Studies in the Literature of Mathematics
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We are scheduled to teach the course MATH0216 – Studies in the Literature of Mathematics on a pilot basis as a core course in the Literary and Philosophical Analysis area during the spring semester of 2005. The course has already been accepted as an Honors course offering. We are concurrently applying to have this course accepted as a permanent course that satisfies the Literary and Philosophical Analysis area of the core.

MATH0216 - STUDIES IN THE LITERATURE OF MATHEMATICS
A study of mathematical literature devoted to selected topics from fundamental scientific, philosophical, artistic, cultural, and technological questions, debates, and revolutions. Source material will be taken from the widely varied genres of mathematical literature: fiction, drama, essays, surveys, memoirs, exposition for lay audiences, history, and philosophy. Regular class discussions, regular writing assignments, poster projects, and research papers will actively involve students in creating and analyzing literature which reflects both their role in and their understanding of the mathematical experience.
Prerequisites: ENGL0102 and at least one 100-level mathematics course.

Narrative

Throughout history mathematicians have developed mathematics as a vehicle to respond to fundamental conditions of the human situation, including:

The nature of truth
The limits of knowledge
Our perception of our physical world
Our understanding of the mechanisms that operate our physical world
The nature of beauty
The structure of logic
Abstraction and the anatomy of primitive, defining elements
The communication and content of information
The role of language in communication and the development of meaning

These issues are, and have historically been, both the life blood of mathematics and the driving forces responsible for its continued development. The goal of this course is to illuminate the critical progress mathematics and mathematicians have had in our understanding of these fundamental issues.

Mathematics is often seen to be a static, archaic field which supplies only exact, inevitable answers to the driest quantitative issues. Nothing could be further from the truth. Mathematics is a living, dynamic field which has played a fundamental role in many of the great scientific, philosophical, artistic, cultural, and technological questions, debates, and revolutions.

This role of mathematics is clearly borne out by historical study.[1] Therefore, in a time when so much emphasis has been placed on interdisciplinary studies, diversity, and the integration of knowledge, it is entirely appropriate for mathematics to be more actively integrated into mainstream educational culture.

We will use literature as our vehicle to illustrate the central role of mathematics and mathematicians in addressing the fundamental issues listed above. There is an appropriate symmetry in this approach. For the literature of mathematics, like mathematics itself, is both broad and widely varied. Its approach to these issues has never been one-dimensional. Mathematicians through the ages have investigated aspects of the human condition using fiction, drama, essays, surveys, memoirs, exposition for lay audiences, history, philosophy, and prose to complement the more often envisioned mathematical research articles and books. And it is not only mathematicians who have sought to illustrate the field's impact through literature, but authors, poets, philosophers, logicians, and others who have do so throughout history.

By and large, contemporary mathematics core curricula focus on the utility of mathematics rather than the more humanistic aspects that have for so long supported mathematics' key place as one of the liberal arts. In this course the focus will be on the more humanistic aspects, enabling us to provide a more natural, historically appropriate, and unified context for students to develop understandings of and appreciation for the human conditions described at the outset. This will provide students a unified approach to mathematics, literature, and philosophy that enables them to analyze, evaluate, and apply key themes, methods, arguments, and world views outside of the narrow confines that too often compartmentalize fields.

Using primary and secondary source literature, this course will provide a historical context through present times that will help inform students' understandings of the role of mathematics and the mathematical experience in the investigation of the human situation. Through class discussions, regular writing assignments, poster projects, and research papers, students will be actively involved in the creation of literature which reflects their role in and their understanding of the mathematical experience.

We believe this course will be of significant use in combating negative stereotypes in mathematics, literature, and philosophy. As liberally educated mathematicians, this is especially important to us when stereotypes of mathematics are so widely held, so educationally detrimental, and so divisive in fueling the continued division between the humanities and the sciences, what C.P. Snow famously referred to as the "two cultures."

Examples

The purpose of this section is to provide brief details about a few specific texts that are appropriate for this course.

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[1] Edward O. Wilson's **Consilience: The Unity of Knowledge** notwithstanding. In this book, the recent choice for our Campus Book for '04-'05, Wilson has mathematics appear only as a peon in service to his greater unifying principles. Yet most, if not all, of the advances that he cites owe a fundamental debt to mathematics. Many of the great figures that people his historical development were primarily mathematicians. Wilson's description of Newton's Universals Laws of Gravitation on p. 32 is a telling illustration.

