Course Description

This course has the multiple goals of continuing to enhance students’ understanding of the “big ideas and themes” in mathematics and of critically examining educational technology that can enhance the teaching of mathematics. As students become familiar with various software and equipment that can support students’ learning of mathematics, they will not only identify strategies to capitalize on this technology to enhance instruction, but they will also examine how the introduction of this technology can affect both instructional goals and teaching practices. At the core of the course are “experiences as learners” where the students engage with important concepts or topics, as learners themselves, in technology-rich instructional experiences. For example, students will solve a set of challenging geometry problems with the support of the Geometer’s Sketchpad software program, and then reflect on what they learned about geometry, the implications of using this technology in a high school class, and what it would take for them to use similar tools in their own teaching. Similarly, students will also engage in algebraic explorations using graphing calculators and later reflect on this “experience as learners” and its implications for future teaching.

Course Goals

The course aims at enabling students to:

1. Become familiar with various technologies now available to support mathematics learning and appreciate their potential for mathematics instruction.
2. Effectively integrate an appropriate use of technology in their teaching of mathematics.
3. Develop strategies to enhance their students’ familiarity and facility with technology in the context of a mathematics classroom.
4. Further their understanding of some fundamental mathematical ideas and concepts in the areas of geometry, numbers, algebra, and/or probability/statistics.
5. Use technology for communicating, collaborating, conducting research, and solving problems.
6. Demonstrate knowledge of current instructional principles, research, and appropriate assessment practices as they relate to computers and technology resources in the curriculum.

Course Activities
This course is intended to introduce students to a variety of technologies that can be used in a middle school or high school setting. The range of technologies will include graphing calculators, calculators with Computer Algebra Systems, Calculator-Based Laboratories (CBL’s and CBR’s), dynamic geometry software (Sketchpad), dynamic statistics software (Fathom), and several other software packages. Students in the course will investigate and develop activities that use these technologies in courses ranging from pre-Algebra through Calculus. Students will consider the affordances and constraints of using these technologies.

The daily activities will revolve around one type of technology. For example, one day will be devoted to motion experiments on the Calculator-Based-Ranger (CBR). On that day we will conduct several experiments using the CBR. The goal of this set of activities will be to familiarize you with the operation and potential uses of the CBR. The instructor will provide challenging mathematics during the activities so that you are stimulated as mathematical learners. After the set of activities we will reflect upon how you might use such a technology in your classroom.

During each class we will discuss readings, work through a collective activity, and develop individual activities. In addition to the class time, each student is expected to spend each afternoon reading articles on technology, reviewing and reflecting on the day’s activity, and developing an activity according to criteria stated below. A final project will be due on August 7th.
<table>
<thead>
<tr>
<th>Class Date</th>
<th>Technology</th>
<th>Activity and Assignments due</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 3 1:00-4:30pm Room 1-154</td>
<td>Graphing calculator</td>
<td>Introduction, survey Activities with matrices (linear algebra activity)</td>
</tr>
<tr>
<td>July 5 1:00-4:30pm Room 1-154</td>
<td>Graphing calculator</td>
<td>Continuation of linear algebra/intro to paranormal Doerr and Zangor article</td>
</tr>
<tr>
<td>July 10 1:00-4:30pm Room 1-154</td>
<td>Graphing calculator</td>
<td>Parametric equations, sequences, and dynamical systems (discrete mathematics)</td>
</tr>
<tr>
<td>July 12 1:00-4:30pm Room 1-154</td>
<td>Graph link CBR</td>
<td>CBR activities for pre-Algebra, Algebra, Pre-calculus and Calculus Hale article Journal: Question 1</td>
</tr>
<tr>
<td>July 17 1:00-4:30pm Room 1-154</td>
<td>CBL</td>
<td>Pressure probe, light probe, temperature probe activities for algebra, pre-calculus and calculus Lapp and Cyrus article</td>
</tr>
<tr>
<td>July 19 1:00-4:30pm Room 1-154</td>
<td>Sketchpad</td>
<td>Sketchpad Investigation 1 Journal: Question 2 Chazan and Yerushalmy article</td>
</tr>
<tr>
<td>July 24 1:00 – 4:30pm Room 1-211C</td>
<td>Sketchpad</td>
<td>Sketchpad Investigation 2 Goldberg and Cuoco chapter Knuth article</td>
</tr>
<tr>
<td>July 26 1:00-4:30pm Room 1-211C</td>
<td>Sketchpad</td>
<td>Sketchpad Investigation 3</td>
</tr>
<tr>
<td>July 31 1:00-4:30pm Room 1-154</td>
<td>Fathom</td>
<td>Fathom Investigation 1 Journal: Question 3</td>
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<tr>
<td>August 2 1:00-4:30pm Room 1-154</td>
<td>Fathom</td>
<td>Fathom Investigation 2 Shaughnessy and Pfannkuck article</td>
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<tr>
<td>August 7 1:00-4:30pm Room 1-154</td>
<td>CAS</td>
<td>CAS Investigation 1 Journal: Question 4 Heid et al. (2002) article Mahoney article Dick article</td>
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</table>
Descriptions of activities

Linear Algebra Activities Using Graphing Calculators
Students will be engaged in a series of activities that will highlight the applications of matrices to: (1) model populations; (2) solve systems of equations; (3) find the equation of a polynomial that goes through arbitrarily selected points; (4) explore graphs; and (5) transform geometric objects. The mathematical goal of this series of activities is to consider the properties and characteristics of matrices and how they can be applied to a variety of problems. A ‘big mathematical idea’ explored in these activities is the consideration of a matrix as a mathematical object that can be manipulated much as a variable is manipulated in a standard algebraic equation. This is made possible largely by the number-crunching capacities of technology.

