



GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH
MATHEMATICS AND DECISION SCIENCES

Volume 13 Issue 9 Version 1.0 Year 2013

Type : Double Blind Peer Reviewed International Research Journal

Publisher: Global Journals Inc. (USA)

Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Something New in Math: Meaningful Mathematics Courses for Liberal Arts Undergraduates

By Gary Stogsdill

Prescott College, United States

Abstract - For over 100 years a vital if little known movement has been underway to allow liberal arts undergraduates to meet their math requirement with more meaningful and relevant options than the traditional skills courses in algebra, geometry, trigonometry, and calculus. Often referred to as *liberal arts mathematics*, and with a subset called *humanistic mathematics*, such courses may explore mathematics as a realm of ideas that are essential to understanding the world we live in and what it means to be human. Although resistance to this movement has been vigorous and tenacious, it is now widely recognized that liberal arts undergraduates deserve access to such courses in order to meet their math requirement. The author describes a century-long argument in favor of meaningful mathematics courses for liberal arts undergraduates, traces the evolution of liberal arts math courses, justifies such courses in a discussion of what mathematics really is, and presents his own innovative pedagogy with a humanistic math course, *Mathematical Explorations*, which provides liberal arts undergraduates with the opportunity to alleviate math anxiety, improve reasoning ability, engage in experiential learning, and explore math-related ideas that are meaningful, relevant, useful, and inspiring.

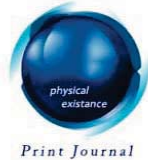
Keywords : *humanistic mathematics, liberal arts mathematics, Mathematical Explorations, liberal arts undergraduates, innovative pedagogy, prescott college.*

GJSFR-F Classification : MSC 2010: 00A05, 00A66



Strictly as per the compliance and regulations of :





Something New in Math: Meaningful Mathematics Courses for Liberal Arts Undergraduates

Gary Stogsdill

Abstract - For over 100 years a vital if little known movement has been underway to allow liberal arts undergraduates to meet their math requirement with more meaningful and relevant options than the traditional skills courses in algebra, geometry, trigonometry, and calculus. Often referred to as *liberal arts mathematics*, and with a subset called *humanistic mathematics*, such courses may explore mathematics as a realm of ideas that are essential to understanding the world we live in and what it means to be human. Although resistance to this movement has been vigorous and tenacious, it is now widely recognized that liberal arts undergraduates deserve access to such courses in order to meet their math requirement. The author describes a century-long argument in favor of meaningful mathematics courses for liberal arts undergraduates, traces the evolution of liberal arts math courses, justifies such courses in a discussion of what mathematics really is, and presents his own innovative pedagogy with a humanistic math course, *Mathematical Explorations*, which provides liberal arts undergraduates with the opportunity to alleviate math anxiety, improve reasoning ability, engage in experiential learning, and explore math-related ideas that are meaningful, relevant, useful, and inspiring.

Keywords : *humanistic mathematics, liberal arts mathematics, Mathematical Explorations, liberal arts undergraduates, innovative pedagogy, prescott college.*

I. INTRODUCTION

Those of us with sufficiently gray hair will remember the failed experiment in the 1960s called *new math*. What many of us may not know is that a vital and now successful movement has been underway for over 100 years to provide liberal arts undergraduates with more meaningful and relevant options than the traditional skills courses in algebra, geometry, trigonometry, and calculus. I will refer to these “new” courses as *liberal arts mathematics* and in some cases as *humanistic mathematics*. The *Encyclopedia of Mathematics Education* offers this definition of liberal arts mathematics: “College courses in mathematics appreciation for students in non-science fields” (Bumcrot, 2001, as cited in Sporn, 2010, p. 1). By *liberal arts undergraduates* I mean students who are working toward a Bachelor of Arts degree in a field other than science, technology, engineering, or mathematics.

a) *A Century-Long Argument for Liberal Arts Mathematics*

Awareness of the need for liberal arts mathematics began in the early 1900s soon after skills courses like *College Algebra* were becoming standardized in the 1890s as a requirement for liberal arts undergraduates (George, 2007). By 1911 the International

Author : Prescott College, United State. E-mail : gary.stogsdill@prescott.edu

Commission on the Teaching of Mathematics was able to reflect that “the average [college] student who does not find mathematics [skills] an attractive subject obtains little advantage of any sort in the required study of it” (as cited in George, p. 36).

