is valid. *Students should be able to justify any assumptions they made in order to make the model less complicated*

Criterion B3: Inclusion of reasoning throughout the curriculum

CONTEXT: Students will expand their mathematical reasoning skills as they develop convincing mathematical arguments. Students will regularly apply inductive and deductive reasoning techniques to build convincing mathematical arguments. *They will use inductive reasoning to develop conjectures and test these conjectures by using logic, direct and indirect proofs and proof by induction (deductive reasoning), by framing examples and counterexamples, and by*

probabilistic and statistical reasoning. They will explore the meaning and role of mathematical identities, support them graphically or numerically, and verify them algebraically or geometrically. Students will judge the validity of mathematical arguments and draw appropriate conclusions. Finally, students will judge the validity of mathematical arguments and draw appropriate conclusions **a***nd will be able to explain why their reasoning is sound.*

Criterion B4: Connecting with other disciplines is expected throughout the curriculum

CONTEXT*:* Students will develop the view that mathematics is a growing discipline, interrelated with human culture, and understand its connections to other disciplines. Topics such as algorithms needed for computer-based solution processes, the use of probability in understanding chance and randomization, and the applications of non-Euclidean geometries lend themselves to a discussion of who developed the ideas, when they were developed, and what kind of human endeavors motivated their developments. Students will need to research sources other than standard mathematics textbooks to determine how mathematics provides a language for the sciences; plays a role in art, music, and literature; is applied by economists; is used in business and manufacturing; and has had an impact on history.

Criterion B5: Communicating is expected throughout the curriculum

CONTEXT*:* Students will acquire the ability to read, write, listen to, and speak mathematics. Students will acquire the skills necessary to communicate mathematical ideas and procedures using appropriate mathematical vocabulary, *mathematical* notation, *and multiple representations of relations between variables.* Students will learn to read and listen to mathematical presentations and arguments with understanding. Furthermore, mathematics faculty will adopt instructional strategies that develop both oral and written communication skills within a context of real applications relevant to the particular group of students.

Criterion B6: Using technology is expected throughout the curriculum

CONTEXT*:* Students will use appropriate technology to enhance their mathematical thinking, *mathematical reasoning***,** and understanding *of concepts* and to solve mathematical problems and judge the reasonableness of their results. Students will develop an ability to use technology to enhance their study of mathematics in *three* ways. First, technology can be used to *assist students in discovering key ideas and procedures. Second, technology can help students understand* mathematical *concepts and* principles. In general, students can use technology to *find patterns,* test conjectures, explore ideas, verify that theorems are true in specific instances, *or find counterexamples of conjectures. Third,* students will use technology naturally and routinely as a tool to aid in the solution of realistic mathematical problems. Technology should be used to enhance the study of mathematics, *actively involve students in their learning, and assist*

students and instructors to assess student learning. Technology should not become the main focus of instruction.

Criterion B7: Developing mathematical power is expected throughout the curriculum

CONTEXT*:* Students will engage in rich experiences that encourage independent, nontrivial exploration in mathematics, develop and reinforce tenacity and confidence in their abilities to use mathematics, and inspire them to pursue the study of mathematics and related disciplines. Students will engage in solving problems that do not have unique answers but, rather, provide experiences that develop the ability to conduct independent explorations *and research. These experiences would require students to locate and identify information, evaluate the credibility of source information, and incorporate it into their work, and to do so ethically and legally.* At the same time, they will learn to abstract mathematical principles in order to promote transfer of problem-solving strategies among a variety of contexts. and to better appreciate mathematics as a discipline. Furthermore, they will develop an awareness of careers in mathematics and related disciplines and have a vision of themselves using mathematics effectively in their chosen fields.

Rubric IV - Assessment of Student Learning (16 criteria)

Summary

This rubric assesses the extent to which the mathematics faculty use the results from the ongoing assessment of student learning of mathematics to improve curricula, materials, and teaching methods. Formative and summative assessment of student learning of mathematics should be aligned with curriculum and instruction to support student learning. Effective assessment practices include the documentation of student learning at the class, course, and program level. The use of the term ‘program’ refers to a program of study that offers students a choice of transferable gateway college-level mathematics courses aligned to their program of study, such as a statistics pathway for students pursuing social and health sciences, a quantitative reasoning/literacy pathway tailored to humanities or general education students, and an algebra-intensive pathway for students majoring in science, technology, engineering, and mathematics (STEM). These course and program reviews and the subsequent revisions should reflect the department’s own analysis of student achievement and the informed practice of the mathematics community. Categories include: A) Course Level Assessment and B) Program Level Assessment.

Part A – Course Level Assessment

Criterion A1: Clarity of learning outcomes and relationship to AMATYC's Standards for Content and Standards for Intellectual Development

CONTEXT*:* This criterion should be fairly self-explanatory. Appropriate documents (such as course syllabi, outlines, descriptions, etc.) should be collected and evaluated by chair/colleagues/peer instructors for clarity and alignment with AMATYC's Standards for Content and Standards for Intellectual Development.

