EASTERN MICHIGAN UNIVERSITY
DIVISION OF ACADEMIC AFFAIRS

REQUEST FOR INCLUSION OF A COURSE IN THE
GENERAL EDUCATION PROGRAM:
EDUCATION FOR PARTICIPATION IN THE GLOBAL COMMUNITY

DEPARTMENT/SCHOOL: MATHEMATICS **COLLEGE:** ARTS AND SCIENCES

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1. Subject Code, Number, and Title: **MATH 110E** Mathematical Reasoning: Applications for Elementary School Teachers

2. Credit Hours _3_

3. Catalog description:
An introduction to quantitative reasoning, with the aim of developing the capacity to comprehend and analyze the quantitative information that is prevalent in modern society. Topics include mathematical modeling, basic probability and statistics, geometry, and practical applications for elementary education majors.

4. This course is (check one):

☐ an existing course with no revisions (need not go through the input system)

☑ an existing course with revisions (attach this form to Request for Course Revision form)

☐ a new course (attach this form to Request for New Course form)

5. Check the General Education requirement this course is intended to meet. If the course is to be proposed for more than one requirement, submit a separate form for each one.

☐ **Effective Communication**

☑ **Quantitative Reasoning (*QR designation*)**

☐ **Writing Intensive (*WI designation*)**

☐ **Perspectives on a Diverse World**

☐ Global Awareness ☐ U.S. Diversity

☐ **Knowledge of the Disciplines**

☐ Arts ☐ Humanities

☐ Science ☐ Social Science

☐ **Learning Beyond the Classroom (*LBC designation*)**

6. Rationale. Provide a concise, clear, jargon-free explanation of why this is a General Education course and how it fits into this specific requirement. This rationale should appear on the general course syllabus provided here and should be included in specific course syllabi given to students.

This course will provide students with ways to approach the quantitative information that they are certain to encounter in later coursework at Eastern Michigan University, throughout their careers, and in daily life. The emphasis is on learning methods for comprehending, analyzing and using quantitative information and on techniques for using data to inform decisions about real world events and problems. For these reasons, MATH 110E will satisfy the **Quantitative Reasoning** requirement in the general education program, *Education for Participation in the Global Community*.

In addition, MATH110E is specifically designed to meet the needs of students that are looking toward becoming elementary school teachers. While the content of this class mirrors that of MATH110, the examples, applications, and projects are designed to help you make connections to the K-5 classroom and help you to begin to think about how you will teach young children to make sense of some beginning mathematical concepts.

7. Clearly and concisely explain how this course meets each of the General Education outcomes for the requirement checked in number five (all outcomes should be addressed). To do this, (a) list the General Education outcomes for the requirement and explain how the course meets each outcome; and (b) explain, in general terms, the method(s) of evaluation to be used in the course and how these methods assess the degree to which students have met the General Education outcomes for this requirement.

Topics covered in MATH 110E will include mathematical modeling, introductory statistics, probability concepts, informal geometry, and measurement. Specific examples, such as financial mathematics and geometric scaling, will help students to see connections with their own lives. While the course will focus on problem-solving and modeling, MATH 110E is specifically designed to meet the needs of students that are looking toward becoming elementary school teachers. While the content of this class mirrors that of MATH 110, the examples, applications, and projects are designed to help students make connections to the K-5 classroom and begin to think about how they will teach young children to make sense of beginning mathematical concepts. In addition, students will use a spreadsheet program to both analyze data and present their conclusions about a particular problem.

Methods of evaluation for MATH 110E will include some of the following: quizzes, tests, graded homework problems, projects, in-class activities, presentations, group problem-solving tasks, and a final exam. Projects may result in a paper, group presentation, or a computer lab.

Outcomes for quantitative reasoning:

Students will learn to solve real-life problems using a mathematical modeling process. They will learn to…

1. Identify an appropriate model.

a. Students will learn techniques for analyzing a problem and determining a mathematical model for investigating the problem. Examples will be presented which allow for models of varying complexities, including linear, quadratic and exponential models. For example, a spreadsheet can be used to develop a model for paying off student loans. In addition, examples of spreadsheets and models used in the K-5 mathematics classroom will be explored. For example, students might measure the circumference and diameter of circles of varying sizes. They then would graph the data and determine a linear model to fit the data ($C = \pi d$).

b. Assessment of this outcome can be via direct questions on quizzes and tests, where a situation is presented and the student determines what an appropriate model will be; and in projects, where an open-ended problem is presented and the student decides what mathematical approach to take.