Criticism of traditional skills-based college math courses would grow over the next several decades. As early as 1923 critics could confidently assert that “most teachers who have given serious thought to the needs of [the liberal arts] student, are...convinced that the traditional courses in trigonometry, college algebra, and analytic geometry can no longer be justified as best meeting their needs” (Young, 1923, as cited in George, 2007, p. 24).

Traditional educators responded to this criticism the way traditional educators often do...by doing nothing. In 1937 a piece in the American Mathematical Monthly captured the growing frustration of progressive educators: “It is deplorable...to contemplate the prevalence even today of traditional, hidebound ‘trigonometry’ and ‘college algebra’...with excessive emphasis on mechanical manipulative processes and petty details, and almost no indication whatever of their possible relation to vital problems [in other human endeavors]” (Schaaf, 1937, as cited in George, 2007, pp. 37-8). The same author would deliver the following timeless lament: “[Given the nature of traditional skills courses,] are students to be blamed if they voice distaste, disgust, or abhorrence for mathematics?” (Schaaf, as cited in George, p. 39).

Michael George (2007) authored a doctoral dissertation on the history of liberal arts mathematics and summarized the first half of the twentieth century as follows:

The traditional [undergraduate math skills] curriculum was being increasingly attacked as unappealing to and overly difficult for many students. The drill-based classroom experience was repetitive, unimaginative, and stifling to students’ creative sensibilities. More importantly, the traditional [skills] curriculum was only *one* aspect of the larger body of mathematics in the world. Ironically, it was in some ways the least accessible form of mathematics.... (p. 51).

Although liberal arts math courses were being offered by then, the second half of the twentieth century would continue to generate strong criticism against traditional math courses. Morris Kline, long time professor of mathematics at New York University, did not mince words in his 1954 response to the still prevalent practice of requiring math skills courses for liberal arts undergraduates:

These subjects comprise nothing but a series of dry, boring, unmotivated, disconnected, and, to the student, unimportant techniques. The subjects are taught as techniques and the students are expected to master and reproduce them in parrot-like fashion....By persisting in the teaching of college algebra and trigonometry to the liberal arts student, college teachers of mathematics have been...teaching brick laying instead of architecture, and color mixing instead of painting. Such teaching has discouraged latent interest in mathematics and has embittered many young people towards mathematics, and in many cases, toward all learning. (as cited in Sporn, 2010, p. 141).

And, yes, the same criticism continues into the twenty-first century: “The mathematics courses commonly used by students to satisfy a [liberal arts] education requirement—college algebra or calculus—have almost nothing to do with anything that will affect their future quality of life or their ability to contribute to...society” (Steen, 2004, as cited in Sporn, 2010, p. 169).

Recall that this century-long criticism began very soon after skills courses like *College Algebra* were becoming standardized in the 1890s as a requirement for liberal arts undergraduates. The chief rationale for this requirement was, and continues to be, *mental discipline* (George, 2007). The argument of mental discipline goes like this: “Learning ‘hard’ subjects like mathematics [skills] and Latin develops one’s raw mental ‘powers’” (George, p. 30). In other words, we need to set the bar high and require liberal arts undergraduates to take skills courses such as *College Algebra* because the mental discipline inherent in these courses benefits students in other ways. Like a bitter medicine, *College Algebra* or another skills course needs to be required of students because it is good for them.

This same argument had been used to justify the requirement of Greek and Latin for American college students for some two-and-a-half centuries (Winterer, 2002). Finally in the 1880s colleges began to drop the Greek and Latin requirement (Winterer), and this is precisely the time period when math skills courses like *College Algebra* began to be required. The mental discipline advocates, having just lost the battle for Greek and Latin, were determined to promote a requirement of challenging math skills.