Criterion A2: Presentation, definition, and discussion of learning outcomes with students

CONTEXT*:* This criterion addresses the concern that students often do not understand the "education-speak" sometimes used to describe Learning Outcomes. Colleagues/peer instructors should be able to note the integration of reminders of the course learning outcomes when visiting/reviewing a course.

Criterion A3: Linkage of summative assessments to learning outcomes

CONTEXT*:* This criterion requires careful articulation of course-level learning outcomes and intentional selection or development of assessments to measure student achievement of the outcomes. A major goal of any assessment program should be to gain information that can be used to improve student learning in the future; a second important goal would be demonstration of achievement for specific students. For a score of three or four, it is essential that assessments are carefully mapped to the outcomes (rather than generically appropriate for the course such as a standardized test used across many sections that provides broad information about student knowledge but is difficult to use for specific course improvements).

The following articles provide research on implementing this criterion: *Aligning Teaching and Assessing to Course Outcomes*, *How to use (five) curriculum design principles to align authentic learning environments, assessment, students' approaches to thinking and learning outcomes*.

Criterion A4: Inclusion of formative assessments

CONTEXT*:* Formative assessments are low stakes assessments, typically ungraded, used for determining learning rather than determining grades, for example, pre-class preparatory quizzes, in-class student problem solving, student response system questions, self assessments, etc. Typically, formative approaches are used by the instructor to adapt their teaching strategy based on student progress.

Criterion A5: Use of instructor independent assessments where available and appropriate

CONTEXT: This criterion addresses the use of assessment tools. Instructor-independent and department-independent tools can include, but are not limited to, validated concept inventories, national society-generated exit exams, and critical thinking assessments, such as the Critical Thinking Assessment Test (CAT) (https://www.tntech.edu/ cat) developed with NSF support.

Criterion A6: Evaluation of the types of student-centered learning activities used in courses

CONTEXT: This criterion measures whether the types of student-centered activities are assessed and documented. Examples of student-centered activities include in-class problem solving as individuals, pairs or groups, student response questions (clickers), and group activities associated with case-based or problem-based approaches. The Teaching Practices Inventory (http://www.cwsei.ubc.ca/resources/TeachingPracticesInventory.htm) developed by Weiman and Gilbert (2014) is an inventory faculty can use to self-evaluate the anticipated effectiveness of the student-centered activities they utilize. The majority of the assessments should have high cognitive demand.

Criterion A7: Evaluation of time devoted to student-centered activities in courses

CONTEXT*:* This criterion is focused on time spent in student-centered activities. Ideally, both student and peer-observers should have a chance to evaluate this factor. For student assessment, course evaluations might include questions about specific active learning techniques. A variety of instruments for peer observation to assess this criterion are currently in use, for example, The Classroom Observation Protocol for Undergraduate STEM (COPUS) and the Reformed Teaching Observation Protocol (RTOP). For departments seeking Teaching for PROWESS Recognition, data from peer-observation is required to justify scores of 3 or 4.

Criterion A8: Use of data on student preparation and interests in course revision

CONTEXT*:* This criterion addresses deployment of instruments to gauge student preparation and interests and using this information to revise course approaches. Entry surveys focused on student interest and career goals or concept inventory/placement tests to determine preparation might be used for individual courses. The Precalculus Concept Assessment (PCA), the Calculus Concept Inventory (CCI), the Statistics Concept Inventory (SCI) are examples of such assessments currently available. The Emergent Algebra Concept Inventory (EACI) is an algebra inventory under development.

Part B - Program Level Assessment

Criterion B1: Assessment of the AMATYC Standards for Content at the program level

CONTEXT*:* This criterion seeks to specifically address the integration of the *AMATYC* Standards for Content into a major or program. Ideally, this would best be evaluated with some sort of "general knowledge survey" based on Standards for Content. However, such an instrument does not currently exist. A viable option is to analyze the mathematics content included in the program (by using course outlines, course syllabi, and course descriptions) to inform departments about the integration of the Standards for Content.

Criterion B2: Assessment of the AMATYC Standards for Intellectual Development at the program level

CONTEXT*:* This criterion seeks to specifically address the integration of the Standards for Intellectual Development into a program. Ideally, this would best be evaluated with some sort of single "general skills survey" based on the Standards for Intellectual Development. However, such an instrument does not currently exist. A viable option could include a capstone project as evidence of students' application of the Standards for Intellectual Development. A second option is to analyze if the use of intellectual skills are integrated in the program (by using course outlines, course syllabi, and course descriptions)

Criterion B3: Collection and analysis of data on program effectiveness

CONTEXT*:* This criterion addresses the collection and use of data to determine programmatic success. Direct measures of student learning include comprehensive exam/concept inventory scores for graduating students, portfolios, capstone projects, or oral examinations. Indirect measures include course grades, measures of the number of students that transfer to a 4-year college or obtain STEM-related employment, success rates of students at transfer institutions, and comparison of enrollment numbers over time. A fairly comprehensive list of direct and indirect measures of student learning can be found at Examples of Direct and Indirect Measures.

Criterion B4: Use of data on program effectiveness

CONTEXT*:* This is a follow-up to criterion B3. This criterion speaks to what extent the analyzed program effectiveness data is used to strengthen the program and encourages departments to consider collecting and analyzing program effectiveness data to inform program revision.