2. Identify and discuss assumptions.

a. When analyzing any real-world situation with a view to setting up a mathematical model, it is necessary to make various assumptions which do not actually hold in the real-world scenario. Generally speaking, different assumptions lead to different models (see Outcome #1), and stronger assumptions lead to simpler models. Typically, when a new scenario is presented, the instructor will lead the class through the making of enough assumptions in order to simplify the situation so that a model can be applied to it. When a student applies such a model, he/she should always be aware of what assumptions were made, and what the significance of having made these assumptions is. See Outcome #12 below.

For example, consider a catch-and-release scenario. The problem is to estimate the size of a wildlife population. A number of individuals from the population are caught, tagged and released; later a sample is taken, and the proportion of tagged individuals in the sample is used to estimate the size of the overall population. There are assumptions of different kinds needed here. Some have to do with the "facts on the ground," and can only be fully discussed with specific domain knowledge about the wildlife population and the catching and tagging techniques that are used. Then there is the "mathematical" assumption that the proportion of tagged animals in the sample equals the proportion of tagged animals in the population. No method of sampling can guarantee that it is true, yet we make this assumption anyhow. The idea of random sampling and its associated mathematical concepts can be brought in at this point.

Every time a model is presented in class, the instructor will outline the assumptions that need to be made in order for the model to be applicable, and will discuss the nature of these assumptions. Again, see Outcome #12. Homework problems and projects will often ask the student directly to list any assumptions that are necessary in order to make the model apply.

b. This outcome can be assessed via direct questions on quizzes and tests, where a situation is presented and the student discusses the assumptions he/she might make in selecting an appropriate model. This includes knowing what assumptions are inherent in a particular model that the student has studied before. This outcome can also be assessed in the write-up of projects, where students will be expected to list and discuss the assumptions that they have made.

3. Collect or generate appropriate data.

a. In the various examples discussed in class, students will learn to identify what types of data need to be collected in order to answer a specific question. Students will get experience collecting or generating data in projects that involve estimation or simulation; in projects that allow for data to be found on the Internet; and in projects involving surveys. In addition, students will explore activities appropriate for the K-5 math classroom that involve collecting data. Students might write a survey and post it online at zoomerang.com. They would then write a report that analyzes and interpret the results of their survey.

b. Identification of suitable types of data can be assessed using direct questions on quizzes or tests, and actual data collection will be part of one or more projects during the semester.

4. Analyze a situation using arithmetic, geometric, algebraic, and probabilistic or statistical methods.

a. The modeling explored in class will utilize a wide variety of methods. Probabilistic methods will be used with simulations to determine probabilities experimentally; algebraic methods will be needed in order to understand and use the various linear and nonlinear models that are studied. Geometric methods are used to create visual representations, and are used in problems involving volume and scaling. Arithmetic methods will be needed in almost all examples. In addition, students will become aware of how these models are evident in the K-5 mathematics curriculum. Circumference of a circle is an example of a linear model, area of a circle is an example of a quadratic model, and doubling patterns are examples of exponential models.

b. This outcome can be assessed with quiz and test questions, and will also be an essential part of the projects.

5. Estimate answers.

a. Estimation is a skill that instructors will focus on throughout the course. Estimation is key in determining the reasonableness of a proposed solution—especially when we rely so heavily on technology as a tool in problem-solving. When students consider a problem to be analyzed by any of the methods studied, they will be asked to estimate an answer as part of the initial modeling process. In addition, estimation is a basic skill in the K-5 mathematics classroom. Techniques for teaching children how to estimate will be explored.

b. Estimation will be tested on quizzes and tests, and provision of an estimated answer may be part of the rubric for grading a project.