Proof by David Auburn is a Pulitzer Prize winning Drama and multiple Tony Award winner. This play uses mathematics as a metaphor to examine fundamental questions of truth, existence, what we accept as evidence, and how we know what we know. In March, 2001 the Math Club took 55 people to see the original Broadway production of this play at the Walter Kerr Theatre in New York City and met the cast and director afterward. This play has been adapted into a movie starring Gwenyth Paltrow and Anthony Hopkins which is scheduled for release in December, 2004.

Indiscrete Thoughts by Gian-Carlo Rota (1997). A memoir recounting selected pet topics of the author - a prominent late-twentieth century mathematician and philosopher. Widely hailed but also widely panned, the book centers around the role of mathematics in science and technology over the second half of the twentieth century. Part recollection of biographical stories, part commentary, and part essay, the book has a wide range of application to the course. Of particular note are the following sections: "The phenomenology of mathematical truth", "The phenomenology of mathematical beauty", "The phenomenology of mathematical proof", "Kant and Husserl", and the most important, "The pernicious influence of mathematics upon philosophy."

A Beautiful Mind (Screenplay by Akiva Goldsman, based on the biography of John F. Nash by Sylvia Nasar, and Directed by Ron Howard) won four 2001 Academy Awards including Best Picture. This movie provides an interesting connection between the actual biography and the screenplay which took liberties, often mathematical ones, with the real story to make psychological points. For example, in the movie Nash has visual mathematical hallucinations involving code breaking for the military, while in reality he never had any visual hallucinations although he did believe that the U.S. Government and the military were after him. Also, the movie portrays Nash coming up with his equilibrium principle (for which he won the Nobel Prize in Economics in 1994) while sitting in a bar. This is not how it happened although this scene does provide a good, understandable description of his solution. This movie provides an opportunity to discuss questions such as: What is real? What is imagined? What do we really know? What are the limits of our knowledge and perception? In February of 2002 the Mathematics Club and the Economics Club took 20 students to see this movie.

The Mathematical Experience by Philip J. Davis and Rueben Davis (1981). An anthology of essays on mathematical philosophy and mathematical history; brief narrative surveys of the driving problems of mathematics and the everyday work of mathematicians; reflections on the cultural and humanistic aspects of mathematics; etc. Called "one of the masterpieces of our age" by the *American Mathematical Monthly*.

Flatland by Edwin Abbott Abbott is a classic story written in 1884 that involves a two-dimensional being's attempts to understand and visualize the third dimension. This book address the questions of perception (What do we know?) and communication (How do we describe events to others that are outside of their experiences?). This book uses these questions to satirize 19th century England and many of its social customs. Mathematically it also attempts to provide its readers with tools and metaphors for thinking about describing the fourth dimension - an issue in the 19th century that was only a mental exercise, but now has profound implications for the nature and structure of our universe.

Alice in Wonderland by Lewis Carroll (a.k.a. Charles Dodgeson) is a classic in children's fantasy. Dodgeson was a mathematician and used logic and problem solving to explore issues of what is real, how accurately we communicate, and how we deal with and solve problems that are outside of our experiences. The fact that this book remains one of the most popular pieces of children's literature is perhaps a testament to the importance of these questions.

Need for Course/Fit into Curriculum

The Literary and Philosophical Analysis area of our core curriculum, as it currently stands, is populated by courses that are squarely from the humanities. We believe that the addition of this course to the Literary and Philosophical Analysis core area provides a link between the humanities and the sciences to which students should have an opportunity to be exposed. As described above, this course will provide a more humanistic and philosophical mathematical context for our students. Moreover, we hope that this course will help students break their habit of compartmentalizing different areas of study by helping them build a bridge between the "two cultures" divide.

The "two cultures" divide is exacerbated from both sides of the divide. Mathematics and science students often view humanities core requirements as meaningless requirements with no relevance to their field of study and little inherent worth. We believe that this course will decisively challenge these misperceptions. Indeed, we hope that it is will nurture students' interest in the humanities.