Criterion B5: Measurement of retention for different student populations

CONTEXT*:* This criterion is focused on retention of all students who enter the program. Specific student populations that often are differentially retained would include minority groups traditionally under-represented in mathematics such as

African Americans, Hispanic/Latino, Pacific Islanders, and Native Americans, first generation college students, and students from socioeconomically disadvantaged backgrounds. Retention of students throughout the program should be included after one course in the department (i.e., how many students go on to take a second course), two courses, 3-5 courses, and majors. The purpose of this criterion is to understand where in your curriculum students most often move away from the study of mathematics or other STEM disciplines.

Criterion B6: Use of retention data to improve student persistence

CONTEXT*:* This criterion is related to the degree to which the data in B1, B2, and B3 above are used to improve student persistence. For scores of 3 or 4, written departmental or institutional plans to increase the persistence of students in mathematics or other STEM disciplines would be important. Because persistence is adversely affected by the time it takes students to complete the mathematics courses in a STEM program, the department should consider if measures were undertaken to accelerate students through the mathematics required. Examples of accelerated mathematics programs of study include corequisite courses (see definition in Chapter 6 of *IMPACT*) and flex-start/fast-track (i.e., 6-week, 8-week, 10-week).

Criterion B7: Assessment of learning in different student populations

CONTEXT: Analysis of outcomes for particular groups of students such as women, underrepresented minorities (URM), or socioeconomically challenged student populations can be very different from the majority of the class. Roadblocks to success for particular at-risk populations can be identified through more sophisticated analysis and used to intervene to alleviate these roadblocks. This type of evaluation can be aided by working with a Discipline Based Educational Researcher (DEBR) who can provide the statistical analyses necessary to tease out the differences and causes/effects. Departments could also collaborate with Institutional Research Offices or other disciplines to dissect the root causes of the challenges sub-populations of students struggle to overcome. A score of 4 would suggest a department was regularly engaged in such discovery and revision of their curriculum to alleviate challenges that impede student success for all populations.

Criterion B8: Use of data on student placement (based on student preparedness) and career-choice interests in program revision

CONTEXT: This criterion is meant to assess the level of consideration used by a department to inform changes to courses and curricula in response to student preparedness and interests. To do this, programs must first collect college preparedness and interest data (score of 1) and then use that data to revise the curriculum (scores of 2-4).

Rubric V – Diversity, Equity, and Inclusion (13 criteria)

Summary

The purpose of this rubric is to assist departments in thinking through the issues of diversity, equity, and inclusion. Given the history of our nation, the scientific community needs to address the issues of diversity, equity, and inclusion for all groups.
This rubric is adapted from the PULSE rubric which was focused on PEERs- Persons Excluded due to Ethnicity or Race (Asai 2020) and the role of the department in promoting antiracism in its interactions with students, faculty and other department/college constituencies. To broaden the scope, the TfP rubric has been altered to include all Under-Represented Groups (URGs).

The DEI rubric is visionary, and for some of the rubric items, departments may find it difficult to achieve exemplar status without institutional support and reform; there are others that can be implemented relatively easily if a department is motivated to do so. Similar to the other six Teaching for PROWESS Rubrics, this rubric is intended to begin dialogue within a department, have a department begin to think about what inclusive excellence looks like in their department, and help determine the department's future work in building a learning environment that intentionally reflects non-biased principles. Since some of the ideas and terminology might be new to the faculty members within a department, some basic definitions and resources for faculty to review prior to starting to score your department using this rubric include: Core Concepts of Racial Equity, 11 Terms You Should Know to Better Understand Structural Racism, Racial Equity Resource Guide, Key Equity Terms and Concepts, , Mental Health Conditions, *Sexual Orientation and Gender Identity*, *Intellectual Disabilities*, and *Intersectionality*.

Addressing diversity, equity, and inclusion is a difficult and emotionally-charged process. For URGs, it can sometimes be traumatic to constantly be reminded of one's "other" status within a small departmental group. This process can be alienating, demoralizing, and lonely for those experiencing the relentless small and large indignities of exclusion. For non-URG individuals, reading these items may inspire a reaction that may include anger or guilt. We remind non-URG individuals that being pushed out of one's comfort zone can be uncomfortable, even as it is necessary for DEI progress. Having strong feelings, no matter one's identity, is expected and natural during this process. We invite our colleagues to approach this work with humility and openness. Department leadership may be concerned about the reaction of their instructors and staff, as well as how their department will score on the various rubric items. However, the process of completing the DEI rubric will, in many instances, represent a department's first action to become more inclusive and create learning environments that embrace equity. Your department's effort in completing the rubric is an important and commendable first step in reflecting on diversity, equity, and inclusion. Your score represents a starting point and provides you with information to decide where to focus your work on DEI. By implementing specific DEI initiatives in your department, your scores will change. Any increase in DEI rubric scores should be celebrated, as it represents a commitment to improving the climate for URGs.

Each criterion begins with a **CONTEXT** section that should be read *prior to* reading the criterion's descriptors. A consistent range for percentages in the descriptors of the criteria is an attempt to help departments quantify their status. These percentages do not reflect the tipping point for social change cited in Andreoni et al. (2021).