6. Propose and evaluate solutions.

a. As students develop mathematical models for real-world data, they will write a narrative interpreting their results. Models generated mathematically need to be interpreted in a real-world context—students will use the model to propose solutions to real-world problems and will evaluate these solutions for their appropriateness to the problem that gave rise to the model. For example, students may investigate alternative packaging for cereal-boxes that use less paper to construct and hence are more environmentally friendly. Students would write a narrative evaluating their proposed solution and its implications. Problems like this one help future teachers develop a deeper understanding of the concepts of volume and surface area, topics taught in the K-5 mathematics curriculum, while at the same time addressing general education by having students use a mathematical model to explore very practical problems.

b. Students will be asked on quizzes and tests to give solutions to models that have been discussed in class. Finding solutions to specific mathematical models can be assessed on graded homework, quizzes, tests and projects. Students can be asked to evaluate proposed solutions in all of these formats, briefly in quiz and test questions, and in greater depth in graded homework, computer labs, and projects

7. Predict outcomes in other situations based on what they have learned from their analysis.

a. Once a situation has been analyzed and a model set up, the results can be used to make predictions as to what might happen in other situations. Using problem situations and small-group projects, students will be encouraged to go beyond the given situation and see how the model might apply to similar situations. For example, once students have completed a project such as the paying off a student loan scenario mentioned above, they could go on to consider if a similar analysis applies to credit card debt or buying a car. In addition, using what they learned as they created their spreadsheet to model this problem, students will be challenged to develop spreadsheet models that can be used in the K-5 mathematics classroom.

b. Assessment of this outcome can be part of the rubric for grading a project.

8. Understand and communicate quantitative relationships using symbols, equations, graphs, and tables.

a. As topics are investigated, students will routinely record data in a table, graph the data to identify trends or patterns, and determine an equation that best fits the data. For example, students can determine the strength of paper bridges made of varying thicknesses. Using the number of pennies supported by the bridge as a measure of its strength, students will record data in a *table*, *graph* the thickness of the bridge verse its strength, and determine a linear model or *equation* that best fits the data. Use of a spreadsheet will enhance all of these, as students will see how an equation becomes a spreadsheet formula.

b. Evaluation of this outcome will occur in all of the standard types of assessment used in the class—graded homework, quizzes, tests and projects.

9. Share their findings in oral and written reports using appropriate mathematical language.

a. Students will present an analysis of a quantitative situation in written and/or oral form. In working up to this, they could work in groups on a problem and then share their work on an overhead with the rest of the class. Students will learn to use a spreadsheet and to incorporate spreadsheet tables and graphs into a written report, or to present them in class and incorporate them into an oral report.

b. The instructor can assess how students talk about the problems in their group work and evaluate use of appropriate language in essay questions on tests and quizzes. At least one project per semester will involve a full-length written report, with graphs and tables as needed.

10. Write summaries to explain how they reached their conclusions.

a. Students will learn to summarize the work they have done in analyzing a given situation. Students might be asked to reflect on a problem solving task they have accomplished and explain to each other or the instructor how they went about solving the problem. As part of the write-up of a project they might write a letter to a fictitious friend about the problem and their approach.

b. This will be explicitly called for in projects write-ups, and will be evaluated when projects are graded.

11. Draw inferences from a model.

a. Once the model has been determined and a solution found, the solution has to be related back to the original problem. Students will learn to do this in the context of the different examples that will be presented during the semester.

b. This outcome can be evaluated using quiz and test questions, and when grading projects.

12. Discuss the limitations of the model.

a. An essential part of the discussion of any model will be an analysis of the assumptions made in constructing it, and its limitations as a model for the given situation. Students will learn to look for hidden assumptions and to examine the predictions of a model with a degree of skepticism. They will see examples of questionable use of quantitative data, and will learn thereby to be skeptical of conclusions presented to them in the media and in other aspects of their lives.

b. This outcome will be evaluated in quiz and test questions, graded homework and on projects.

8. Attach a syllabus (1-inch margins and 10-12 pt. font). The syllabus must include the rationale from #6 above and clearly reflect the outcomes and methods detailed in #7 above.

Please submit all materials in electronic form.