However, the argument of mental discipline was dealt a serious blow as early as 1923 with the research of the prominent psychologist Edward Thorndike, who found in repeated experimental studies that “improvement in any particular mental function rarely improved other functions” (George, 2010, p. 31). Specific to mathematics, Thorndike (1923) concluded, “The old notion that Latin or mathematics made the mind more effective [in other human endeavors] was largely superstition....Mathematics improves mathematical reasoning but not the power to reason in general” (as cited in Sporn, 2010, p. 64). Thorndike’s studies inspired an abundance of follow-up research, with an occasional result seeming to contradict certain aspects of Thorndike’s conclusion—for example, findings “suggesting that sense-discrimination could be transferred from one sense to another” (George, 2007, p. 31)—but with most of the subsequent research continuing to corroborate Thorndike (Sporn).

In spite of the experimental evidence against it, the mental discipline argument in favor of setting the bar high by requiring *College Algebra* for liberal arts undergraduates has a Hydra-like existence and continues to raise new heads into the twenty-first century, which prompted David Lemire, editor of the *Journal of College Reading and Learning*, to review all of the accumulated experimental evidence regarding mental discipline and to conclude in 2002 that “there is little or no relationship between [traditional] math problem solving and real life problem solving....[therefore,] math skills (algebra, geometry, trigonometry, and calculus)...should never be required within the normal...college curriculum” (as cited in Sporn, p. 172).

Even if a grain of truth existed in the mental discipline argument, which seems unlikely, a more obvious and compelling truth is that “a student’s interest in a subject [is] much more instrumental in that student’s achieving valuable learning than the subject’s perceived inherent value [as mental discipline]” (George, 2007, p. 31). Clearly all of the above signals an end to the era of requiring liberal arts undergraduates to suffer through skills courses like *College Algebra*.

b) *What is Mathematics Really?*

At this point it may be helpful to explore what mathematics really is because some of us will be thinking, "Wait, if liberal arts undergraduates are not working math skills, then how can they be 'doing math'?" Recall the previous definition of liberal arts mathematics: "College courses in mathematics appreciation for students in non-science fields" (Bumcrot, 2001, as cited in Sporn, 2010, p. 1). A pertinent analogy would be to consider undergraduate courses in literature, music appreciation, and art appreciation. Imagine enrolling in a music appreciation course and being told that you will have to master piano technique in order to receive credit. That would be absurd. Skill at the piano is neither a prerequisite nor a corequisite for understanding and appreciating great music. The same is true with literature and art. Technical proficiency in skills is a separate issue from understanding and appreciating a subject from a liberal arts perspective.

While we can easily see this distinction with music, art, and literature, it may not be as obvious with math because often all we know of math is the skills part: doing operations with numbers and solving equations. Yet this is merely the grammar of mathematics. The traditional skills approach to teaching math to liberal arts undergraduates is like trying to teach Shakespeare by requiring students to diagram selected sentences of that magnificent prose into their grammatical components. By doing this students would miss the essential experience of Shakespeare, and we can certainly understand and appreciate Shakespeare even if we cannot distinguish an adjective from an adverb. It is the same with mathematics. Focusing on technical math skills tends to obscure what mathematics really is, and we can understand and appreciate mathematics from a liberal arts perspective whether or not we can factor a quadratic equation.

Mathematics is not numbers, algorithms, and equations any more than literature is a set of grammar rules. Yes, of course skills are one component of mathematics just as grammar is one component of writing, but would it not seem odd if we continued into college to teach writing as merely a set of grammar rules and taught nothing of the actual purposes for writing and nothing of the masterpieces of literature that comprise a significant portion of the intellectual heritage of our culture?

What, then, is mathematics really? Mathematics is a powerful symbolic language that has the ability to discover and convey important ideas about the patterns and relationships that surround us, patterns and relationships that not only serve the mundane necessities of daily commerce but also the loftier aims of natural science, social science, technology, human development, philosophy, esthetics, the arts, and virtually every other realm of human endeavor. Therefore, liberal arts undergraduates are actually "doing math" more faithfully and more rigorously when they work with ideas than when they practice skills. As Harald Ness, professor of mathematics at the University of Wisconsin observed:

What is not [commonly] realized is that mathematics deals primarily with ideas and that those ideas are some of the most profound and important in our culture....We need to communicate to our students and the public in general that mathematics is *not* a set of skills (bag of tricks, if you will) to solve mundane problems, but a vast body of knowledge that is an integral part of our culture. (1990, as cited in Sporn, 2010, p. 146).

c) *Evolution of Liberal Arts Math Courses*

In order to have widespread liberal arts math courses there had to first be liberal arts math textbooks. According to George (2007), the prototype for such a text was

