

Mathematics Program Assessment Plan

Introduction

This assessment plan is tentative and will continue to be refined as needed to best fit the requirements of the Board of Regent's and UAS Program Review Policy 10.06.01A, and the needs mathematics program.

Resources for assessment of discipline specific aspects of the mathematics program and its functions will be various relevant publications of, and activities organized by the Mathematics Association of America (MAA) and the American Mathematical Society (AMS). The MAA focuses primarily on undergraduate mathematics education in the United States and has organized in depth studies on assessment of undergraduate mathematics programs. Many mathematics programs in US colleges and universities have implemented assessment practices based on the research of MAA and AMS affiliated committees; the advice given by assessment teams from such programs stress designing assessment methods around the needs of the program in question.

The UAS mathematics faculty has endeavored to follow this advice by designing an assessment plan which is best suited for the needs of a young degree program in a growing institution. The program assessment coordinator will work closely with relevant members of the university administration to ensure this assessment plan satisfies not only program needs, but also the requirements of UAS and Board of Regent's Program Review policies.

Briefly, the assessment procedure addresses the two functions served by the mathematics program:

- (1) Service courses, and
- (2) The mathematics minor and B.S. programs.

Service courses: The mathematics faculty will continue to discuss the relevance of course content, the coordination of multi-section courses, student abilities and preparedness, as well as *course assessment practices* at the end of each semester. Service courses include:

- a. Developmental courses such as MATH 054, 055 and 105
- b. GER courses such as MATH 107 and STAT 107
- c. Required courses for degrees in other disciplines. Such courses include MATH 108, 200, 201, STAT 273 and STAT 401.

The math faculty will also periodically review how these courses contribute toward the six UAS "*competencies*".

The mathematics assessment plan will acquire data from the UAS Office of Institutional for purposes of flagging possible problems and/or reforming the above, and other, courses to better serve the needs of other disciplines within UAS. Discussions between the program assessment coordinator, program faculty and UAS IR staff on what the

above data may include, and how they might best be obtained and organized are ongoing. Up to the time of this revision, data on enrollments and student success rates have been obtained. Other useful data, if obtainable, might include:

- a. The distribution by majors of students registering for each course and their relative success rates (as percentages).
- b. Distributions of how students meet the prerequisite(s) for courses, if possible.
- c. Assessments of the effectiveness of prerequisite courses offered at UAS.

Additionally, the effectiveness of mathematics courses which are prerequisites of courses in other disciplines might be examined quantitatively, and through consultations with faculty from other disciplines. Finally, periodic reviews of the literature will be conducted for current trends in service type courses.

Mathematics B.S. and Minor Programs: *Program Assessment* for the B.S. and minor in mathematics will follow the guidelines set forth in the CUPM Curriculum Guide, 2004 (and subsequent reports) published by the MAA Committee on the Undergraduate Program in Mathematics. *Assessment tools* will include:

1. The *mathematics seminar* will be used to evaluate how effective the program is in preparing students to read, write and communicate mathematical ideas and methods. The seminar will also help evaluate how effective the program is in developing student abilities in synthesizing their mathematical knowledge for use in a variety of settings.
2. Yearly *consultation* among the mathematics faculty about the progress and effectiveness of the program, possible improvements and adjustments.
3. The *status of graduates* will be kept updated, as much as possible. Recent graduates will also be surveyed for feedback on how effective the UAS mathematics program was in preparing them for their respective occupations – such as graduate school or current employment.

A breakdown of target areas of *assessment* and proposed *tools* are listed below. These have been compiled, and will be kept current, according to recommendations provided in the MAA CUPM curriculum guide and other such publications. As suggested by the guide and individuals recognized within the mathematics community as experts on program assessment at the undergraduate level, answers to questions appropriate only to UAS and the needs of the UAS mathematics program are sought.

Summary of Assessment Plan

Specific activities and proposals concerning student assessment in lower level mathematics coursework will be included in annual reports and will be addressed during program meetings at convocations or other meetings as needs dictate. Matters relating to assessing students enrolled in the Mathematics BS and Minor programs will be addressed on an ongoing basis and will be formalized at mathematics program meetings.

