



Basic Proficiencies in Quantitative Reasoning

AS REVISED December, 2005

As approved by Faculty Senate, February 1, 2006

This recommendation is submitted in response to the guidelines of the Undergraduate Education Initiative, a campus-wide review of FSU's undergraduate curriculum, as approved by the Faculty Senate in February, 2005.

Membership

The following FSU faculty members served on the planning group for the establishment of criteria for basic proficiencies in quantitative reasoning:

Dr. Marc Michael, Mathematics;

Dr. Lance Revenaugh, Mathematics;

Ms. Beth Stallings, Academic Counselor/Math Specialist, Programs for Academic Support and Studies;

Dr. Danny Welsch, Geography;

Dr. Gerard Wojnar, Mathematics.

Dr. Jim Limbaugh, Assistant to the Provost, served as convener and facilitator.

The Case for Quantitative Reasoning

Our General Education Goals specifically cite a focus on students' attainment of core skills—to “understand and apply mathematical reasoning to solve quantitative problems and to evaluate quantitative information and arguments.” The establishment of this goal provides a direct response to a “call to arms” issued both from society at large within and circles of higher education regarding the crisis in quantitative literacy—the development and application of basic skills in using and applying numerical data and mathematical concepts in an information-driven society.

Writing about the world beyond college, Steen (2001) observes that “the world of the twenty-first century is awash with numbers” (p. 1). As a result,

Quantitatively literate citizens . . . need a predisposition to look at the world through mathematical eyes, to see the benefits (and risks) of thinking quantitatively about commonplace issues, and to approach complex probes with confidence in the value of careful reasoning. Quantitative literacy empowers people by giving them tools to think

for themselves, to ask intelligent questions of experts, and to confront authority confidently. (p. 2)

Reflecting this same sentiment, Schoenfeld (2001) observes succinctly that “The absence of mathematical sense-making makes a big difference in the real world” (p. 51).

Authors and researchers in higher education also recognize the importance of quantitative literacy. Ewell (2001) notes that “all students, regardless of major or career aspiration, need context-rich quantitative literacy as an integral part of their education.” (p. 39). Steen (2004) asserts that “College-level quantitative literacy is inextricably connected to virtually all areas of undergraduate study” (P. 5). In order to develop quantitative literacy, Ellis (2001) writes of the importance of students being “involved in both abstract thought and practical problem solving,” (p. 66) goals which are mutually supportive. Schneider (2001) effectively summarizes the issues before colleges and universities relating to quantitative literacy:

We must recognize that it really is malpractice to allow students to slip through college without developing the ability to use quantitative strategies to examine significant questions. . . We are only shortchanging our graduates with respect to the actual demands of a number-infused world. (p. 105).

As this short review of the literature shows, the need to engage students in the development of basic skills in quantitative reasoning is very clear if we are to prepare them to enter a “data drenched society” (Steen, 2001, p. 2). As the result of the imperative that our students achieve a basic level of quantitative literacy, and in tandem with external mandates to identify students’ basic skill levels (as detailed below), the University will use the definition of quantitative literacy, as outlined in a following section, to help students develop skills in quantitative reasoning and to guide assessments of student learning outcomes.

External Mandates

The development and assessment of core skills in general education also responds to the requirements of two external entities: The Maryland Higher Education Commission and the Middle States Association of Higher Education.

The Maryland Higher Education Commission (MHEC) has mandated that all Maryland institutions of higher education establish specific definitions and benchmarks regarding college-level skills in seven basic skills. In addition to quantitative reasoning, these skills include written communication, critical thinking, scientific reasoning, oral communication, technological literacy, and information literacy. Said benchmarks are to be assessed on a regular basis and reported to MHEC every three years, beginning in 2007.

The University's accrediting agency, the Middle States Association of Higher Education, in its revised standards, also specifically mentions the need to assess students' skills in quantitative reasoning. The accreditation standards of the Middle States Commission on Higher Education state that an institution's program of general education must be designed "so that students acquire and demonstrate college-level proficiency in general education and essential skills" including those cited above (*Characteristics of Excellence*, 2002, -p. 37).