Discrete Mathematics Activities Using Graphing Calculators
Students will explore a variety of discrete mathematics concepts involving parametric equations and recursive functions. Recursive functions will be used to explore dynamical systems using multiple representations; furthermore, dynamical systems will be used to investigate elementary applications of chaos theory.

Modeling Activities Using the Calculator-Based Ranger
During this set of activities, students will use the Calculator-Based Ranger (CBR) to generate data of motion that can be modeled by quadratic, exponential, and trigonometric functions. Emphasis will be placed on the accuracy and reasonableness of the functions as models of the phenomena.

Modeling Activities Using the Calculator-Based-Laboratory
Students will use the Calculator-Based-Laboratory (CBL) to generate measurements of temperature, light, and pressure. These data will be modeled by exponential, trigonometric, and rational functions. As in the previous set of activities, the focus will be on the consideration of models as being representative of the phenomena under consideration.

Geometric Conjecturing and Proving Activities Using the Geometers Sketchpad
Students will explore how to use dynamic geometry software to generate conjectures that motivate the need for proof. The initial activities are designed to promote students’ familiarity with the software while the latter activities are designed to provoke conjectures that will need to be proved.

Statistics and Probabilistic Reasoning Activities Using Fathom
Students will explore statistics using object-based dynamic statistics software. The students will generate simulations and perform more traditional calculations involving inferential statistics. One emphasis of these activities is to consider how the Fathom software program permits the development of probabilistic reasoning to solve problems previously modeled by more static algebraic methods.

Symbolic Algebra Activities Using Computer Algebra System
Students will use the Computer Algebra System (CAS) on the TI-Voyage 200 or similarly equipped calculator to symbolically investigate and prove a number of conjectures related to
Calculus. The goal of these activities is to illustrate how a CAS can be used to promote the use of symbolic reasoning and the need for general arguments.

**Networked activities using TI’s Navigator**

Students will explore creating mathematics in a social space using simulations and discuss the implications of this form of activity on mathematics instruction. The University of Rochester, in connection with Professor Nancy Ares, is serving as a demonstration site for this technology.

### Journal Questions

For each of the types of technology or software listed below, please answer the following questions:

A. What are some of the advantages of using this software? This can include representational fluency, potential for exploration, interactive and dynamic nature.

B. What are some of the limitations of the technology or software? This can include what this takes away from students, ‘black box’ effect, limited flexibility in terms of representations or display, learning curve.

C. Briefly reflect on the class activities related to the technology. Discuss the educational value of the activities and suggest revisions for future use.

<table>
<thead>
<tr>
<th>Question #</th>
<th>Technology</th>
<th>Due date</th>
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<tbody>
<tr>
<td>1</td>
<td>Graphing calculators</td>
<td>Thursday, July 12</td>
</tr>
<tr>
<td>2</td>
<td>CBL/CBR</td>
<td>Thursday, July 19</td>
</tr>
<tr>
<td>3</td>
<td>Sketchpad</td>
<td>Thursday, July 26</td>
</tr>
<tr>
<td>4</td>
<td>Fathom</td>
<td>Thursday, August 2</td>
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### Required Course Materials

1. Readings will be made available on WebCT or will be provided to students.
2. Students will need access to the NCTM *Principles and Standards for School Mathematics*. 
Course Requirements

1. Course Readings
   a. Discussion of the class readings will be an integral component of our daily meetings. Students will be expected to read and to reflect upon the ideas and the research presented in the readings. One component of each student’s evaluation at the conclusion of the course will be his/her participation in the class discussions. Students should prepare for 30 minutes of discussion about each reading. The goal of this component of the course is to develop professional vocabulary and reasoning skills required of teachers to sustain their intellectual growth over the course of a career.
   b. Students will be expected to discuss the ideas and the methods in the readings in their journal entries. The readings have been deliberately chosen with this goal in mind. Students may wish to incorporate additional readings of their own choosing or as recommended by the instructor to support particular interests.

2. Journal entry
   Four times during the course, students are expected to write a brief reflection piece about a particular technology. Details for the journal entries are listed above.

3. Final project
   Students, in groups of two or three (pairs unless we have an odd number of students), will complete a final project, to be due on August 7th. The project will consist of designing a technology-rich instructional experience in one of the following five subject areas: (1) pre-Algebra; (2) Algebra (including advanced Algebra); (3) Geometry; (4) pre-Calculus or Calculus; or (5) Probability and Statistics.

   The project must include the following: (a) a description of the mathematics; (b) a description of the learning goals; (c) a description of the set up for the activity, which can include procedures, prompts, or instructions; and (d) predictions of how students will think about this activity.

   Each pair of students is responsible for submitting a hard copy of the activity comprehensively addressing the four criteria. The anticipated length is between 10- and 15- typewritten pages. Students are strongly encouraged to adapt an activity from the curricula they teach in designing this project.
Evaluation

Your evaluation for this course will depend upon your level of participation in the various activities required of each student. The table below lists the percentage value of each activity.

<table>
<thead>
<tr>
<th>Course Requirements</th>
<th>Percentage of Course Activity</th>
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</thead>
<tbody>
<tr>
<td>1. Participation</td>
<td>20%</td>
</tr>
<tr>
<td>2. Activity reflections</td>
<td>35%</td>
</tr>
<tr>
<td>3. Final project</td>
<td>45%</td>
</tr>
</tbody>
</table>

References


