

PROPOSAL TO THE ACADEMIC SENATE

TITLE: Quantitative Reasoning Competencies - Issue I-00-10

SUBMITTED BY: Academic Policies Committee

DATE: 10/13/00

ACTION IS: Legislative Authority

REFERENCE IS: *Faculty Handbook*, Constitution of the Academic Senate of the University of Dayton, Article II, B, 3.

DESCRIPTION OF PROPOSAL:

The Basic Skills Subcommittee of the Academic Policies committee submitted the original proposal for the new University competency program on December 8, 1998. The Academic Senate on December 7, 1999 accepted the Basic Skills Subcommittee report with modifications (Senate Doc 99-8). The modifications concerned the phased implementation plan for each competency area and a streamlined governance structure. The Quantitative Reasoning competency was not included in Senate Doc 99-8 since it was still being reviewed.

This proposal, Senate Document 1-00-10A is to accept the Quantitative Reasoning Competencies with modifications as proposed in the attachments.

# Quantitative Reasoning Competencies

## Introduction

Every well-educated citizen should be proficient in mathematical thinking and be able to employ mathematical techniques that demonstrate quantitative reasoning capability. We refer to this proficiency as quantitative reasoning. A college-educated adult should be able to apply simple mathematical methods to the solution of real world problems in order to help them make wise choices in dealing with quantitative issues in their personal life. The use of technology is assumed to be implemented and an important element in each of the competencies. College graduates should be expected to use technology to assist in quantitative data analysis and computations. College graduates should be expected to go beyond routine problem solving to handle problem situations of greater complexity and diversity. College graduates should be proficient at recognizing and applying mathematical concepts in and outside the contexts of classroom mathematics.

A quantitatively literate college graduate should be able to

- Interpret mathematical models such as formulas, graphs, tables and schematics and draw inferences from them.
- Represent mathematical information symbolically, visually, numerically, and verbally.
- Employ commonly useful mathematical and statistical methods to solve problems.
- Estimate and check answers to mathematical problems in order to determine reasonableness, identify alternatives, and select the most useful results.
- Recognize that mathematical and statistical methods have limits.

Quantitative reasoning includes making important financial decisions as well as making decisions based on information that is presented in a probability, statistical, or graphical format. These problem solving skills needed for dealing with diverse sets of quantitative reasoning can be described in terms of three modules: algebraic models, geometric growth models, and probability and statistical models. Mathematical modeling refers to the process of applying mathematics to solve real world problems.

## General Quantitative Reasoning Competencies

Module 1: Algebraic Modeling (Real world problems that are best modeled mathematically by lines and other polynomial equations)

Students should be able to

- Algebraically manipulate the equation of a line, sketch its graph and interpret its slope as a rate of change
- Appropriately use linear models (ex. finding sales tax, cost of gasoline per gallon, total cost based on revenue and profit)
- Fit a line through given data points in order to find the line of best fit
- Sketch quadratic equations, which are second degree polynomials, and find the maximum or minimum value.
- Compare and contrast different models to determine which is better in a particular context
- Select and employ various types of mathematical reasoning and methods of proof to justify and explain solutions

Sample Problems:

- Graphically interpret the formula used for computing Federal income taxes, and use this formula to calculate the effective rate of taxation for various incomes
- One cell phone option involves a monthly payment of \$17.99 plus a per minute charge of 15 cents; another option is a monthly charge of \$7.99 plus a per minute charge of 40 cent. Graphically compare the options and determine which is the better buy for various amounts of usage.

Module 2: Growth Modeling (Real world problems that are best modeled mathematically by equations that grow multiplicatively, geometrically)

Students should be able to

- Visualize, describe verbally, and graph an exponential function
- Use an exponential function to model growth phenomena, i.e. population, financial etc.
- Determine compound interest when it is compounded yearly, monthly, daily, or continuously (exponential growth)
- Use appropriate methods (logarithms or estimating) in order to analyze annuities and amortization of loans
- Select and employ various types of mathematical reasoning and methods of proof to justify and explain solutions

Sample Problems:

- You want to purchase a car with a loan of \$12,000 at an annual interest rate of 9% to be paid in 60 monthly installments. Determine the monthly payments and the outstanding debt after two years.
- To prepare for future college expenses of their child, a young couple decides to set up an annuity with fixed deposits over the next 18 years. They expect to earn an annual rate of 8% on the annuity and want \$50,000 available at the end. Determine the monthly deposit needed to accomplish this goal.
- Compare graphically the interest payments versus what you are paying on the loan for the purchase of a home with a mortgage interest rate of 7% over 15 years with the payments you would make with a loan of 6.25% over 25 years. Describe which loan you would choose to obtain and why

Module 3: Probability and Statistics Modeling

Students should be able to

- Use counting principles to determine how many different permutations or combinations are possible
- Determine probabilities or risks of simple events occurring
- Represent data using a variety of graphical methods, such as bar graphs and pie charts
- Make reasonable inferences from data presented in a table or graph
- Compare the different methods to represent a data set with one value, namely mean, median, mode
- Determine the spread of a data set by finding the range and standard deviation and its relationship to appropriate sample size.
- Be able to apply the basic concepts of sampling, estimation based on sample results and estimation errors
- Find probabilities of certain values of a variable for distributions such as normal and binomial
- Select and employ various types of mathematical reasoning and methods of proof to justify and explain solutions

Sample Problems

- In how many ways can an extended jury of 13 people (12 jurors and 1 alternate) be chosen from a pool of 20 people? Assume that the order of selection of the 12 jurors is immaterial, but that the thirteenth juror selected is designated as the alternate.
- Make a list of the daily high temperatures for the past month by consulting your daily newspaper. Decide on an appropriate grouping of these temperatures and display the data in a histogram. Then calculate the mean, median and standard deviation of the data. What inference can you draw?
- The heights of the Rockette dancers at New York City's Radio City Music Hall must be between 65.5 inches and 68.0 inches. If a woman is randomly selected, find the probability that she meets the height requirement to be a Rockette. Note: women's heights are normally distributed with a mean of 63.6 inches and a standard deviation of 2.5 inches.
- It is believed that the rate of minor defects for a product is .01, i.e. 1% of the products have defects. For an inspection plan of examining 5 such products, calculate the risk or probability of finding 2 or more of the products with minor defects.
- We want to develop a good estimate for the proportion of voters who will vote for a certain ballot initiative. We believe that the proportion is now close to .4 Determine the required number of likely voters we

- should sample in order to estimate this proportion with a possible error of +/- 3 percentage points (at 95% confidence).

### **Graduation Quantitative Reasoning Competencies**

Graduation competencies ~~are extensions of the general competency areas and~~ should reflect the quantitative reasoning competencies central to the academic discipline or area of specialization. Academic departments and programs must identify and define the graduation quantitative reasoning competencies they will develop through course work in the major disciplines. Disciplines may choose to emphasize the ways their areas of study represent mathematical information symbolically, graphically, visually, or verbally. 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, consultation with the Department of Mathematics, and, when appropriate, from external standards established by professional organizations, domain specific learned societies, and accrediting bodies