Quantitative Foundations

Quantitative reasoning (QR) is a conceptual process that employs one or more of a family of mathematical or logistical methods to analyze and solve problems in a variety of disciplines. Such methods guide both deductive and inductive reasoning in mathematics, the sciences (including physical, life, psychological, social, political, and economic sciences), the humanities and arts as well as in engineering, computer science, and information technology. They also have great utility in helping students clarify and critically evaluate information that is relevant to personal life and to everyday decisions about health, finance, citizenship, and government. When these methods are applied to real-world examples and taught in contexts that engage student interest they have been found to improve the capacity of students to draw sound inferences. Quantitative reasoning is multi-disciplinary and invites a wide diversity of disciplines and departments to offer courses to satisfy this requirement. We describe here the requirements for the first course in Quantitative Reasoning, focusing on Mathematical, Logical, and Statistical Foundations. Statistical elements in this course are at the level of basic skills in descriptive statistics; the second course in Quantitative Reasoning will focus on Statistical Reasoning and Inference and is described in its own template.

Learning Outcomes

As with all General Education courses, students in this course will demonstrate information literacy by their measurable ability to independently locate, identify and utilize information resources from a variety of credible sources. They will be able to understand the ethics surrounding the information. Using critical thinking skills, students will extract, evaluate and validate information as well as organize, communicate and accurately use it in their research.

Courses designed to meet the Mathematical, Statistical, and Logic Foundations requirement will demonstrate how the course elements (e.g., structure, activities, assignments, projects, homework, papers, and exams) will contribute to the following student learning objectives.

Learning Outcomes: *Students will be able to:*

1. demonstrate proficiency with number sense (e.g., order of magnitude, estimation, comparisons, effect of operations) and with functional relationships between two or more sets of variable values (i.e., when one or more variables depend upon, or are functions of, other variables) and also relate different representations of such relations (e.g., algebraically or symbolically, as tables of values, as graphs, and verbally). Relations between numerical values must be included in order that students will be prepared for the Statistical Inferential Reasoning course.

2. apply fundamental elements of mathematical, logical, or statistical knowledge to model and solve problems drawn from real life. In this modeling process, students will be able to:

    a. recast and formulate everyday problems onto appropriate mathematical or logistical systems (viz. algebra, geometry, logic), represent those problems symbolically (i.e., in numbers, letters, or figures), and express them visually or verbally.

    b. apply the rules, procedures, and techniques of appropriate deductive systems (e.g., algebra, geometry, logic) to analyze and solve problems.

    c. apply correct methods of argument and proof to validate (or invalidate) their analyses, confirm their results, and to consider alternative solutions.

    d. interpret and communicate their results in various forms, including in writing and speech, graphically and numerically.

    e. identify and evaluate arguments that contain erroneous or fallacious reasoning (e.g., unsound mathematical or logical inferences), and detect the limitations of particular models or misinterpretations of data, graphs, and descriptive statistics.

At least 30% of the course should address objective (1), and at least 40% of the course should address objective (2). (If the course has more than three credit hours, then these percentages refer to the equivalent time of a three credit hour course.)

Guidelines for Course Designers

There are definite needs and rich opportunities for many different departments (besides the ones currently addressing the current USP Basic Skills and Inference requirements) to develop and offer courses. Courses at our benchmark institutions that are addressing their own QR requirements are drawn from mathematics, statistics, engineering, natural and physical sciences, humanities, social sciences, art, and other disciplines.

The course should have a central applications-driven, problem-solving focus, with particular attention to problems of potential "real-life" relevance to the students. The students should be actively engaged in modeling and problem-solving (though the problems and modeling may range from relatively straightforward to complex). There are various technology tools (e.g., interactive applets or computer programs) that can assist in visualizing concepts and making models, as well as reinforcing basic skills. The desire is that the course will develop such quantitative reasoning skills as to be generally useful to students in their further studies, work, and engagement in civic life.

The course will embed information literacy incorporating independent learning and utilizing active learning techniques, technology, instruction and consultations and/or tutorials. Instructors will collaborate with librarians to create a course-relevant component developing lifelong learning skills allowing students to identify, evaluate, utilize, apply and communicate information, a critical competency in becoming a contributing member of society.

The course will ensure that students will create at least one assessable product (e.g., the result of modeling and solving a problem) that can be shared with UK's Assessment Office to contribute to the assessment of the General Education program.

It is to be assumed that students will enter the course with an appropriate mastery of high school mathematics through Algebra I, Algebra II, and Geometry to earn a Math ACTE score of at least 19, or the equivalent.