Categories include: A) Curriculum, B) Assessment, C) Faculty Practice/Faculty Support, and D) Climate for Change.

Part A – Curriculum

Criterion A1: The curriculum includes high impact practices and other inclusive pedagogies

CONTEXT*:* This item considers the incorporation of high impact practices (HIPs) and other inclusive pedagogies into the curriculum. HIPs include service learning/civic engagement, internships, writing intensive courses, capstone courses, learning communities, common intellectual experiences, diversity/global learning, collaborative assignments/projects, e-portfolios, and undergraduate research (Kuh 2008). HIPs have been shown to improve student learning (Kinzie 2012) and to have a positive impact on URG students' perception of learning (Finley & McNair 2013, Network of STEM Education Centers). However, participation in HIPs has not been equal, with certain URGs not having access to these transformative educational experiences (Longmire-Avital 2019*).* Therefore, it is important to find ways to modify HIPs to reach as many students as possible and to consider the quality of HIPs being offered (HIP Quality Report). One method of assessing the extent to which this is occurring is to look for high impact practices in approved course outlines.

Inclusive pedagogies are teaching practices fostering an environment where varied backgrounds are considered so that all students feel valued and included. The Instructional Practices Guide (MAA, 2018) provides a rich resource of strategies to improve equity in the classroom. The strategies focus on maximizing student participation, building community for all students, monitoring behavior and cultivating divergent thinking, and supporting all students in the classroom so they can think, talk, and learn effectively. *Small Teaching* (Lang 2016) and *Small Teaching Online* (Darby and Lang, 2019) are two books offering similar immediate-use strategies to increase classroom equity and learning. *Grading for Equity* (Feldman, 2018) requires more investment in change, but may also yield more inclusion and equitable outcomes. Additional valuable resources include: Transparency in Learning and Teaching Framework (TILT); specifications-based grading, *Building Thinking Classrooms in Mathematics* (Liljedahl, 2021), Nilson 2016, *Specifications Grading: Restoring Rigor, Motivating Students, and Saving Faculty Time* (Nilson, 2014); more frequent formative assessment, *Assessment and Classroom Learning* (Black & Wiliam, 1998), *Focus on formative feedback (Shute, 2008)*; invitational office hours (Jack 2019); structured active learning (Eddy et al. 2017), (Theobold et al. 2020); and some advice guides on writing inclusive and equity-minded syllabi (APA, 2021).

Criterion A2: Course materials are intentionally made available to all student

CONTEXT*:* This item addresses the importance of making courses and course materials available to all students, regardless of their socio- economic status, and as a result, increasing access* to higher education. Factors to consider within a department for this criterion are: (1) the use of open educational resources (OERs) as a way to make course materials available on the first day of class, as well as reducing textbook costs; (2) courses are designed to intentionally consider bandwidth issues needed to view and use digital course materials; (3) additional software students may need outside of the university's online learning management system (e.g., Blackboard, Canvas) both in terms of cost to students and student's personal computer capacity; (4) ability to be on campus or to specific off-campus sites for assignments and activities required in the course.

*Access is used in this case to refer to all students having educational materials readily available to them, rather than referring to ADA compliance issues.

The following sources provide information to assist departments with this criterion: Videoconferencing Alternatives: How Low-Bandwidth Teaching Will Save Us All; OER Commons, Open Textbook Library, and OpenStax.

Criterion A3: Diverse perspectives are represented in the curriculum

CONTEXT*:* This item allows you to examine whether your department's curriculum strives to maximize varied voices and to highlight contributions from a broader body of URG mathematicians and mathematics educators. This may help your department reflect the diversity of your student population. It has been established that students become more engaged when they can recognize themselves within the curriculum and when they make connections between the curriculum and their lives, increasing their sense of belonging (Schinske et al. 2017; Yonas et al. 2020; Sheffield et al. 2021). It is important that instructors include multiple contributions from diverse scholars in the discipline; a single example of a URG contributor does not speak to this rubric criterion.

The following sources provide information to assist departments with this criterion: Multicultural Mathematics Book Recommendations, Testimonios: Stories of Latinx and Hispanic Mathematicians, She Does Math!, How Do We Make Math Class More Inclusive of Trans and Non-binary Identities, Scientist Spotlights Initiative and Diversity Dialogues (my.amatyc.org). While the levels of accomplishment for this criterion do not mention the value of critiquing the absence of diverse contributors, these discussions are also important for student development.

Part B – Assessment

Criterion B1: Student success metrics are disaggregated to allow the department to find and address success gaps between various groups in mathematics courses

CONTEXT: Gathering student metrics (e.g., GPA, progression, graduation & transfer data) allows departments to begin to examine student success. However, simply gathering data is not enough. This item addresses how data are analyzed so that the success of specific groups of students can be uncovered. Once student success gaps are identified, the department is expected to "close the loop" by developing strategies to improve student performance. In addition, some departments may benefit from creating their own surveys or conducting focus groups to gather information about the student experience. These surveys and focus groups can supplement and inform the student success metrics.