Moreover, this course fills an important need for students in majors with substantive mathematical requirements. For such students, the required mathematical curriculum that provides sufficiently deep study of the mathematical tools, concepts, ideas, algorithms, and applications that are necessary precludes the significant study of these literary, philosophical, and historical questions. While we do not argue that these students need to be exposed to the breadth of the common core of studies, their mathematical experience will be deficient without a course such as this. Many other departments offer courses that serve both core and major requirements subsequently, there is no reason for mathematics to be otherwise. (E.g. English majors may fulfill ALL of their composition, literary and philosophical analysis, appreciation of the arts, and diversity core requirements, a total of 24 out of 43 required core hours, in English Department courses.) This course will be particularly important for our elementary and secondary education students who are required to have exposure to historical and cultural aspects of mathematics for their certification.

Audience

Our primary audience will consist of Mathematics, Computer Science, and Computer Information Systems majors and minors. We hope to enroll a significant proportion of students from each of these areas who need to fulfill remaining core and/or elective requirements. We also hope to draw a significant number of Liberal Studies students with Concentrations in Mathematics.

The historical and cultural areas of study in this course are areas required for certification for our elementary and secondary education students. This course will greatly benefit these students in this area.

Our secondary audience will include General Science, Biology, and Environmental Science majors and minors. While the content of the literature which will be used may not be specifically from these fields, the philosophy, historical contexts, and methodologies of the course are closely allied with those in the other areas and will therefore be beneficial to students in these programs.

The inclusion of mathematical history, the role of mathematics in the arts, and mathematics in culture in courses such as MATH110 – Mathematical Explorations has encouraged some students to pursue additional studies in mathematics. We believe that this course would provide yet another such opportunity for interested students. So we hope to have Art, Music, English, Philosophy, and students from across the breadth of the majors enroll in this course.

Scheduling issues

The first offering of this course, as an honors course in Spring 2005, will be team-taught by Profs. Hotchkiss and Fleron. Subsequently, this course will be taught by a single professor within the standard teaching load.

Should this course be approved as a permanent course within the Literary and Philosophical Analysis area of the core, we plan to offer one section of this course in the spring of each academic year. This will certainly adequately serve the needs of our primary audience. It remains to be seen how many students from our secondary audience this course will draw. We believe it would be healthy for the course to draw enough students that it may require one section in both spring and fall semesters, but we do not foresee any greater demand than this. I.e. we do not foresee this course becoming a multi-section course each semester. That being said, there are more than enough faculty in the Department of Mathematics with both the ability and interest to teach this course that it will not strain departmental resources.

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Selected Course Materials

What follows is a collection of course materials appropriate for our proposed course Studies in the Literature of Mathematics and the Mathematical Sciences. This list is not complete, it is a work in progress whose purpose at this point is to illustrate the breadth of the literature on which the course will be based. Please note that the collection of literature below is sufficient to provide the fodder for three relatively independent offerings of this course. We expect to choose some half dozen books and two dozen excerpts/articles as the material for a specific semester.

Essays

The Two Cultures by C.P. Snow (1960) – Classic essay on the schism between the worlds occupied by those in the humanities and those in the sciences.

Gödel, Escher, Bach: The Eternal Golden Braid by Douglas Hofstadter (1979) - Pulitzer Prize winning book which intertwines the music of Bach, the twentieth century art of M.C. Escher and the twentieth century breakthroughs of Gödel to provide a context for meditating on human thought, artificial intelligence, and the limits of knowledge.

Consilience: The Unity of Knowledge by Edward O. Wilson (1998) - Called "A dazzling journey across the sciences and humanities in search of deep laws to unite them" by the Wall Street Journal, the famed biologist virtually excludes mathematics in giving rise to a new schism as inane as the one he was trying to combat.

Mathematics and Culture I edited by Michele Emmer (2000).

Demon Haunted World by Carl Sagan (1996).

Pale Blue Dot by Carl Sagan (1994).

Fiction and Drama

Proof by David Auburn (2001) - Script of the play that won four Tony Awards and a Pulitzer Prize.

The Curious Incident of the Dog in the Night Time by Mark Haddon (2003) - New York Times Best Seller (current as of 2/04) and widely heralded as a piece of literature, it is the story of a young mathematical prodigy who has Asperger's Syndrome.

Flatland by Edwin Abbott Abbott (1880) - Classic primer of the geometry of the higher dimensions which set the stage for CAT scans and MRI and is a biting social satire of Victorian England.