Action of the Department/College

1. Department

Vote of department faculty: For **15** Against **0** Abstentions **1**

_____ _____

Department Head Date

2. College

_____ _____

College Dean Date

Action of General Education Advisory Committee

Vote of General Education Committee: For _____ Against _____ Abstentions _____

_____ _____

Chairperson, General Education Advisory Committee Date

Approval

Associate Vice-President for Undergraduate Studies and Curriculum	Date

MATH 110E : MATHEMATICAL REASONING: APPLICATIONS FOR ELEMENTARY SCHOOL TEACHERS
Syllabus

Course Catalog's Description
An introduction to quantitative reasoning, with the aim of developing the capacity to comprehend and analyze the quantitative information that is prevalent in modern society. Topics include mathematical modeling, basic probability and statistics, geometry, and practical applications for elementary education majors.
Prerequisite: Placement or at least a C in MATH098 or MATH098B, or MATH104, MATH105, MATH107, MATH108, or MATH118.

Goal of the Course
This course will provide students with ways to approach the quantitative information that they are certain to encounter in later coursework at Eastern Michigan University, throughout their careers, and in daily life. The emphasis is on learning methods for comprehending, analyzing and using quantitative information and on techniques for using data to inform decisions about real world events and problems. For these reasons, MATH110E will satisfy the **Quantitative Reasoning** requirement in the general education program, *Education for Participation in the Global Community*.

In addition, MATH110E is specifically designed to meet the needs of students that are looking toward becoming elementary school teachers. While the content of this class mirrors that of MATH110, the examples, applications, and projects are designed to help you make connections to the K-5 classroom and help you to begin to think about how you will teach young children to make sense of some beginning mathematical concepts.

Course Objectives
Upon completing the course, students should be able to:

- solve real-life problems using a mathematical modeling process
- analyze and interpret data
- evaluate how statistics are used and misused to make an argument
- explore multiple strategies for solving measurement problems
- solve problems using geometric models
- investigate methods of incorporating data analysis and measurement topics in the elementary school classroom
- reflect upon how technology has impacted the way we teach mathematics

Required Text
Required: Mathematics for Elementary Teachers: A Contemporary Approach. 7th edition, by G. Musser, W. Burger, and B. Peterson, John Wiley & Sons

Course Outline

SECTION 1: DATA ANALYSIS

- Collect and organize data either from surveys, experiments, or the internet.
- Use a spreadsheet program to investigate ways to represent data graphically
- Use a spreadsheet program to determine a mathematical model that best fits the data.
- Explore what is meant by "a model that best fits the data"
- Interpret models in a real world context
- Determine the inherent strengths, weaknesses and assumptions for a given model
- Investigate applications of mathematical modeling in the K-6 mathematics classroom
- Use data analysis software created specifically for the K-6 mathematics classroom
- Explore the use and misuse of statistics in the real world
- Become a more critical consumer of statistics presented in the news
- Develop a research question along with the survey instrument that would result in data that can answer the specified research question.
- Become aware of the strengths and weaknesses in the different ways that samples are generated for surveys

Examples of possible projects for this unit

Project: Create a survey instrument. Collect and analyze data. Write a report including graphs and descriptive statistics that interprets the survey results

Project: Create a spreadsheet to investigate how long it will take to pay off a student loan

Project: Show how to use children's literature to teach a lesson/unit on data analysis

Project: Write a report on children living in poverty – what do the numbers say?

Project: Analyze the way statistics are used/abused in one article from a recent issue of a news magazine (for example, Newsweek or Time)

Project: Create a portfolio that includes eight examples of mathematical models that can be investigated in the K-8 classroom.

SECTION 2: PROBABILITY

- Explore the role of probability in our daily lives including confidence intervals as they relate to survey results
- Compare and contrast theoretical probability models with experimental probability models
- Create probability models to simulate real world problems
- Discuss fairness in the context of fair and unfair games
- Investigate online resources for teaching beginning probability concepts

Examples of possible projects for this unit

Project: Write a paper on how simulations are used to provide information for decision making in the real world

Project: Create a portfolio that includes eight examples of probability models that can be investigated in the K-8 classroom.