Introduction to Mathematics, published in 1911 by Alfred North Whitehead, one of the great mathematicians of his time and a professor at both Cambridge and Harvard. Whitehead belonged to an age when a breadth of liberal learning was the norm, and he contributed seminal ideas to not only mathematics but also the fields of philosophy, science, and education. In mathematics Whitehead co-authored with Bertrand Russell the monumental work *Principia Mathematica*, a comprehensive attempt to systematize the logical basis for all of mathematics. This was hardly a math teacher who could be accused of wanting to “set the bar low.” Rather, this was a scholar who possessed sufficient breadth of learning to fully understand that the essence of mathematics is ideas and who wanted to convey this essence to students. Being about ideas, Whitehead’s text did not contain skills problems at the end of each chapter (George), which is the hallmark of every traditional math textbook. Perhaps this reveals the reason Whitehead’s text failed to catch on in the classroom: because math teachers, then as now, tend not to know how to teach mathematics without basing it on skills problems.

The next liberal arts math textbooks would not appear until the 1930s when it was well established that “clearly students who did not have majors in mathematics, science, and technology would be better off terminating their mathematical education with some kind of [liberal arts] mathematics course, designed specifically for them” (George, 2007, p. 42). Even with several textbooks on the market, the inertia of tradition caused colleges to drag their feet in creating the new liberal arts math courses. In many cases colleges chose to abolish altogether any math requirement for liberal arts undergraduates rather than offer them meaningful courses (George). This trend would grow over the next few decades, with a survey of all American colleges in 1957 finding that only half of the colleges offering liberal arts degrees required any mathematics at all of their liberal arts students (Sporn, 2010).

The liberal arts math courses that *were* created in the 1930s and 1940s were slow to catch on, with an unsuitable text being a frequently cited criticism (George, 2007). Although well intentioned, math educators seemed unable to create truly new textbooks that did not mirror the traditional pattern of requiring skills problems at the end of each chapter. Further, as may have been the downfall of Whitehead’s 1911 text, math teachers tend not to know how to teach mathematics without basing it on problem sets. The result was that the early liberal arts math courses were little improvement over traditional math skills courses.

This focused widespread attention in the 1940s and 1950s on how to create a successful and meaningful liberal arts math course, with a number of interesting outcomes. One outcome was the recommendation that all undergraduates, not just liberal arts students, would benefit from being required to take such a course because “the student completing [a liberal arts math course] will actually have a type of mathematical knowledge and an understanding of mathematical concepts that the typical major in the field does not possess” (Newsom, 1949, as cited in George, 2007, p. 81). Other outcomes included the general consensus that “there is not a single course that meets the needs of all students and all instructors” and that “the choice of topics is not as important for the success of the course as are the attitudes and interests of the teachers, and the attitudes and emotions of the students” (Special Committee on College Mathematics for Non-Science Students, 1956, as cited in Sporn, 2010, p. 13).

As a result several new liberal arts math courses were created in the late 1950s and 1960s that did meet with success, and available data from community colleges actually

show a greater enrollment in liberal arts math courses than in *College Algebra* during the late 1960s and early 1970s (Sporn, 2010). However, liberal arts math courses began a sharp decline in the mid 1970s that would continue through the early 1990s (Sporn). Perhaps liberal arts math courses, like so many other innovative trends that thrived in the 1960s and early 1970s, were a casualty of the societal and educational pendulum that swings toward tradition and conservatism after a prolonged period of innovation and liberalism.

However, a sharp increase in offerings and enrollments in liberal arts math began in the 1990s and continues to grow into the twenty-first century (George, 2007; Sporn, 2010). Currently a majority of American colleges and universities offer a liberal arts math course as meeting the math requirement for liberal arts undergraduates, with many institutions offering several such options (Sporn, 2010).