The following resources provide statistics as well as suggestions of what leaders and faculty can do to address the success gaps: AAC&U (2015) Step Up & Lead for Equity: What Higher Education Can Do to Reverse Our Deepening Divide and Another Way to Quantify Inequality Inside Colleges.

Criterion B2: Perceptions of equity and inclusion (climate data) are assessed annually

CONTEXT: Climate surveys can include internal or external instruments that evaluate perceptions of equity and inclusion. Measurements of inclusion often reflect the sense of belonging *all* students feel irrespective of their identities. These surveys can reveal hidden feelings of exclusion and provide evidence of the effectiveness of actions taken to improve equity and inclusion. Offices of Institutional Research/Institutional Effectiveness or Diversity and Inclusion should be consulted first to check for the possibility of extant data and to help with supplying data and ways to develop strategies based on these data to foster improvements. In the absence of centralized climate surveys, some departments may benefit from creating their own surveys, vetted by a DEI expert (Anderson 2020), or gathering qualitative data (e.g., conducting focus groups) to gather information about the student experience that can possibly inform the student success metrics.

A variety of external surveys are available, such as the Collaborative on Academic Careers in Higher Education (COACHE) Faculty Job Satisfaction Survey, the Higher Education Data Sharing Consortium (HEDS) Diversity and Equity Campus Climate Survey, and the Center for Community College Student Engagement. While the national surveys mentioned are regularly used at the college level, this criterion, in part, is looking at whether the results of these surveys are provided to departments, and once received by departments, are used by them to drive change.

Part C – Faculty Practice/Faculty Support

Criterion C1: Faculty awareness of the terminology and knowledge of history of systemic institutional discrimination in higher education

CONTEXT*:* One of the first steps in developing an inclusive culture is individuals recognizing they have implicit and explicit biases. For this item, faculty within a department are asked to self-assess their knowledge of systemic institutional discrimination in higher education and report as a department their overall knowledge so that the department as a whole can improve their collective knowledge. Developing this knowledge requires coming to a deep understanding of a variety of terms commonly used in the history of systemic institutional discrimination in the United States.

The resources about terminology listed in this rubric's instructions (page 1) will assist departments with their work.

Criterion C2: Faculty engage in professional development opportunities on such topics as diversity, equity, inclusion, and culturally responsive teaching

CONTEXT*:* Professional development can include directing faculty to resources (such as the Implicit Association Tests), providing texts and journal articles that present frameworks to develop curriculum addressing diversity and ways to include inclusive practices in the curriculum to provide high quality instruction/learning for all students (Ginsberg & Wlodkowski (2009). *Diversity and motivation: Culturally responsive teaching in college)*, offering sessions through the institution's Center for Teaching and Learning or Center for Inclusive Excellence (sources for content of these sessions include - The Diagnosis and Treatment of Dyscalculia, Teaching Students with Physical Disabilities, and DEI in math), and attending external conferences/workshops/webinars focusing on diversity, equity, and inclusion in STEM (for example: AAC&U Diversity, Equity, and Student Success Conference).

Criterion C3: Faculty are given opportunities to engage in various types of work that promote diversity, equity, and inclusion (DEI) and serve as leaders at the college in this area

CONTEXT*:* This criterion focuses on faculty having opportunities to pursue work, such as participating in DEI work with professional organizations (e.g., AMATYC's Equity Committee, AMATYC DEI webinars, American Mathematical Society Committee on Equity, Diversity and Inclusion (COEDI), MAA's Diversity, Equity and Inclusion program, and TODOS: Mathematics for ALL Excellence and Equity in Mathematics) and engaging in DEI-related activities (discussing relevant books, conducting educational research, collaborating on interdisciplinary work with a peace and justice focus) that have traditionally not been pursued by math faculty. In addition, the department also assists in providing opportunities for faculty to develop expertise in areas such as culturally

responsive teaching and ways to increase diversity, equity, and inclusion in the curriculum, as well as in STEM fields.

Criterion C4: The department has opportunities for faculty to develop mentoring skills that are inclusive of URG students

CONTEXT*:* The high impact practice of faculty mentoring students has been shown to be effective. This particular criterion is focused on mentoring URG students. (References: Getting More Students Through – Not Just To - College, Academic Pipeline Programs for Underrepresented Students That Work, Advice on Advising: How to mentor minority students, Relevant Mentors Matter for Historically Underrepresented Students in STEM, and Mentoring Underrepresented Minority Students).

Part D – Climate for Change

Criterion D1: To reduce bias, academic policies are reviewed and modified through the lens of diversity, equity, and inclusion for URGs

CONTEXT*:* Institutions and departments might have policies in place that were useful at some point. However, with changing demographics, policies should be reviewed as part of the institution's or department's continuous improvement plan to reflect current needs. Examples may include academic policies such as pre/co-requisites, grading policies, withdrawal, pass/fail options, attendance policies, readmission, and credit for prior learning. Once policies have been reviewed, changes are implemented that support student success.