Proposed Assessment Cycle

The mathematics program assessment cycle will comprise of *Annual Reports*, *Five-Yearly Self-Studies* as well as *Board of Regents required Program Reviews*.

Annual Reports, along with supporting material where applicable, will be performed at the end of each academic year. Among other material – relevant portions of items 1, 2, 3, 5 and 6 of the B.O.R. policy mentioned above - these reports may include, as appropriate:

- a. Observations on current trends, areas of possible further investigation.
- b. Recommendations and/or proposals agreed upon by the mathematics faculty.
- c. Justifications for the above recommendations and/or proposals from the literature, or based on observations from annual program or UAS statistics.
- d. Implementation time-line of proposed changes, if applicable.

To date, it has been difficult to obtain data for annual reports. Efforts are under way to determine the most efficient and effective way in which data may be obtained.

Five-Yearly Self-studies will address a majority of items listed in the Board of Regent's Policy 10.06.01.A, except those relating to costs. Information concerning costs will be left to those offices best equipped to address financial matters. The program assessment coordinator will consult with relevant UAS offices and departments to ensure there is no duplication of efforts and reports.

Program Reviews, as per Board of Regent's Policy 10.06.01.A, will be performed according to the timeline established by the Dean of Natural Sciences and the Provost's office UAS. Annual reports and Self-Studies will serve as resources for B.O.R. required Program Reviews.

Main Areas of Interest

The academic responsibilities of the UAS mathematics program regarding program assessment may be placed in two broad categories.

GER and Service Courses

Answers to two questions will serve in assessing service related obligations of the mathematics program.

Is the program fulfilling its obligation to students by offering appropriate (and practically feasible) courses?

The purpose of answering this question is to understand UAS student and partner discipline needs, determine the feasibility of course offerings, verify the availability of faculty for future course offerings, identify the possible need of additional sections for mathematics courses (if any), and establish relative course enrolments by discipline – thereby allowing for the coordination of schedules so as to avoid conflicts with high user disciplines. Answers for this question will be sought from:

- a. Periodic surveys of UAS client programs.
- b. Annual UAS Institutional Research descriptive statistics.
- c. Resources from the MAA will be referred to periodically to keep track of national trends so as to ensure the transferability of UAS mathematics GER and other service courses.

Are the current GER and service courses fulfilling their intended purposes?

Answers this question will determine whether the courses in question actually provide what they were originally designed to provide, and whether they meet nationally established standards suggested by MAA curriculum and other related guidelines.

Answers to this question will be sought from:

- a. Periodic surveys of UAS client programs.
- b. Institutional Research data and statistical tests performed by UAS Institutional Research Office at the request of mathematics program assessment coordinator, and approval of the Provost's office. These tests will establish the effectiveness of courses as prerequisites of subsequent courses.
- c. Periodic review of the literature and the UAS mathematics program curriculum by mathematics faculty.

Mathematics BS and Minor Programs

To ensure that the B.S. and minor programs maintain their place among US degree programs, based on curriculum guidelines suggested by the MAA, the mathematics faculty has identified five points of importance in program assessment.

Maintaining Viability

The effective recruitment of new majors and minors and timely graduation of mathematics majors and minors suggests an attractive and healthy program. The appeal and health of the B.S. and minor programs in mathematics will be monitored by:

- a) Identifying and capitalizing on common sources of new majors and minors.
- b) Periodically surveying current majors and minors to identify ways of maintaining or improving recruitment.
- c) Tracking current majors to ensure efficient six-year plans for course schedules.

Maintaining Validity

Mathematics courses offered at UAS must, at least, be comparable with similar courses offered at other institutions. This is essential for UAS and the UAS mathematics program to acquire and retain recognition among employers or universities and mathematics departments at which UAS students or graduates may choose to continue their studies. This will also ensure the competitiveness of UAS mathematics graduates in the job market and in academics at the national level. To monitor the strength of UAS mathematics courses, the mathematics faculty will periodically:

- a) Assess the appropriateness and feasibility of course offerings.
- b) The usefulness and applicability of course content.
- c) Identify current trends in the use of technology and their appropriateness for UAS mathematics courses.
- d) Identify new and innovative approaches to presenting current courses and their appropriateness for UAS mathematics courses.