There is no consensus for what the ideal liberal arts math course should look like (George, 2007; Sporn, 2010), and even a quick survey of American institutions reveals a wide spectrum of liberal arts math courses, with some being traditional skills courses masquerading as liberal arts math, some being remarkably innovative idea-based courses, and everything in between. However, one promising approach to liberal arts math is called humanistic mathematics. Humanistic math courses focus on understanding the great math-related ideas that have helped to define the world we live in and that “inspire the imagination and sense of wonder in students” (Sporn, 2010, p. 185). In addition, according to the *Journal of Humanistic Mathematics*, humanistic math courses explore “the human face of mathematics” through “the esthetic, cultural, historical, literary, pedagogical, philosophical, psychological, and sociological aspects [of mathematics] as a human endeavor” (<http://ccms.claremont.edu/publications/jhm>)

The Mathematical Association of America (MAA) has begun emphasizing the importance of humanistic mathematics not only for liberal arts students but for all undergraduates. In 2004 the MAA’s Committee on the Undergraduate Program in Mathematics published the following recommendation:

Students should encounter some meaningful ideas of mathematics. College students study the best paintings, the most glorious music, the most influential philosophy, and the greatest literature of all time. Mathematics departments can compete on that elevated playing field by offering and making accessible to all students intriguing and powerful mathematical ideas....[T]he mathematical component of every student’s education [should] contain some of the most profound and useful ideas that the student learns in college. (as cited in Sporn, 2010, p. 140)

d) *An Example of a Humanistic Math Course: Mathematical Explorations*

My own contribution to humanistic mathematics is the course *Mathematical Explorations* at Prescott College. Seeds for this course were sown as long ago as 1985 when I first began teaching math at the local community college. There I taught a sequence of three remedial skills courses whose purpose was to prepare liberal arts students to pass the required *College Algebra*. Like a factory worker my job was to crank out skills instruction to terrified students whose fervent hope was that they could retain these memorized skills long enough to pass chapter tests and then the final exam. If they could repeat this stressful process through the capstone course, *College Algebra*, then they would be done forever with the torture. I made a point of asking all of my students about the quality of their learning, and without exception they told me that they found no use in the algebra skills and quickly began to forget them as soon as each course ended, if not

sooner—a fact that I can corroborate since I often had the same students in all three courses.

I vowed that if I ever had the privilege of teaching in a private liberal arts college I would do all I could to create meaningful learning experiences for math students. My good fortune was to be given exactly that opportunity, starting in 1990, to teach mathematics at Prescott College, a progressive student-centered institution. However, on the very first day of my first course, two of the nine enrolled students came separately to the classroom door to tell me they were sorry but they just could not enter a math classroom because of being so traumatized by math. That is when I knew my work was cut out for me. I quickly learned that students who are terrified of math or have a history of being unsuccessful in math or are just not interested in math need innovative pedagogy in order to become engaged and successful. Unfortunately, in my experience a majority of liberal arts undergraduates fall into one or more of those three categories of math avoidance.

For the 13 years that I taught in the resident program of [the author's institution] I was required to teach traditional math skills, but I discovered that my students would become much more engaged if I added humanistic math components to the class. For the first half of every class period I began to provide students with idea-based discussions and projects. As an example of our discussions, we would put a human and cultural face on mathematics by exploring the intriguing math-related ideas and creations of ancient and indigenous cultures. As an example of our projects, I would introduce the golden ratio and its relationship to art by bringing prints of Impressionist paintings and having students pair up and search for golden ratios within their paintings. I found that students who had previously hated math responded well to these discussions and projects, and in many cases actually became interested in math.

Then in 2004, I was asked by the limited-residency program of Prescott College to create a new kind of online math course for liberal arts undergraduates that would be the antithesis of traditional *College Algebra* and that would engage our students, many of whom are long past traditional college age, with meaningful and relevant learning. I eagerly adapted my previous experiments with humanistic mathematics to create *Mathematical Explorations*, a course that does not rely on a textbook. The three major components of this course are reasoning exercises that enable students to develop better quantitative thinking abilities, a self-chosen experiential project, and self-chosen research into an interdisciplinary math-related topic of vital importance in the human quest to understand the world we live in and what it means to be human.

However, the first thing we do is a math therapy exercise where students journal extensively and then discuss their past experiences with math, many of which tend to be decidedly negative. On the surface this may look like an innocuous activity, but I have been doing it for 23 years—that is how I got those two traumatized students to finally enter my classroom in 1990—and it always enables the anxious students to enter *Mathematical Explorations* with an improved mindset. Other students find benefit in the exercise, too. Please see Stogsdill (2013) for a detailed description of the math therapy exercise.

