

# Mathematics: One of the Liberal Arts

A report on Henderson State University's New General Education Mathematics Course

Fred Worth

*Associate Professor of Mathematics*

## Abstract

*Recently the Department of Mathematics and Computer Science instituted a new general education mathematics course. This paper describes the process and reasoning that went into the development of the course.*

## What are the "Liberal Arts?"

Traditionally the liberal arts has referred to the Trivium and the Quadrivium.

Trivium, which comes from the Latin for "place where three roads meet, public square," was the elementary division of the seven liberal arts in medieval schools, consisting of grammar, logic and rhetoric.

Quadrivium, which comes from the Latin for "place where four ways meet," was the higher division of the seven liberal arts in the Middle Ages, composed of geometry, astronomy, arithmetic and music.

So, traditionally, the seven liberal arts are:

1. grammar
2. logic
3. rhetoric
4. geometry
5. astronomy
6. arithmetic
7. music

Clearly geometry, arithmetic, and (to a great degree) logic are mathematical concepts. It can easily be argued that astronomy is mathematical in nature. The structures of grammar and music have much in common with mathematics. Additionally, the compositional and oratorical nature of rhetoric require the kind of logical thought processes that are an integral part of mathematics.

Today, few people would probably limit the liberal arts to the original seven areas. Now, areas such as history, philosophy, literature and natural sciences ought to be included in the category of "liberal arts."

Additionally, though, for a truly "liberal arts" education, it seems reasonable that the different areas should be viewed as an integrated collection of subjects rather than a disjoint collection.

Before going any further, let us consider the following.

## **Henderson State University's Mission**

Henderson State University is Arkansas' public liberal arts university. True to the century-long tradition that has distinguished Henderson since its founding, the University remains dedicated to providing excellent undergraduate curricula in the arts and sciences. Further, the University is committed to offering strong professional programs in teacher education and business administration at both the undergraduate and graduate levels. Believing that a liberal education is essential for all undergraduates, regardless of their specific educational interests, Henderson has developed a program based on a comprehensive core of courses in the arts and sciences.

Through this common core of courses, as well as through the more specialized curricula, the University fosters the maximum growth and development of each student. More specifically, Henderson endeavors to provide an education which will nurture in each student the capability

- To think logically and critically
- To communicate effectively
- To appreciate the complexity and diversity of world cultures
- To understand the physical universe
- To participate as a concerned, intelligent citizen
- To acquire mastery of a particular field of study
- To mature intellectually, emotionally, and physically

Considering the position of Henderson State University as Arkansas' public liberal arts university, all disciplines should examine their role in accomplishing that mission.

Consider the objectives at the end of the mission statement. Mathematics is well qualified to speak to all of these areas.

1. **To think logically and critically** - Mathematics is ideal for this. The very nature of mathematics forces students to be able to think logically in order to solve problems. It requires that students be able to critically examine data and make intelligent decisions regarding conclusions drawn on that data.
2. **To communicate effectively** - Communication is a twofold process. It involves sending and receiving the message. With statistics and technology being such large parts of the modern society, mathematical thinking is essential to good communications. If students do not learn how to think mathematically then they are likely to fall victim to poor reasoning and argument in all kinds of areas.
3. **To appreciate the complexity and diversity of world cultures** - Obviously, not all cultures are the same. They will have different strengths and different weaknesses. They will have different things to offer to the world. Mathematics develops the logic thought processes necessary to recognize differences, benefits and disadvantages in different

cultures and perspectives.