Quality of Graduates – Student Assessment

The quality and success of its graduates will provide a sound measure of the effectiveness of the mathematics program in preparing students for the workforce and/or graduate school. The *goals and exit outcomes* identified by the mathematics faculty as being relevant to measuring the potential success of UAS mathematics graduates in the workforce or in academics are outlined below.

Goal 1: Competency in Core Subject Content

Outcome 1A (Introductory Level): Graduates will demonstrate skills in basic quantitative and analytic problem solving, and competency in basic undergraduate mathematics coursework.

Outcome 1B (Developmental Level): Graduates will demonstrate an understanding of foundational theoretical concepts required to pursue further studies in mathematics.

Outcome 1C (Mastery Level): Graduates will demonstrate an ability to extend and generalize foundational concepts, critically analyze and solve abstract problems in mathematics, and acquire a deeper understanding and appreciation of the subject.

Comments: Transcripts will be used to assess satisfactory completion of mathematics coursework with the understanding that each mathematics course in a graduate's program of study has addressed the above outcomes. In addition to regular coursework, the mathematics seminar will be used to further develop and assess skills in core content areas.

Goal 2: Skills in Analysis, Application, and use of Technology

Outcome 2A (Introductory Level): Graduates will have a broad awareness of the value of, and the ability to use technology as an aid to understanding and solving mathematical problems.

Outcome 2B (Developmental Level): Graduates will have a broad awareness of the interdisciplinary connections and applications of mathematics.

Outcome 2C (Mastery Level): Graduates will possess a strong foundation in utilizing skills and knowledge gained from mathematics and interdisciplinary courses to critically analyze and solve a wide variety of problems using theoretical or technological tools.

Comments: Transcripts and advisor interaction will be used to assess breadth and the mathematics seminar will be used to further develop and assess skills in interdisciplinary applications and connections.

Goal 3: Professional Awareness, Ability to Conduct Independent Studies and Present Mathematical Ideas

Outcome 3A (Introductory Level): Graduates will be aware of opportunities available to mathematics graduates and accepted ethical behavior within the mathematics community and associated professional responsibilities.

Outcome 3B (Developmental Level): Graduates will be able to read, comprehend and communicate mathematical ideas, verbally and in writing, at the undergraduate level in a competent manner.

Outcome 3C (Mastery Level): Graduates will display a high level of confidence and independence in pursuing further investigations in the mathematical sciences. Graduates must be able to communicate knowledge gained in writing and through class presentations at a level deemed appropriate by the mathematics faculty.

Comments: Term projects in certain mathematics courses and projects done for the senior seminar will serve to assess Outcomes 3B and 3C. Though Outcome 3A will not be formally assessed the completion of projects for the mathematics seminar, and interaction

with advisors and other Natural Science faculty will serve to fulfill this objective as well as provide a means for informal assessment.

Student Resources and Opportunities

In order for the UAS mathematics B.S. degree to be accessible to a broad spectrum of students, a reliable source of academic assistance and the availability of financial aid and part time employment or internship opportunities should be present. Here assessment will be done in conjunction with university wide assessments of the same resources.

Information on: financial aid and scholarships; discipline related part-time employment; and internship opportunities will be obtained from appropriate UAS offices, the UAS learning center and other resources of relevance.

Workloads, Opportunities and Availability of Resources for Faculty

The teaching effectiveness of the faculty is a function of the workload under which they operate. Since mathematics program is exclusively staffed by bipartite faculty members, this includes teaching and service responsibilities. So as to ensure retention of faculty, it is recommended that the assessment plan include measures which might indicate whether the numeric strength of the mathematics faculty is appropriate for current or projected needs.

Institutional Research data will be used to determine trends in course offerings as well as faculty teaching loads, on average, and help in identifying when it may be appropriate to seek approval for additional mathematics faculty.

Annual workloads for individual faculty members will be used to determine the diversity of involvement in service related activities. This data may then be used to determine whether the mathematics faculty as a whole needs to increase or decrease their involvement in particular areas of service.