The quantitative reasoning exercises are a weekly series of brainteasers that help students improve their general reasoning ability. These brainteasers are very different from traditional math skills problems and word problems, which we have learned do little or nothing to improve reasoning in general. Unlike traditional math problems where everything hinges on knowing the right equation and the right skills to produce the one

right answer, these reasoning exercises cannot be solved with an equation and instead emphasize the *process* of learning how to reason more creatively and effectively in situations involving quantitative concepts. Students post to an online forum their thoughts about that week's reasoning exercises—just answers are not allowed, students must write about their process—and then they interact with each other's thought processes while I provide clues as needed toward the effective way, or ways, to approach the reasoning. Then students continue their thought processes based on my clues and feedback from other students until at the end of the week I provide not just the answers but also a final explanation about the thought process for each brainteaser. Students are graded minimally on the right answer and primarily on their willingness to engage in the process of creative problem solving.

The experiential project provides students with an opportunity to do something hands-on that interests them and that involves math skills and/or math ideas. Students choose from a list of potential projects and at the end of the course share their finished product with the rest of the class through an online forum. Following are examples of experiential projects that have been completed recently. One student designed and constructed an elaborate tool shed, documenting the extensive use of mathematics at every stage of this process. An adventure education student documented a wide variety of mathematical patterns in nature through a 23-page original photo essay. An expressive arts student who was exploring chaos theory and fractals for her research topic purchased a computer fractal program and created several beautiful pieces of original fractal art. A creative writing student wrote and illustrated an original story for children on his research topic of cosmology. A sustainability student designed a passive solar home, complete with calculations pertaining to solar gain. A human development student wrote a substantial business/financial plan for her future work as an aromatherapist. A teacher preparation student who worked as an aide in a classroom created and taught a series of lesson plans on his research topic of indigenous mathematics.

The math-related research topic is the heart of *Mathematical Explorations*. Students choose from a list of potential topics that include the history of great mathematical ideas, cosmology, quantum theory, chaos theory and complexity, fractals, sacred geometry, the golden ratio, infinity, space and time, and ancient and indigenous mathematics. They investigate several resources, including at least two books, in order to synthesize and reflect on their learning in a 7-10 page paper. As with the experiential project, at the end of the course students share this paper with the rest of the class through an online forum so that each student benefits from the research of every other student. This research is often where students become fascinated with mathematics and inspired to pursue further learning because they realize that math is about ideas that directly relate to their lives in meaningful ways.

Students respond to *Mathematical Explorations* exceptionally well. As with other courses at Prescott College, at the end of Mathematical Explorations all students complete a narrative self-evaluation. Following are excerpts from three self-evaluations in recent offerings of *Mathematical Explorations* that capture the most prevalent feedback I receive about the course: that it changes their relationship with math in a positive way.

"This course completely changed my perspective about math. I went from disliking math intensely and feeling it had no relevance to my life, to discovering it had everything to do with my life!"

"This course has truly ignited an interest in mathematics in me that I thought had been crushed in high school."

"The most compelling result of this course was a stunning realization of how interconnected mathematics is to every element of our existence: a paradigm shift as vivid as if I had been living in the black-and-white world of Kansas and was transported through the whirlwind of this semester's explorations to the fantastical and extravagantly Technicolor realm of Oz....I will never again look at numbers without seeing their infinite capacity as an exquisite language of discovery, invention, and imagination."

Another common outcome of *Mathematical Explorations* is that students are inspired to continue learning about math-related topics, as illustrated below in excerpts from three recent self-evaluations:

"I became utterly engrossed while learning about [my research topic] and am inspired and passionate about continuing my studies."

"I...discovered immensely practical applications for math in my life and work that I will continue to explore with great interest."

"My chosen research topic of chaos theory and fractals provided me with not only some fascinating insights into the world of math and science, but also some new perspectives on psychology, art, and philosophy, which contributed in many unexpected ways to the evolution of my understanding of human development. I expect that my new views on the balance between order and chaos, and the all-encompassing interconnectedness of earthly and cosmic things, will have a lasting influence on the way I perceive natural cycles, systems theory, human behavior, thought process, and social interaction."

