Number, Nature, and Mind
A GE New Themes Proposal

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Theme Statement

Mathematics seems to be, simultaneously, a construct of the human mind, an extraordinarily powerful tool for understanding nature, and an abstract realm that exists independently of both humans and natural phenomena. Courses in this theme will address foundational issues in mathematics, applications of mathematics in the natural sciences, and aspects of cognitive psychology and artificial intelligence that apply to mathematical comprehension and logical reasoning. This theme is designed for students coming from a wide range of major fields who want to explore the fundamental questions at the intersection of Number, Nature, and Mind.

Overview Narrative

The central issues of this theme are encapsulated in the titles of two essays, both originally published in 1960. *The Unreasonable Effectiveness of Mathematics in the Natural Sciences,* by the physicist Eugene Wigner, examines the conundrum that mathematical concepts, which seem to have an independent life as logical constructs, are also astonishingly successful at describing and even predicting the observable phenomena of nature. *What is a Number, that a Man May Know It, and a Man, that He May Know a Number?*, by the computational neuroscientist Warren McCulloch, asks how, and why, human minds are capable of comprehending mathematical objects and using them to derive logical conclusions that are apparently unassailable.

Courses in this theme will address foundational issues in mathematics, applications of mathematics in the natural sciences, and aspects of cognitive psychology and artificial intelligence that apply to mathematical comprehension and logical reasoning. Students will examine the differences and interactions between "pure" mathematics that seeks logical proof and mathematics as applied to science and the description of nature. Students will grapple with the still unresolved philosophical questions of whether and how logical reasoning leads to incontrovertible truths, of why mathematics is so "unreasonably effective" in the natural sciences, and of how and why humans are able to understand and use mathematics.

We anticipate that this theme will be attractive to quantitatively minded students from a wide variety of backgrounds including:
-- Students majoring in natural and mathematical sciences, engineering, or computer science who have interest in foundational philosophical questions that underpin their fields.
-- Students majoring in psychology, linguistics, or philosophy who have interest in human cognition and artificial intelligence.
-- Students from any field who have interest in the philosophical foundations of mathematics and science and in striking applications of mathematics to scientific discovery.

The currently approved GE themes do not offer an obvious home for such students, nor do they provide a natural destination for many of the courses in our list below, even though these courses are popular with undergraduates. While some of these courses can be reconfigured into the GE Foundations, most of them are better suited to the deeper level of inquiry expected in the Themes.

Courses

We anticipate three general categories of courses within this theme:
1. Courses that examine philosophical foundations of mathematics, logic, and natural science.
2. Courses that illuminate the most striking examples of the application of mathematics to the natural sciences, including at least some courses that are designed to be accessible to non-scientists.
3. Courses that examine cognitive and linguistic aspects of mathematics and logic.

Existing courses that might fit into this theme, or be adaptable into courses for this theme, include those listed below. Some of these courses are now being proposed for a GE Foundations category, and some may be at too high a level to slot into a GE Theme without change. However, if this theme is approved then any of these could become the basis of a course that would fit within it. The number and range of these existing courses demonstrates the faculty expertise and student interest in the topics of this theme.

If the theme is approved, we anticipate developing at least one 4-credit interdisciplinary course that takes a unified approach to this theme's philosophical, scientific, and cognitive issues. Possibly there would be two or more versions of such a course pitched for students with different levels of math and science background.

Other potential new courses that would be highly desirable for this theme include:
-- A physics course on quantum mechanics that is accessible to non-majors.
-- Courses in other science departments that address the goals of this theme and are accessible to non-majors.
-- A more introductory level survey of cognitive science if the courses listed below are too advanced for most potential GE students.