4. **To understand the physical universe** - Mathematics is a vital element in any attempt to understand the physical universe. It is necessary in order to truly understand the world around us, be it through thinking logically about the evidence or more rigorous study. A rigorous study of chemistry, physics, biology or any of the other natural sciences is impossible without at least some mathematical sophistication.
5. **To participate as a concerned, intelligent citizen** - If one cannot understand statistics, one cannot vote intelligently and make informed decisions. Logical thought allows us to be better jurors, better workers, better educators, better parents and better citizens. Mathematical thought, ideally, allows us to distinguish between sound and bogus arguments.
6. **To acquire mastery of a particular field of study** - Virtually every field of study requires expertise of mathematics at some level. Some require a fairly high level of sophistication in mathematics. All benefit from mathematical reasoning.
7. **To mature intellectually, emotionally, and physically** - The development of logical and critical thinking through a mathematics course will certainly bring intellectual maturity.

In light of these considerations, the Department of Mathematics and Computer Science considered the possibility of offering an alternative to College Algebra as the main general education mathematics course. State law in Arkansas requires that anyone obtaining a bachelor's degree from a public four year institution in Arkansas must pass College Algebra or "a course of similar sophistication." For a long time the department had desired to offer an alternative course but resistance from outside sources prevented that. Fortunately, in the last few years, the climate changed and alternative courses began being looked on in a different light. Therefore, a new course was proposed and approved.

## **New Course Proposal**

With the new course, we started with a general idea of the areas we wanted to cover. Our desire was to create a "liberal arts mathematics course." We decided that we should cover elementary number theory, set theory and logic, algebraic functions, geometry (plane and solid), and probability and statistics. Logic and geometry, being among the traditional liberal arts, were obvious choices for topics. Number theory and algebra would cover the traditional area of "arithmetic." Probability and statistics seemed like a good choice for a topic that would work well in preparing students to be able to think intelligently in today's society. We decided to include some writing in the course to help integrate the grammar and rhetoric parts of the trivium. In order to make the course more all-encompassing than just the traditional liberal arts, we decided to include at least a modest portion of the history of some of the mathematics involved.

We also decided we would have the same prerequisite (Intermediate Algebra, with a grade of C or better; or the required mathematics test score) as for college algebra. There were two reasons for that decision.

First, we felt an algebra competency of at least the intermediate algebra level was necessary to be able to handle all of what we would be covering. The department's desire was not to come up

with a class that would be "easier than college algebra." The depth to which material is covered is not as great as in college algebra but the breadth of material is much greater. In some ways that makes the course more difficult than college algebra.

Secondly, state law says we have to.

## **Subject Areas**

In choosing among the variety of possible topics within each subject area we focused on two factors. One was the rigor necessary to comply with the state requirement of having a course "as sophisticated as college algebra." Second was our desire to offer a course that would provide liberal arts majors with as much mathematical knowledge as possible that would have real relevance to them.

In the number theory portion of the course we decided to cover history, numeration systems, number sets and some applications like credit card security using check digits.

In the set theory and logic portion we chose history, the necessary prerequisites of notation, subsets and set operations, Venn diagrams and truth tables. Our main objective here is to provide students with a way to determine the differences between valid and invalid arguments.

The geometry portion includes history, axiomatic systems, angles, polygons, perimeter, area and volume. We are also including some applications such as the value of triangles in construction and why stools often have only three legs.

For probability and statistics we again chose to cover history. Also covered are counting principles and probability. We will look at various representations of data, central tendencies and deviations and how to differentiate between good and bad statistics.

Lastly, the algebra portion will cover history, linear, quadratic exponential and logarithmic functions and inequalities. Additionally, we chose to cover applications such as growth and decay, compound interest, annuities and amortization.

## **Technology**

Another consideration in the development of this course was the use of technology. Should computers be used in the class? For instructional purposes computers will sometimes be used but not for students due to the logistical problems and difficulty of taking class time to teach software. Should calculators be required? The nature of some of the arithmetic involved in the class Should graphing calculators be required? We decided not to require graphing calculators for several reasons. First, most of the students in the class will be from non-scientific fields. They will not need a graphing calculator for their discipline and will not likely come in with the knowledge of how to use one. Secondly, we do not want to have to take the time to teach calculator usage. Lastly, the advantages of graphics calculators over scientific calculators are simply not necessary for what the course covers.