The availability of funding and opportunities for faculty development allow faculty the opportunity and ability to broaden their base knowledge, strengthen current skills, and share ideas with their peers. Also essential to ensure faculty capabilities and effectiveness are access to appropriate current technology – computers and software, and an adequate library collection in mathematics. The health of the program in these respects will be assessed by way of information obtained from appropriate departments or offices in the university administration. Resources for equipment upgrading will be determined by Information Technology Services and library resources will be tracked through the Natural Sciences liaison in the Egan Library.

Note: Faculty evaluation is performed at the institutional level and, as such, will not be part of the mathematics program assessment process.

Main Tools and/or Resources:

- UAS Institutional Research resources.
- MAA/AMS/SIAM/NSF annual surveys of the mathematical sciences and/or other relevant publications and journals when applicable.

- Surveys of recent graduates by the UAS Public Relations Office or Alumni Association.
- Surveys of client UAS programs and/or unsolicited requests from other programs.
- Individual course assessment tools, seminar “capstone” projects, other interdisciplinary and/or course projects.
- Offices of the Dean of Arts and Sciences, the Provost, the Chancellor and other departments/offices as appropriate.
- Annual mathematics faculty program review.

UAS General Student Competencies

<p>Computer and Technology Usage:</p>	<p>Students should have the knowledge to make efficient use of computers and information technology in their personal and professional lives because basic technological knowledge and skills apply to all fields and disciplines. Necessary skills range from a basic ability to use a keyboard through word processing concepts, spreadsheet and graphics applications to telecommunications, conferencing, and electronic mail technologies.</p>
<p>Information Literacy:</p>	<p>Competency in information literacy combines the skills of being able to 1) identify needed information; 2) locate and access the information; 3) analyze and evaluate the content; 4) integrate and communicate the information; and 5) evaluate the product and the process. Reading and writing literacies plus traditional library skills provide the foundation to access the vast availability of electronic information.</p>
<p>Communication:</p>	<p>College graduates should be able to write, speak, read, and listen effectively for a variety of purposes and audiences. Whether their aim is personal, academic, or professional, they should be able to communicate ideas and information effectively.</p>
<p>Quantitative Skills:</p>	<p>A quantitatively literate person is capable of analytical and mathematical reasoning. This individual can read and understand quantitative arguments, follow logical development and mathematical methods, solve mathematical and quantitative problems, perform mathematical calculations, express functional relationships, and apply mathematical methods. As a minimum, a student should know the mathematical techniques covered in the general education mathematical requirements.</p>
<p>Critical Thinking:</p>	<p>Competency in critical thinking reflects proficiency in modes of thought: conceptualizing, analyzing, synthesizing, evaluating, interpreting, and/or applying ideas and information. A critical thinker can approach a concept from multiple perspectives and frames of reference, compare and contrast ideas or models, and demonstrate a willingness to take intellectual risks. A critical thinker knows not only how but also when to apply particular modes of thinking. It should be noted that problem solving and analytical approaches may vary from discipline to discipline.</p>
<p>Professional Behavior:</p>	<p>Professional behavior is expected of college students. Success in professional life depends on many behaviors, including responsibility, good work habits, ethical decision making, recognition of the value of community service, and successful human relations.</p>

Curriculum Map For UAS Competencies

Courses	General Ed. Requirements				Science Requirements		Required Mathematics Courses						Mathematics, Statistics, or other Approved Electives												
	General Ed. Requirements				Science Requirements		Core Lower Div.			Core Upper Div.			Seminar		Mathematics		Statistics		Other						
	Communication GER: English and Speech	Humanities & Social sciences GER	Natural Sciences GER	Mathematics GER: MATH 107, or approved higher mathematics or statistics course.	8 Credits of General Physics (PHYS 103/104 or PHYS 211/212)	8 Credits Additional Science Courses (Selected from Biology, Chemistry, Environmental Science, Geology, Philosophy, or other approved courses)	MATH 200: Calculus I	MATH 201: Calculus II	MATH 202: Calculus III	MATH 215: Introduction to Proofs	STAT 273: Elementary Statistics	MATH 302: Differential Equations	MATH 311: Modern Algebra	MATH 314: Linear Algebra	MATH 324: Advanced Calculus	MATH 392: Junior Seminar	MATH 492: Senior Seminar	MATH 305: Geometry	MATH 410: Complex Variables	MATH 411: History of Mathematics and Science	MATH 460: Mathematical Modeling	STAT 373: Probability and Statistics	STAT 401: Regression and Analysis of Variance	Accepted upper division courses in other disciplines of the applied sciences.	
Computer and Technology Usage	X			X	X	X	X				X		X	X			X	X	X	X	X	X	X	X	
Information Literacy	X															X									
Communication	X									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Quantitative Skills				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Critical Thinking			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Professional Behavior																									

