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DOC 2003-01 Quantitative Reasoning Competencies - Issue I-03-01

University of Dayton. Academic Policies Committee

PROPOSAL TO THE ACADEMIC SENATE

TITLE: Quantitative Reasoning Competencies – Issue I-03-01

SUBMITTED BY: Academic Policies Committee

DATE: January 17, 2003

ACTION IS: Legislative

REFERENCE IS: *Faculty Handbook,* Constitution of the Academic Senate of the University of Dayton, Article II, B, 3, Senate Documents 99-8, 00-10A and 00-10B.

DESCRIPTION OF PROPOSAL:

On October 13, 2000, the Academic Senate passed document numbers 00-10A and 00-10B. These documents detailed, respectively, the content of the Quantitative Reasoning Competency and a plan and schedule for its implementation. The Quantitative Reasoning Competency was to become operational in the fall of 2002 but the members of the Competencies Implementation Subcommittee, together with representatives from the Mathematics Department, were unable to develop a workable plan for implementation and so the Quantitative Reasoning Competency did not go into effect as planned. As a result, the Mathematics Department developed a revised Quantitative Reasoning Competency that they believe will satisfy the intent of the Competency Program and that can be implemented. The proposal is to accept the recommendations listed below in order to replace the existing Quantitative Reasoning Competency and implementation plan detailed in Senate document numbers 00-10A and 00-10B with the revised Quantitative Reasoning Competency and implementation plan, as described in the attachment entitled General Quantitative Reasoning Competencies.

Rationale

The primary difference between the revised plan in this proposal and the original plan previously passed by the Academic Senate is the replacement of the Growth Modeling module with a Mathematical Modeling module. The Mathematics Department feels that the more general module clearly emphasizes the ability to develop and understand the limitations of a mathematical model. They view this ability as an important ingredient in developing the skill to think critically about world events. Mathematical modeling can be done using a wide range of mathematical tools, from the simple to the sophisticated. Hence, the content of this module can be delivered in each of the variety of entry level Mathematics courses. The previous Quantitative Reasoning Competency emphasized the use of various models but not the process of developing the models. It was felt that the Growth Modeling module could not be delivered in the existing curriculum and it was feared that requiring students to satisfy the Growth Modeling module with an online test would lead to a failure rate that was too large to address with existing resources.

In addition to the replacement of the Growth Modeling module with a Mathematical Modeling module, the revised plan reduces the scope, somewhat, of the statistics module. Counting principles and risk analysis are not part of the Statistics module in the revised plan whereas they were part of the Probability and Statistics Modeling module in the original plan. This reduction in scope was done in order to bring this module more in line with the existing curriculum.

The desirable outcomes associated with the revision include the development of mathematical modeling skills and the ability to deliver modules two and three of the competency, for the most part, through the curriculum. The requirement that the courses satisfying the modules must be passed with a C- raises the level of mathematical competency that our students must develop in order to graduate beyond the current requirements. The first module in the proposed revision, Algebra, would be satisfied with an online test initially given as an entrance exam. Failure of the entrance exam would allow for early intervention with students whose mastery of algebra is substandard.

Consultation

After the revised Quantitative Reasoning Competency and implementation plan gained the full support of the Mathematics Department, it was brought to the Academic Policies Committee of the Academic Senate in April of 2002. Early in September 2002 the Academic Policies Committee appointed a subcommittee tasked with studying the proposed revision. This subcommittee had membership from each of the major divisions of the University as well as from the Committee on General Education and Competencies and the Competency Implementation Subcommittee. After consultation with department chairs and deans from each of the major divisions of the University as well as with the Academic Affairs Committee of the College and the Provost's Council, this subcommittee unanimously recommended to the Academic Policies Committee that the revised Quantitative Reasoning Competency and implementation plan be adopted. The Academic Policies Committee accepted this recommendation and brings this proposal to the full senate.

Recommendations

Recommendation I – Demonstration of General Quantitative Reasoning Competencies

- That satisfactory completion of all three general quantitative reasoning competency modules, described below in the attachment entitled "General Quantitative Reasoning Competencies," become a General Education requirement.

- That all students, including transfer students, in a timely fashion, be required to demonstrate mastery of the competency requirements for each module in the manner detailed in the attachment entitled "General Quantitative Reasoning Competencies."