The following sources provide information to assist departments with this criterion: United States Census Bureau; AAC&U Transparency Project; More Colleges Should use Equity Audits; How Does An Equity Audit Work; Harper et al., 2009; Skyline College Comprehensive Diversity Framework for Realizing Equity and Excellence (2013); Skyline College's Diversity Framework: Equity Audit using Completion by Design Framework (2012); Center for Urban Education's Impact on Equity Gaps; Complete College America (2017); College Completion Network.

Criterion D2: The department utilizes a holistic approach to recruit, retain, and advance URG faculty during their career

CONTEXT*:* The significance of hiring, retaining, supporting, and advancing qualified URG faculty in math cannot be overstated. URG faculty provide excellent role models to students and diversify college committees, bringing new insights and perspectives to educational issues and developing innovative solutions. While these contributions are important, there needs to be enough representation from all groups so as to not overburden the few URG faculty at the institution. This should not be the exclusive work of URG faculty.

This criterion includes strategies, policies, and transparent efforts that support and advanced qualified URGs at all stages of their career (from recruiting, hiring, transition, retention, and advancement). Recruiting URG STEM faculty may be part of an institution's standard equal opportunity employment policy, but departments can do more. For recruitment and hiring, departments can actively participate in efforts to recruit and hire URGs through innovative processes (e.g., cluster hires or targeted hires) that allow recruitment and hiring of faculty who can add unique diversity aspects to the department. To address retention and support, hired faculty (both URG and non-URG) should be supported and retained by providing targeted opportunities and developing strong ties to institutional resources, such as the Chief Diversity Officer and Centers for Inclusive Excellence (or equivalent), that can assist with hiring/retention practices (Qazi & Escobar, 2019).

Departments should foster the advancement of URGs by providing support opportunities for internal career advancement. URGs should be encouraged to participate in leadership development workshops, become a student club advisor, assist with advising and mentoring students, and take advantage of relevant professional development opportunities.

The following source provides information to assist departments with this criterion:
Stewart & Valian (2018) *An Inclusive Academy*.

Criterion D3: The department strives to ensure all department members are treated equitably with particular attention to the intersectionality of marginalized identities with URG identities

CONTEXT: Coined by Kimberley Crenshaw, intersectionality refers to the recognition of interlocking attributes of identity, such as gender, ethnicity, class, sexuality, physical ability, as well as race (for example Black and female; Latinx and LGBTQIA+; Indigenous and uses a wheelchair). The sum of the impacts of intersectionality is greater than the sum of the individual impacts. One must consider the intersectionality of their URG identities with their other identities. All of these identities have led to the oppression of individuals, and since all oppression is linked, departmental work on addressing discrimination of any of the aforementioned identities represents progress to a more equity-minded department. By supporting URGs in this way, non-URGs who identify with the other marginalized identities will also be elevated. This work may include collaborating with campus resources already in place to support some of these identities, such as the campus LGBTQIA+ center, or student accessibility services.

The following sources provide information to assist departments with this criterion:

Charleston et al. 2014; Rosenthal & Crisp 2006; Prati et al. 2020, *Intersectionality Involving Intellectual Disabilities*.

Rubric VI – Professionalism (9 criteria)

Summary

This rubric assesses the extent to which institutions hire qualified, diverse mathematics faculty, and support these faculty as they engage in ongoing professional development and service. Institutions should be proactive in recruiting candidates with diverse backgrounds and hiring qualified mathematics faculty. These faculty need to continually expand their mathematics knowledge, stay current with new research on learning and teaching, and be active in the college and the profession. The institution should support mathematics faculty by providing opportunities for faculty to learn and grow in their profession. Categories include: A) Professional Development.

Part A – Professional Development

Criterion A1: Awareness of national efforts in undergraduate STEM education reform

CONTEXT*:* This criterion addresses the degree to which faculty members are aware of national reports on mathematics/statistics and STEM education (such as Common Vision for Undergraduate Mathematical Sciences Programs in 2025 and 2012 Engage to Excel PCAST) as well as current research. Are faculty members aware of summer institutes, workshops and other professional development related to the reform efforts? Are faculty members interested and aware that these reports support making their classrooms student-focused and inquiry-based? Are faculty aware and willing to consider that there is strong evidence from educational and cognitive science studies that student- centered teaching strategies are more effective for learning than lecture-based teaching?

Criterion A2: Faculty engagement at meetings and other professional development opportunities related to STEM education reform

CONTEXT*:* This criterion addresses the extent of faculty member professional development and engagement with education reform. Examples of meetings that faculty members might attend, focused on mathematics education and its reform, include AMATYC, ASA, MAA, NCTM, etc. This is not an exhaustive list as there are many other regional and national meetings and workshops focused on mathematics undergraduate education.

Criterion A3: Awareness/implementation of discipline-based education research (DBER)

CONTEXT*:* This criterion addresses a deeper knowledge about mathematics and STEM education research and use of this knowledge to improve teaching and

learning. Scholarly teaching (also called scientific teaching) is the practice of evaluating whether students achieve learning goals and reflecting on teaching practice to continuously improve student learning. Discipline-based Education Research (DBER) includes peer-reviewed studies that assess the effectiveness of various pedagogical approaches and theories.