Project: Investigate how normal curves and z-scores are used by teachers to interpret test results

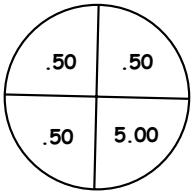
Project: Teach a small group of elementary school children a lesson that incorporates beginning probability concepts. For example, have the children explore the following problem:

Matthew had a dilemma. Normally his weekly allowance is $2.00. However, his family has proposed, that for the next 12 weeks he could pick one of the following allowance plans:

Plan A: Receive $2.00 per week

Plan B: Receive 1 cent for the first week, 2 cents for the second week, 4 cents for the third week, and so on, with the amount doubling each week for the 12 weeks

Plan C: Use a spinner on the diagram below to determine the allowance for each week



Plan D:	Flip a coin each week to determine the allowance. Heads, you get no allowance that week. Tails, you get $7.50 What allowance plan should Matthew use for the next 12 weeks? Would you use a different plan if it were for 16 weeks? Is there a certain number of weeks that Plan A would be best? Plan B? Plan C? Plan D? Are there other risky plans that you would like to consider for your allowance?

SECTION 3. GEOMETRIC MODELS

- Investigate geometric models for determining theoretical probabilities
- Describe geometric patterns algebraically
- Explore characteristics and properties of geometric shapes in both two and three dimensions

Examples of possible projects for this unit

Project: Research the connection between mathematics and tessellations. Create your own tessellation
Project: Computer lab using either LOGO or geometer's sketchpad
Project: Comptuer lab using the online virtual manipulatives

SECTION 4. MEASUREMENT

- Estimate measurements for distance, areas, populations, and volumes
- Explore models for estimating unknown quantities, for example, capture – recapture techniques for estimating the number of fish in a lake
- Estimate measures that are very large and very small
- Solve real world problems that involve area, perimeter and volume
- Investigate the area, perimeter and volume of similar figures
- Investigate the relationship between volume and surface area

Examples of possible projects for this unit

Project: Design a more environmentally friendly cereal box. In your new design, the volume of the box should remain constant but the surface area should be reduced. How much paper would you save using your new design?

Electronic Reserves and Internet Links:
Some course readings are available online in Electronic Reserves. To get to electronic reserves: http://reserves.emich.edu/. Click on your instructor's name and press go and then select "MATH110e". The class password is "mathematics".

Calculators
You are encouraged to bring a calculator to class. You may use calculators on assignments, quizzes, and tests. A graphing calculator is not necessary.

Spreadsheets
Some of our assignments will use spreadsheets. We'll use Microsoft Excel in class, however you may use another program if you prefer. Software used in class is available in 502 Pray-Harrold.

Assessment

We will use the following grading scale:		The weight of each assessment varies by instructor:	
A	90 - 100	Group Presentation	0 - 10%
B	80 - 89	Projects	10 - 30%
C	70 - 79	Computer labs	10 – 30%
D	60 - 69	Homework	0% -30 %
E	Below 60	Exams	40% - 60%

Attendance & Class Participation
I would like everyone to contribute to our classroom environment. Please attend class regularly; I do take roll. Please finish the assigned reading before class, since it gives a useful preview of what we will discuss. I would encourage you to ask and answer questions in class. If you find something unclear, ask! If you do not know an answer, guess!

Group Presentation
You will be responsible for a small group presentation in class later in the semester. The presentation should be about 15-20 minutes. I will meet with your group beforehand to discuss your plans, and I will give you the grading rubric.

Extra Help
You are always welcome to meet with me if you are having difficulties with course material. In addition, there is a math-tutoring center where you can get individual help in Room 220 of Pray-Harrold.

Special Needs
If you have learning disability or other physical impairment that may affect your ability to do the work in this course, please let me know as soon as possible so that we can make appropriate arrangements. See the link at www.math.emich.edu/access.services.html for information about support services. In addition, international students should check the information at www.math.emich.edu/SEVIS.html concerning registration.

Academic Honesty
I expect all students to abide by the University's code of conduct, and in particular to abide by rules concerning academic honesty. In order to assess how the class is going and what you have learned, I need to see your own work: your own words and the details of your own computations. You may work with other students or math tutors on your assignments, but you must do an independent write-up. I will give failing grades for academic dishonesty.