Recommendation II – Student Support

- The Department of Mathematics, in collaboration with the Learning Teaching Center, will ensure that students will have access to an online tutorial that contains exposition, practice problems and sample tests that pertain to Module 1: Algebra.
- The Department of Mathematics, in collaboration with the Learning Teaching Center, will ensure that students will have access to an online tutorial that contains exposition, practice problems and sample tests that pertain to Module 2: Descriptive Statistics.
- The Department of Mathematics, in collaboration with the Learning Teaching Center, will develop support methods for students with weak (or missing) high school background in topics that pertain to Module I: Algebra.

Recommendation III – Graduation Quantitative Reasoning Requirements

- That each degree program should identify and assess appropriate graduation quantitative reasoning competencies that develop the quantitative reasoning abilities of its majors in a manner suitable for that field of study. If appropriate, these graduation quantitative reasoning competencies can go beyond the general competency level. Development of graduation competencies should emerge from guidelines and recommendations set forth in the Basic Skills Subcommittee Report, from discussions within each department and program, from consultation with the Department of Mathematics, and, when appropriate, from external standards established by professional organizations, domain specific learned societies, and accrediting bodies.

Recommendation IV – Implementation Dates

- That the general quantitative reasoning competencies will become operational in the fall of 2003.

- That the graduation quantitative reasoning competencies will be in effect for the class entering in the fall of 2003.

- That these quantitative reasoning competencies and implementation strategies are covered by the previously approved Governance Document (Senate Document 99-8).

Attachment: General Quantitative Reasoning Competencies

At the college level, a student should build upon the algebra and geometry experience of high school to further develop the mathematical knowledge necessary to support that student's academic pursuits, enhance that student's professional opportunities, and generally improve that student's quality of life. This furthered mathematical knowledge is the substance of the quantitative reasoning competencies. The term "quantitative" is essential because computation is an integral part of mathematics. The term "reasoning" is essential because quantification alone leads to very limited usage of the power of mathematics. The term "reasoning" contains the skill, "critical thinking;" College graduates should be proficient at recognizing and applying mathematical concepts inside and outside the contexts of classroom mathematics.

For the purpose of this document, the quantitative reasoning competencies are partitioned into three modules. The modules are not mutually exclusive, but are treated as distinct for the purpose of implementation. In the description of each module the competencies that each graduate of the University of Dayton should master and the manners in which demonstration of competency is to be accomplished are listed. Module 1 and Module 2 focus on the term "quantitative." Module 3 focuses on the term "reasoning."

Module 1: Algebra.

Mathematics is sometimes called the language of science and technology; algebra is the most common language of mathematics. This module sets a standard for the minimal expectations with respect to algebra-based quantitative reasoning competencies for all academic units and can be interpreted as an entrance expectation. Most incoming students have been exposed to at least one course in algebra in a high school experience. However, quantitative literacy issues are recognized as nationwide problems and so University of Dayton students will be required to demonstrate competency in the use of algebra.

The competencies are:

- A student can algebraically manipulate first and second order polynomials.
- A student can sketch the graphs of first and second order polynomials.
- A student can interpret the slope of a line as a rate of change.
- A student can find the extreme value of a parabola.
- A student can competently employ first and second order polynomials in problem-solving exercises.
- In a problem-solving setting, if a student is given two or more algebraic models, the student can select the better model for that problem.

Recommendation to implement Module 1:

- A student will pass an online examination. Passing is achieved by correctly answering 80% or more of the exam questions. An online tutorial and tutorial resources are available. Initially, a student has 3 opportunities to pass the online examination. The first opportunity occurs at the time of the online placement examination offered each summer to incoming students. The Dean's offices will contact students who do not pass the online exam and those students will be instructed to go to the online tutorial and take the exam a second, and if necessary, a third, time. If the student does not pass the online exam on these second and third attempts, the student will be directed to the Learning Teaching Center to receive additional support. The student may then take the online exam additional times.

Rationale: Module 1 focuses on fundamental algebraic skills. An online, "gateway" examination is an effective tool

for evaluating fundamental algebraic skills.

Module 2: Descriptive Statistics.

High-speed computers provide access to large amounts of data. Daily interaction with quantification in the form of data and analysis of data has become routine for individuals in today's society. Descriptive statistics provides a framework in which data are organized so that one can extract useful information from that data. All UD graduates will be competent with respect to standard methods in descriptive statistics that organize data.