Criterion A4: Sharing of information about evidence-based and effective pedagogy

CONTEXT*:* This criterion is focused on the creation of a community of practice or learning communities around mathematics or STEM education. Sharing could include formal opportunities such as Teaching & Learning Center workshops on mathematics teaching and department meetings or retreats dedicated to sharing pedagogical ideas and outcomes. Informal sharing of ideas is also important, such as welcomed discussions between and among faculty members about pedagogical approaches.

Criterion A5: Alignment of pedagogical approaches with evidence-based practices

CONTEXT: This criterion is focused on the use of evidence-based practices in student learning. Two factors are being assessed here: first, the degree to which student-focused approaches are used in the classroom and second, the number of faculty members who are using these approaches. There is a wide range of student-focused approaches including use of student response devices (clickers) and group activities often associated with case- based or problem-based learning. To support claims of extensive use of evidence-based pedagogy, scoring of active learning using classroom observation tools (such as COPUS (http://www.lifescied.org/content/12/4/618.full) would be required to justify a score of 4. Counts of courses using evidence-based, active engagement strategies and inquiry vs. traditional lecture format would be appropriate evidence for scores of 2-3.

Criterion A6: Alignment of course goals, learning activities, and assessments

CONTEXT: This criterion pertains to the degree to which instructors have intentionally aligned their learning goals, activities, and assessments. One possible strategy for such alignment is ‘backward design.’ Evidence of success in this area would be documents that show how learning goals and objectives align with assessment and activities.

Criterion A7: Support for teaching/learning needs in math

CONTEXT*:* This criterion pertains to the degree of institutional support for teaching and learning. At many institutions, Teaching and Learning Centers have been established to serve as an organizing hub for these activities. The criterion is written in terms of what a Teaching and Learning Center might provide, but it is

possible that similar institutional support could be provided in the absence of a Teaching and Learning Center, so the criterion should be interpreted in that light.

Criterion A8: Quality of onboarding and faculty mentoring program

CONTEXT*:* This criterion addresses the quality of faculty onboarding and mentoring programs. Faculty onboarding programs can be as short as 1-2 hours in a single session. However, some are much more extensive, with multiple sessions that extend over the entire first year. The best onboarding programs provide for a discussion of issues related to teaching and pedagogy. Departmental or institutional formal mentoring programs are also valuable. The best faculty mentoring programs assign faculty members from different ranks and perspectives to serve as mentors, often specify the frequency of meetings between mentor and mentee, and provide guidance for mentors specifically to discuss issues around teaching performance and pedagogy.

Criterion A9: Institutional support for faculty training in areas emerging from research

CONTEXT*:* This criterion addresses the degree to which a faculty member's institution supports training in areas emerging from research. For students to be well-prepared for careers in mathematics and for mathematics-based decision-making to understand real-world problems, teaching about new areas of research and technologies is essential. To ensure that students are exposed to new and areas emerging from research that are critical to the future success of students, faculty members require training to master these areas before introducing them in the classroom. This type of training can take multiple forms including 1) day-long or week-long workshops, 2) professional discipline-based meetings, or 3) spending time with an expert in the area.

Rubric VII – Climate for Change (8 criteria)

Summary

The purpose of this rubric is to assist departments in assessing the institutional, administrative, and departmental openness to and movement toward the type of change outlined for mathematics education in the *AMATYC Standards.* Categories include: Attitude Toward Change Initiatives, Strategies for Promoting Change in Teaching Culture, and Concrete Implementations Promoting Change in Teaching Culture. Although many of these criteria are out of the control of departmental faculty, they are critical for transformation and sustainability of reform efforts in mathematics education. The criteria included in this rubric are broadly applicable to other STEM disciplines.

There is no doubt that the efforts of charismatic or energetic individuals are critical to catalyzing transformation and/or reform. However, there is a critical role for the Board of Trustees and senior level administration, including the Provost, Chancellor, President, VPs, and in some cases Deans, at a given institution to play in setting a tone or climate that is conducive to change efforts. In addition to allocating basic resources necessary for teaching, senior administration determines to a large extent what efforts are recognized or rewarded. Departments that have a

positive climate for change – positive working relationship and/or empowerment by the institution's administration – are more likely to be successful in the long term in their efforts to reform mathematics education. Therefore, although this rubric can be challenging to complete given the qualitative nature of the items being assessed and the fact that departments often have little control of these criteria, this rubric measures an important component for promoting departmental transformation. Categories include: A) Attitude toward Change Initiatives, B) Strategies for Promoting Systemic Change in Teaching Culture, and C) Concrete Implementations Promoting Change in Teaching Culture.

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Part A – Attitude Toward Change Initiatives

Criterion A1: Administrative support for national change initiatives in higher education

CONTEXT: This criterion addresses the degree to which the administration is aware of and acts on national change initiatives (such as American Association of Community Colleges Pathways, Achieving the Dream, Center for Community College Student Engagement, Community College Research Center, California Acceleration Project, Complete College America, National Research Council).