Mathematics Program Goals and Outcomes

Goal 1: Competency in core subject content	
Outcome 1A:	(Introductory Level) Graduates will demonstrate skills in basic quantitative and analytic problem solving, and competency in basic undergraduate mathematics coursework.
Outcome 1B:	(Developmental Level) Graduates will demonstrate an understanding of foundational theoretical concepts required to pursue further studies in mathematics.
Outcome 1C:	(Mastery Level) Graduates will demonstrate an ability to extend and/or generalize foundational concepts, critically analyze and solve abstract problems in mathematics, and acquire a deeper understanding and appreciation of the subject.
Goal 2: Skills in Analysis, Application, and use of Technology	
Outcome 2A:	(Introductory Level) Graduates will have a broad awareness of the value of, and the ability to use technology as an aid to understanding and solving mathematical problems.
Outcome 2B:	(Developmental Level) Graduates will have a broad awareness of the interdisciplinary connections and applications of mathematics.
Outcome 2C:	(Mastery Level) Graduates will possess a strong foundation in utilizing skills and knowledge gained from mathematics and interdisciplinary courses to critically analyze and solve a wide variety of problems using theoretical or technological tools.
Goal 3: Professional Awareness, Ability to Conduct Independent Studies and Present Mathematical Ideas	
Outcome 3A:	(Introductory Level) Graduates will be aware of opportunities available to mathematics graduates, accepted ethical behavior within the mathematics community and associated professional responsibilities.
Outcome 3B:	(Developmental Level) Graduates will be able to read, comprehend and communicate mathematical ideas, verbally and in writing, at the undergraduate level in a competent manner.
Outcome 3C:	(Mastery Level) Graduates will display a high level of confidence and a degree of independence in pursuing further investigations in the mathematical sciences. Graduates must be able to communicate knowledge gained in writing and through class presentations at a level deemed appropriate by the mathematics faculty.

Sample Assessment Related Excerpts from Course Syllabi

Excerpts of assessment relevant content from sample course syllabi are given below. These illustrate the assessment phases of *introductory*, *developmental* and *mastery* level skills, referred to as *outcomes*, in each of the three *assessment goals* listed above.

100-Level Courses

Such courses are either developmental in nature, serve as GER course, or as prerequisites for subsequent courses. College algebra, which is a GER course, provides a means of assessing *quantitative skills* and *critical thinking*. These are two of the six *UAS competencies*. In college algebra and other 100-level courses students are introduced to fundamental concepts in mathematics needed for other disciplines and later mathematics courses.

MATH 107: College Algebra

Objectives: Math 107 students should develop an understanding of mathematical concepts and techniques which can be used to formulate and solve quantitative and analytic problems. These concepts and techniques, and the critical thinking their use requires, can be generalized to other academic disciplines and applied in professional careers.

Assessment of Competencies: *Quantitative skills* will be assessed by assignment of homework problems and examination questions that require a variety of mathematical techniques for their solution. *Critical thinking* will be *assessed* by assignment homework and examination questions that require mathematical problem solving.

Assessment tools: These include homework assignments, semester tests and a comprehensive final examination, standardized for multi-section/multi-campus courses.

MATH 108: Trigonometry

Objectives: MATH 108 is a math course which provides students with *analytical and quantitative skills* needed in a wide range of liberal arts, sciences, and educational careers. The course will help students gain an understanding of trigonometric functional relationships with their *real world applications* through symbolic, graphical, and numerical methods. The emphasis will be on *gaining perspective and understanding the mathematical concepts and principles* and the usage of a variety of *problem solving skills*. Students will be asked to *analyze problems*, construct valid arguments, *use acquired knowledge* and relationships to explain their reasoning, verify and interpret their results. They will *apply mathematical concepts and reasoning* to situations within and outside of this course.