Another common outcome, one that may be even more surprising, is that students talk about enjoying math and having fun with it, as illustrated below in three more excerpts from recent self-evaluations:

"The course was very exciting, thought provoking, and led to great discussions with my classmates."

"*Math Explorations* showed how enjoyable math can be if approached in the right way. I felt no hesitation in doing my best for the work for this course because it was fun."

"I always knew that math was interesting and I even suspected that it could be fun. I just always assumed that the fun, interesting parts were for other people, not for me. Taking this math class has changed everything for me."

For those who find it unsavory to combine the words *fun* and *rigor* in the same sentence, students also complete a course questionnaire consisting of a five-point Likert-type scale where one equals *not at all* and five equals *very much so*. One of the questions asks about rigor: "Please rate the level of difficulty or challenge you faced from readings, assignments, and discussions." The average response of all students who have taken *Mathematical Explorations* is 4.3, or somewhere between *challenging* and *very challenging*.

And for those who still doubt that it is really possible to provide meaningful math courses for liberal arts students, the average of all responses to the question "How relevant and useful were the required readings, dialogues, and assignments?" is 4.8, which is getting pretty close to *very relevant and very useful*.

Mathematical Explorations is but one example of the many innovative possibilities in meaningful math courses for liberal arts undergraduates. These possibilities are only limited by the imagination and breadth of learning of individual mathematics instructors.

It will truly be something new in math when all liberal arts undergraduates have the option of meeting their math requirement with a course that alleviates math anxiety, improves reasoning ability, provides experiential learning opportunities, and allows the exploration of math-related ideas that are meaningful, relevant, useful, and inspiring.

II. ACKNOWLEDGEMENTS

I am indebted to Michael George and Howard B. Sporn for their outstanding dissertations on liberal arts mathematics. I am grateful to Merrill Glustrom, Bill Walton, and Steve Walters for believing in my potential as a math educator.

REFERENCES RÉFÉRENCES REFERENCIAS

1. Bumcrot, R. (2001). Liberal arts mathematics. *Encyclopedia of mathematics education*. New York: Routledge Falmer.
2. Steen, L.A. (2004). *Achieving quantitative literacy*. Washington, DC: Mathematical Association of America.
3. Committee on the Undergraduate Program in Mathematics (2004). *Undergraduate programs and courses in the mathematical sciences: CUPM curriculum guide 2004*. Washington, DC: Mathematical Association of America.
4. George, M. (2007). *The history of liberal arts mathematics* (Doctoral dissertation). Retrieved from Pro Quest.
5. International Commission on the Teaching of Mathematics (1911). *Mathematics in the technological schools of collegiate grade in the United States*. Washington DC: Government Printing Office.
6. Kline, M. (1954). Freshman mathematics as an integral part of western culture. *American Mathematical Monthly*, 61(5), 295-306.
7. Lemire, D. (2002). Commentary: Math problem solving and mental discipline—the myth of transferability. *Journal of College Reading and Learning*, 32(2), 229-238.
8. Ness, H.M. (1990). Mathematics—a significant force in our culture. *Humanistic Mathematics Network Journal*, (5), 3-8.
9. Newsom, C.V. (1949). A course in college mathematics for a program of general education. *The Mathematics Teacher*, 42, 19-24.
10. Schaaf, W.L. (1937). Required mathematics in a liberal arts college. *American Mathematical Monthly*, 44, 445-453.
11. Special Committee on College Mathematics for Non-Science Students (1956). College mathematics for non-science students. *American Mathematical Monthly*, 63(9), 639-642.
12. Sporn, H.B. (2010). *A contemporary analysis of the content of mathematics for liberal education at the college level* (Doctoral dissertation). Retrieved from Pro Quest.
13. Stogsdill, G. (2013). A math therapy exercise. *Journal of Humanistic Mathematics*, 3(2).
14. Thorndike, E. (1923). *The psychology of algebra*. New York: Macmillan.
15. Whitehead, A. N. (1911). *Introduction to mathematics*. New York: Holt.
16. Winterer, C. (2002). *The culture of classicism: Ancient Greece and Rome in American intellectual life, 1780-1910*. Baltimore: Johns Hopkins University Press.
17. Young, J.W. (1923). The organization of college courses in mathematics for freshmen. *The American Mathematical Monthly*, 30, 6-14.