Da Vinci Code by Dan Brown (2003) - Smash best seller which has cryptography as a central theme.

A Beautiful Mind (2001) – Oscar winning movie about John Nash; based on the book by Sylvia Nassar.

Uncle Petros and Goldbach's Conjecture by Apostolos Doxiadas (2001) – A novel whose release was advertised by a $1 Million reward for solving the famous problem after which it was named. This book provides rich settings for discussions about the limits of mathematical knowledge.

The Number Devil: A Mathematical Adventure by Hans Magnus Enzensberger (1997) – A young adult novel about a twelve year-old boy who discovers the beauty and magic of

mathematics from the Number Devil – a dream induced nemisis to his boring, uptight mathematics teacher.

The Fractal Murders: A Mystery by Mark Cohen (2002).

Mathematical Memoirs

Indiscrete Thoughts by Gian Carlo Rota (1997) – A description of scientific and technological progress in the second half of the twentieth century through the eyes of a mathematician. Extensive coverage given to the culture, people, and philosophical implications of the events that are described.

Mathematical Apocrypha: Stories and Anecdotes of Mathematicians and the Mathematical by Steven Krantz and William Watkins (2002).

A Mathematician's Apology by G.H. Hardy (1940) – Classic account of the creative artistry of mathematics as well as the place of pure mathematics in the mathematical realm.

Mathematical Anthologies, Mathematical Surveys, and General Mathematical Exposition

The Mathematical Experience by Rueben Hersh and Philip Davis (1981) – A classic which the *New York Times* called "A brilliant and highly engrossing view of the development of mathematics… Wonderful at communicating its beauty and excitement to the general reader."

The World of Mathematics by James R. Newman (1956).

What is Mathematics? by Richard Courant and Herbert Robbins (1941) – The classic lay survey of mathematics.

Mathematics Elsewhere: An Exploration of Ideas Across Cultures by Marcia Ascher (2002).

Mathematical History and Biography

In Code: A Mathematical Journey by Sarah Flannery (2001) – An autobiographical account of an Irish school-girls recent breakthrough in cryptography.

The Man Who Loved Only Numbers: The Story of Paul Erdos and the Search for Mathematical Truth by Paul Hoffman (1999) – Biography of the mathematician Paul Erdos, one of history's most prolific mathematicians.

A Beautiful Mind by Sylvia Nasar (2001) - Book about the life of John Nash which inspired the Academy Award winning movie adaptation.

I Want to Be a Mathematician by Paul Halmos (1985) – Biography of one of the twentieth century's foremost mathematicians.

Fermat's Enigma by Simon Singh (1997) – National Bestseller which is the story of the history of Fermat's Last Theorem, mathematics' Holy Grail, and its solution by Andrew Wiles in 1994.

Classical Literature with Mathematical Themes and/or Connections

A Wrinkle in Time by Madeline L'Engle (1963) – Classic young adult science fiction work involving travel in the fifth dimension.

The Complete Sherlock Holmes by A.C. Doyle.

Alice in Wonderland and **Through the Looking Glass** by Lewis Carroll.

Writing in Mathematics

Writing to Learn Mathematics and Science by Paul Connelly and Teresa Vilardi (1989)
Using Writing to Teach Mathematics by Andrew Sterrett (1990)
Writing in the Teaching and Learning of Mathematics by John Meier and Tom Rishel (1998)
Handbook of Writing for the Mathematical Sciences by Nicholas Higham (1998)
"Advice for undergraduates on special aspects of writing mathematics" by Stephen B. Maurer, *PRIMUS*, March, 1991, 9- 28.
"Writing about Mathematics" and "Clean Writing in Mathematics" by W.M. Priestley, Appendix 1 and Appendix 4 in **Calculus: A Liberal Art**.
"Writing for a Math Class", www.mathacademy.com/pr/minitext/writing/index.asp
"What's an assignment like you doing in a course like this? Writing to learn mathematics" by George Gopen and David Smith, *College Mathematics Journal*, Jan. 1990, 2 – 19.
"How to write mathematics" by Paul Halmos, *L'Enseignement Mathematique*, May-June, 1970, 123-152.
Westfield State College Writer's Guide, biology.wsc.ma.edu/wscwg