## Writing

As mentioned before, we intended writing to be a significant portion of the class. The major writing component will be in the form of a paper. We assign a 500-word paper that must be written on a pre-approved topic relating to mathematics. Biographical papers will not be acceptable since our goal is for the paper to help students learn some mathematics that they might not otherwise see.

## The Book

After deciding what topics we wanted to cover we did the best we could in finding a book that covered those topics. Very few available books actually covered all of the topics we wanted. We eventually did decide on a book but it still had drawbacks. The primary problem was that the book covered far more than we can cover in one semester. This necessitated skipping significant portions of the book. The department considered writing its own book to alleviate this problem. However, the publisher of the book we are using is helping us to put together a custom book based on the current text that will not require a lot of skipping around.

## Student reactions

Student reaction has been generally positive. The course was offered for the first time during the summer of 1998. At the end of the semester I polled my students on their reactions to the course.

Following are the students' responses to the poll.

		Strongly Disagree				Strongly Agree
		1	2	3	4	5
1.	This course has improved my attitude towards mathematics.	0	0	3	2	4
2.	This course has hurt my attitude towards mathematics	6	2	1	0	0
3.	I feel more confident about my mathematical abilities than I did before this class.	0	0	2	4	3
4.	I have learned some things that will be useful to me.	0	0	3	4	2
5.	The book helped me in learning the material.	1	0	4	2	2
6.	Skipping so many sections in the book made it difficult to follow what we were doing.	4	3	1	0	1

I also gave the students some opportunities for written comments.

First I invited response on "Things I liked about the course."

*The material was much easier than college algebra. It was introduced to the class well.*

*Things didn't get too deep.*

*I liked learning some new areas of math that I didn't learn before.*

*It was not all algebra.*

*I liked it. I'd been dreading taking math and it was much better than I expected. I also liked taking it during summer school. Concentrating on it so hard made it much easier.*

Also, "Things I didn't like about the course."

*Moved fast through material (summer class).*

*It had algebra.*

*Algebra.*

*The text needs to be condensed.*

*Skipping around.*

*Nothing. The algebra part.*

*It was just offered for the first time.*

Lastly, "General Comments."

*I have thoroughly enjoyed this class and can graduate now. Thanks.*

*I enjoyed the class and the teacher.*

*I'm glad to get this requirement over with.*

*It's better than college algebra.*

*Some topics were very interesting.*

*I think this class was long overdue and I greatly appreciate*

*Henderson finally coming around.*

Clearly the students taking this class do not like algebra very much. Many of those taking it had already taken college algebra at least once. We believe that a good portion of the positive student response is due to the fact that many of the areas are ones with which they are not familiar. Because of that there are no preconceived notions or biases regarding the material.

## **Changes**

Originally the algebra portion was scheduled to be the third topic. However, during the first semester the course was offered, student attitudes changed dramatically when we got to algebra. Because of that, we have decided to move algebra to the end. It is hoped that this switch will give the students more opportunity for success in other topics which will hopefully build their confidence going into the algebra portion of the course.

## **Conclusion**

Further study and fine tuning will be necessary, but so far Mathematics for the Liberal Arts appears to be a success.

## **Biography**

Fred Worth received his B.S. in Mathematics from Evangel College in Springfield, Missouri in 1982. He received his M.S. in Applied Mathematics in 1987 and his Ph.D. in Mathematics in 1991 from the University of Missouri at Rolla. He has been teaching at Henderson State University since August, 1991.

-----  
Disclaimer: Henderson State University and the Office of Computer and Communication Services assume no responsibility for any information or representations contained in the student/faculty/alumni web pages. These web pages and any opinions, information or representations contained therein are the creation of the particular individual or organization and do not necessarily reflect the opinion of Henderson State University or its Office of Computer and Communication Services. All individuals publishing materials on the Henderson State University Web Server understand that the submission, installation, copying, distribution, and use of such materials in connection with the Web Server will not violate any other party's proprietary rights.