Criterion A2: Administrative support for state and national change initiatives in mathematics education

CONTEXT*:* This criterion addresses the degree to which the administration is aware of, has read about, and acts on national recommendations concerning mathematics education. State initiatives may be created by state-wide task forces, steering committees, forums, or summits. National initiatives may be from national mathematics organizations included in the Conference Board of the Mathematical Sciences or by other groups (Dana Center, Carnegie, PCAST, TPSE, Common Vision).

Criterion A3: Attitude of department faculty toward national change initiatives in higher education

CONTEXT*:* This criterion addresses the degree to which the department faculty are aware of, have read about, and act on national change initiatives (such as AMATYC Standards documents, American Association of Community Colleges Pathways, Achieving the Dream, Center for Community College Student Engagement, Community College Research Center, California Acceleration Project, Complete College America, National Research Council)

Criterion A4: Attitude of department faculty toward state and national change initiatives in mathematics education

CONTEXT*:* This criterion addresses the degree to which department faculty are aware of, have read about, and act on state and national recommendations involving mathematics education. State initiatives may be created by state-wide task forces, steering committees, forums, or summits. National initiatives may be from national mathematics organizations included in the Conference Board of the Mathematical Sciences or by other groups (Dana Center, Carnegie, PCAST, TPSE, Common Vision).

Part B – Strategies for Promoting Systemic Change in Teaching Culture

Criterion B1: Strategies to recruit and retain qualified diverse teaching faculty

CONTEXT: This criterion addresses the degree to which the institution takes specific actions towards hiring and retaining a diverse teaching faculty. Formal actions might include 1) placing job advertisements on sites that are targeted to diverse groups, 2) policies that relieve the department of the travel costs for on campus interviews for diverse faculty, 3) formal mentoring plans for faculty members, 4) exposing candidates to the diversity on campus when they visit, 5) requiring potential hires to explain how they have, or plan to, incorporate equity and inclusion in their teaching of mathematics.

Criterion B2: Institutional support for faculty to update courses

CONTEXT: This criterion is focused on the degree to which the institution supports the efforts of faculty to update courses to align with the principles outlined in the *AMATYC Standards*. The underlying issue here is that it takes time to redesign a course to make changes such as moving from an instructor-focused lecture course to a student-focused course engaging students in active learning. Many faculty express interest in changing the way they teach, but find it difficult or impossible to do it due to other time constraints. Thus, institutional support that incentivizes faculty, such as providing stipends or release/reassign time for course redesign, can be critical. Institutions may also fund course leads who provide templates for redesigned courses

Part C – Concrete Implementations Promoting Change in Teaching Culture

Criterion C1: Mechanisms for collaborative communication on significant educational challenges

CONTEXT*:* This criterion addresses the degree to which stakeholders (faculty, staff, administrators, etc.) across the institution effectively communicate about nationally-recognized and institution-specific challenges and issues in mathematics education in the first two years of college. Such discussions might include how to address recommendations from national reports and studies, educational best practices, data on student outcomes, and measures of student

success. Institution-specific data and issues might include DFW rates, retention, persistence, success of students from non-traditional and underrepresented backgrounds, and outcomes such as graduation rates, types of employment, rate of entry into additional educational programs, etc. For scores of 3 and 4, formal mechanisms such as committees or professional learning communities are likely to exist that actively engage key stakeholders across the institution around these issues. To achieve a score of 4, discussions that identify significant disparities or issues must lead to changes in programs to address those issues.

Criterion C2: Institutional assessment of student engagement and learning

CONTEXT*:* This criterion reflects the culture of an institution in understanding the learning experience of their students and using that information to inform improvements in their general education and disciplinary programs.

Indirect measures usually ask students to complete surveys or respond in focus groups regarding their perception of their learning, engagement, and/or their satisfaction with their experience at the institution. Surveys of student engagement may include the Survey of Entering Student Engagement (SENSE), Community College Survey of Student Engagement (CCSSE), Community College Faculty Survey of Student Engagement (CCFSSE), and Survey of Online Student Engagement (SOSE). These institutional assessments are shared with a broad spectrum of stakeholders across the institution and used for improvement in institutional structures.

Direct assessments are aimed at directly evaluating student skills or knowledge, measured either with artifacts produced within courses or through end of course or end of program assessments, etc. These institutional assessments are shared with the mathematics department and used for improvement in institutional structures.

Criterion C3: Formal evaluation of faculty with a focus on teaching and learning

CONTEXT*:* The purpose of formal evaluation of faculty should be to assist faculty to use the latest research to improve teaching and learning. Formal evaluation includes regular/annual review as well as review for promotion/tenure of faculty.

These formal evaluations should include scholarly teaching using the following criteria: student evaluations, peer evaluations, and self-assessment/reflection. Scholarly teaching is the practice of evaluating whether students achieve learning goals and reflecting on teaching practices to continuously improve student learning. Student course evaluations vary from institution to institution.

At a minimum, course evaluations ask for student perceptions about the quality of the class and the quality of the faculty. At the high end, course evaluations might ask about the teaching approaches utilized and student perception of learning gains. Peer evaluations are when other faculty assess teaching effectiveness and can include information about the strategies utilized and the level of student engagement. The self-assessment/reflection should include utilizing the student and peer evaluations as well as personal reflection to establish goals and to create a course of action to improve their teaching and student learning.