Assessment tools: These include homework assignments, semester tests and a comprehensive final examination, standardized for multi-section/multi-campus courses.

200-Level Courses

Such courses include those which provide students with additional *preparation for upper level mathematics* as well as those which may be viewed as important *service courses* for

other disciplines. The objectives of such courses vary, depending on the course in question. Excerpts from three typical 200 level courses, each serving a different purpose, are listed.

MATH 200: Calculus I

Objectives: This course is designed to give an *intuitive introduction* to Calculus. As you will see, the text is written in a formal definition-theorem-proof-example style. This is one of the classic Calculus texts and will serve as a good reference book. We will cover most of the sections in the first 6 chapters of the text. Subject matter includes limits, differentiation and integration of functions, as well as applications of differentiation and integration. A majority of class time will be spent introducing and discussing certain examples, *definitions, theorems and proofs*.

The main objectives of this course are to: Enhance your *mathematical intuition*; empower you with new approaches to *problem solving*; help you develop a *competency* in limits, differentiation and integration; and help you to have a great time as you acquire a taste for the calculus.

Assessment Tools: These include homework assignments, semester tests and a final examination.

STAT 273: Elementary Statistics

Objectives: Statistics 273 students should develop an *understanding of basic mathematical and statistical concepts and techniques* used to *analyze data, solve quantitative and analytical problems of a statistical nature*, and acquire the *ability to review, understand and discuss statistical reports in a critical and knowledgeable manner*.

Students will be assessed for *written (statistical) communication and quantitative skills, technology usage, problem solving and critical thinking*. Students should expect to *write observations about data; solve quantitative problems* that arise from the data using appropriate concepts introduced in this course; take advantage of, and *effectively use technology* where appropriate; and develop their *problem solving and critical thinking skills*.

Assessment Tools: These include homework assignments, semester tests and a final examination.

MATH 215: Introduction to Proofs

Objectives: This course is designed to give an introduction to *reading and writing proofs*. The main goals of this course are for students to acquire: enhanced *logic skills*; an understanding of the role and importance of *sentence structure in arguments*; an increased *competency in reading and writing proofs*; and an *appreciation* of the nature of upper division mathematics.

Assessment Tools: These class presentations, homework assignments, semester tests and a final examination.

Upper-Division Courses

Such courses include *pure courses* intended mainly for students planning to pursue further studies in mathematics at the graduate level, as well as those courses having an *applications emphasis*. The later courses are fairly heavily attended by students from other majors in the Natural Sciences. The objectives of upper-division mathematics and statistics courses may vary. Excerpts from two upper-division mathematics courses are listed.

MATH 311: Modern Algebra

Objectives: After completing this course, the student will be able to

- *Define, recognize, and give examples of different types of algebraic structures;*
- *State basic properties of various algebraic structures;*
- *Explicitly identify similarities and differences among various algebraic structures and to illustrate these similarities and differences with examples;*
- *Demonstrate enhanced mathematical maturity by writing coherent proofs of basic properties of various algebraic structures;*
- *Demonstrate enhanced mathematical maturity by verbally presenting coherent explanations of logical mathematical arguments; and*
- *Better appreciate the nature of mathematics and the need for an axiomatic treatment of the subject.*

Assessment of Competencies: These include homework assignments, tests, and oral presentations.

MATH 460: Mathematical Modeling

Objectives: Students with an emphasis in mathematics will learn of the *value of mathematics in other fields* and the *relevance of underlying physical or biological principals in the modeling process*. Students with an emphasis in the biological or physical sciences will be exposed to *mathematical methods and concepts* which will enable them to better *understand and solve mathematical modeling problems* they may encounter in their respective careers. The course will also *familiarize* students with the process by which a researcher may go about *seeking answers to questions encountered in the process of constructing mathematical models*.

Students will be assessed for *verbal communication, quantitative skills, technology usage, problem solving abilities, critical thinking, and writing ability*.

Assessment Tools: These include participation in classroom discussions, homework assignments, and the term project.