The competencies are:

- A student can competently infer appropriate information when the data are given in a visual or graphical form such as a bar graph or a pie chart.
- A student can competently communicate appropriate information by constructing relevant visual or graphical forms of representing data.
- A student can competently calculate the standard measures of center: sample mean, sample median or sample mode.
- A student can make appropriate interpretations with respect to the standard measures of center.
- A student understands that there is a distinction between a sample mean and a population mean.
- A student can competently calculate the standard measures of spread: sample variance and sample standard deviation.
- A student can make appropriate interpretations with respect to the standard measures of spread.
- Using tables or otherwise, a student can competently compute probabilities for a random variable having a normal distribution with known mean and standard deviation.

Recommendations to implement Module 2:

- A student will pass with a C minus or better any of MTH 114, 149, 205, 207, DSC 210, PSY 216, POL 207, SOC 308, CEE 320, or
- A student will pass with a C minus or better any course that is transferred to the University of Dayton as equivalent to one of the above listed courses, or
- A student will have earned EM credit (as a result of the corresponding AP exam) for MTH 207, or
- A student will pass an online examination. Passing is achieved by correctly answering 80% or more of the exam questions. An online tutorial and tutorial resources are available. A student has 4 opportunities to pass the online examination. The Dean's offices will contact students who do not pass the test on the first attempt and those students will be instructed to go to the online tutorial and take the exam a second time. If the student does not pass the online exam following 4 opportunities, the student will satisfy Module 2 by scoring a C minus or better in any of the courses in the preceding bullet.
- Additional courses for which a student can satisfy the competency requirement by passing the course with a C- or better must be approved by the Committee on General Education and Competencies after consultation with the Mathematics Department.

Rationale: Some academic programs require the MTH 168-169 calculus sequence in which descriptive statistics is not covered. These academic programs may demonstrate that one of the courses in their discipline contains a component that would satisfy the Descriptive Statistics competency or they may direct their majors to satisfy the competency requirement by taking the online examination.

Module 3: Mathematical Modeling.

Mathematical modeling is a rich, dynamic and complex process that provides connections to broad and diverse academic areas. Mathematical modeling should not be confused with "word problems." In typical word problems, the mathematical equation or model is already known. A student extracts the appropriate parameters from the word problem to employ in the equation or model. Word problems will be employed to assess the competencies in each of

Module 1 and Module 2. Mathematical modeling is an active process that begins with an open-ended problem. One formulates and assesses hypotheses, one represents ideas in a mathematical context, and one understands, seeks, and develops connections to problems within and outside of classical mathematics. In good modeling, one must not only assess an "answer," but one must also assess the model (problem-solving algorithm, equation, etc.). It is in the context of the modeling process that a student develops the competencies related to mathematical reasoning and critical thinking.

The competencies are:

- A student understands how hypotheses and reasoning can create a process that leads to a mathematical model (problem-solving algorithm, equation, etc.).
- A student understands how different hypotheses and different reasoning processes lead to different models (problem-solving algorithms, equations, etc.).
- A student can employ a mathematical language to represent a problem in a mathematical framework.
- A student can relate a problem-solving algorithm and solution to the original problem and can determine if the mathematical model is useful.
- A student can extend or adapt a problem-solving algorithm to apply to a new problem.
- A student can employ a mathematical model to make meaningful predictions.
- A student recognizes reasoning and proof as essential parts of mathematics.

Recommendations to implement Module 3: In order to develop competence with respect to modeling, a student must participate in real mathematical modeling experiences.

- A student will pass with a C minus or better any of the courses MTH 114, 128, 129, 148, 149, 168, 169, 204, 205, 207, or
- A student will pass with a C minus or better any course that is transferred to the University of Dayton as equivalent to one of the above listed courses, or
- A student will have earned EM credit (as a result of the corresponding AP exam) for either MTH 168 or MTH 207, or
- If a student receives a D in one of the courses listed in the previous bullet, the student may satisfactorily complete a mathematical modeling project developed and administered by the Mathematics department.
- Additional courses for which a student can satisfy the competency requirement by passing the course with a C- or better must be approved by the Committee on General Education and Competencies after consultation with the Mathematics Department.

Rationale: Contemporary applications of mathematics are broad and diverse. The modeling experience can occur in the applications of the general laws of physics, consumer mathematics, discrete mathematics, or inferential statistics, for example. Thus, any one of the many courses listed above can be employed to implement Module 3. In recognition that these courses span a wide range of complexity, once a student has failed to receive a C- or better in one of these courses, they may satisfy the competency by satisfactory completion of a project designed and administered by the Department of Mathematics. Passing an online test is not an adequate demonstration of competency in this module which requires participation in a real modeling experience.