Definition

At Frostburg State University, students are provided experiences in quantitative literacy that will allow them to develop the ability to apply basic concepts and understand quantitative issues that a university graduate will likely encounter in his or her personal and professional life.

Therefore, a student who is proficient in basic skills of quantitative literacy will be able to

1. Interpret mathematical models such as formulas, graphs, and tables, and will be able to draw inferences from them;
2. Communicate mathematical information symbolically, visually, numerically, or verbally (written and/or oral);
3. Use arithmetical, algebraic, geometric, or statistical methods to solve problems;
4. Estimate and check answers to mathematical problems in order to determine reasonableness, identify alternatives, and select optimal results.

Please note that this definition is subject to continual review and refinement as assessment results are analyzed in light of institutional learning goals.

Connection to Undergraduate Institutional Learning Goals

Frostburg State University's definition of quantitative reasoning supports the following Undergraduate Institutional Learning Goals:

- Liberal Knowledge and Skills of Inquiry, Critical Thinking, and Synthesis...specifically, "apply different methods of inquiry from various perspectives and disciplines to gather information";
- Core Skills...specifically, "understand and apply mathematical reasoning to solve quantitative problems and to evaluate quantitative information and arguments."

Assessment Strategies

To assess students' demonstration of quantitative literacy as outlined by the University's definition, a common rubric (see Attachment A) will be used in Introductory Statistics (MATH209), Introduction to Mathematical Problem Solving (MATH 104) and College Algebra (MATH 102). These courses have been identified as the assessment sites because they have

been identified by the University as those courses that meet basic (i.e., Level I) criteria for college-level mathematics..

The rubric has four sections, each based on FSU's definition of quantitative literacy: Interpret Mathematical Models, Communicate Mathematical Information, Use Appropriate Methods to Solve Problems, Estimate and Check Answers. The rubric will be used as an imbedded grading tool in each section of the aforementioned courses, with a pilot application planned for spring 2006. The rubric will then be used as a grading tool for a problem set at some point past the tenth week of the semester. The rubric will be collected and the results tallied in order to ascertain student progress.

The assessment process will be ongoing, with results from each assessment becoming part of the discussion of continued improvement of student learning. Changes will be made as necessary in response to the results of assessment. Reports on student performance in the aggregate (not by individual class) will be shared with appropriate University constituencies.

Internal Benchmarks

Frostburg State University will report that its students are demonstrating basic skills in quantitative reasoning if 70% or more of the students enrolled in MATH 209, MATH 104, or MATH 102 each semester have attained a "meets standards" in all portions of the grading rubric.

Timeline for Implementation

1. February 2006: Faculty Senate reviews criteria for quantitative reasoning. If accepted, then the grading rubric is piloted in selected sections of MATH 209, MATH 102, and MATH 102.
2. Spring 2006: Initial pilot course assessments are reviewed for sufficiency. Adjustments/revisions to the definition and/or rubric are made as necessary. Assessments continue, utilizing a broader sample of courses.
3. Fall 2006 and beyond: Assessment continues, using a broader sample of courses.

*Submitted by Jim Limbaugh, Assistant to the Provost
on behalf of the Faculty Planning Group for Quantitative Reasoning
November, 2005*

References

- Ellis, W. (2001). Numerical common sense for all. *Mathematics and democracy: The case for quantitative literacy* (L. Steen, Ed.). pp. 61-66. National Council on Education and the Disciplines.
- Middle States Commission on Higher Education (2002). *Characteristics of excellence in higher education: Eligibility requirements and standards for accreditation*. Philadelphia: Middle States Commission on Higher Education.
- Schoenfeld, A. (2001). Reflections on an impoverished education. *Mathematics and democracy: The case for quantitative literacy* (L. Steen, Ed.). pp. 49-54. National Council on Education and the Disciplines.
- Steen, L. (2001). The case for quantitative literacy. *Mathematics and democracy: The case for quantitative literacy* (L. Steen, Ed.). pp. 1-22. National Council on Education and the Disciplines.
- Steen, L. (2004). Everything I needed to know about averages...I learned in college. *Peer Review* (summer 2004), pp. 4-8.