

Technology in Teaching Elementary School Mathematics: *Geometry and Measurement*

University Bulletin

Use of technological tools in teaching elementary mathematics. Current computer software for mathematical explorations. Teaching methods, curriculum materials, psychological factors for developing geometric and measurement concepts.

Course Description

In this course we address teaching geometry and measurement in the elementary school mathematics curriculum. Our focus will be upon conceptual foundations of geometry and measurement in space and in the plane. We will emphasize representing and investigating basic notions of shape, position, size, and motion. We will include spatial and planar ideas about point sets, parallels and perpendiculars, constructions, congruence, similarity, transformations, justification by explanation, basic concepts of measuring, length, area and volume, and basic concepts of measuring with statistics and with probability. We will experience a wide variety of applied situations that can be approached with teaching methods and materials that feature investigations and projects. The underlying educational philosophy is constructivist that focuses on stimulating and guiding students to develop greater mathematical power through activities that foster conceptual understanding and higher order thinking, supported and enhanced with powerful computer tools.

Goals & Objectives

- 1 To deepen our understanding of how and why we can teach geometry, measurement, probability, and statistics in ways that allow our students to experience the power, beauty, and usefulness of mathematics.
- 2 To have experiences in investigating problematic situations in which the mathematics of geometric and measurement reasoning can be used to interpret, analyze, conclude or predict, generalize, and understand more deeply the problem being investigated.
- 3 To learn about resources and tools that we mathematics teachers can use to support applied problem solving and investigations by our elementary school students.
- 4 To develop ideas and beliefs about teaching methods that can support our students to be actively investigating and using mathematics.
- 5 To collect and develop problematic situations and related materials that can be used in our mathematics classrooms.

General Expectations

- 1 Attendance is required, since much of the value of the course will be through the experiences that occur during our class sessions. I reserve the right to lower your grade due to lack of attendance or participation.
- 2 Active participation is expected, as a critical assumption for learning anything more deeply. The pedagogy being advocated and modeled through our course is the belief students must commit to, and be involved actively in, the problems posed.
- 3 Thorough preparation for each class session is expected. The better prepared one is for any experience, the more one will likely benefit from it.
- 4 Thoughtful reflection following each course experience is expected. "Looking back" at one's experiences can help to review and consolidate what is important to remember. Being reflective can help to sort out the "slag" or discards and find the "gems" to keep. At times, it can help one to evaluate goals and strategies, and make needed changes. In general, a reflective person makes better choices and decisions.
- 5 Deadlines are goals which can be altered as we may need to do so. Flexibility is needed when dealing with humans, who differ in their needs and circumstances in unique ways.
- 6 High quality is expected at all times. All students should be expected to contribute and produce in very high quality ways, striving always to do their very best. This must be especially true of those who would choose to be a teacher of others!
- 7 Enjoy while you are learning. Find positive energy in our course. Deal with your anxieties or fears of mathematics. Strive to reach a new state of awareness and peace, as you achieve one more step in being an outstanding school mathematics teacher!
- 8 [Required statement] All academic work must meet the standards contained in "A Culture of Honesty." Students are responsible for informing themselves about those standards before performing any academic work.
www.uga.edu/ovpi/honesty/acadhon.htm

Assignments

1. Weekly article summaries/reflections: Find and read one article each week that corresponds to the teaching of geometry or measurement in the elementary school. For each article, provide a typed, 1-2 page reflection. In each reflective piece, describe how the article aligns with the GPS and the most beneficial information you gained from reading the article. Include complete reference information for each article. Due 6/11, 6/18, 6/25, 7/2 (10 points each)

2. Read the case "What time is it?" and write a 2-3 page response to the case. What would you do if you were the teacher in this case to help students resolve their confusion? Due 6/11 (10 points)

3. Read the case "Zeroes aren't important" and write a 2-3 page response to the case. What would you do if you were the teacher in this case to help students resolve their confusion? Due 6/11 (10 points)

4. A summary and analysis of two web resources or software packages: Choose web sites or software packages that are useful in teaching geometry or measurement at the elementary level. Provide the name of the web site or software package, the URL or publisher, the purpose of the resource, an analysis of its strengths and weaknesses, and a discussion of how you would use it (both where it fits in the curriculum and specifically how you would use it in a lesson or assignment). Due 6/18 (10 points)

5. Your grade level team is debating how, when, and where to teach the metric system. What is your position on the teaching of the metric and English systems of measurement? For example, should linear measurement in both systems be taught together, or should linear, area, and volume measures be taught in one system and then the other? You may direct your comments to a particular grade level if you wish (if you think there are different answers for different grade levels). Due 6/18 (10 points)

6. Many teachers struggle with teaching the metric system because they have little experience with it. Find one good activity that addresses the metric system. You may look in books, magazines, and the internet for ideas, or you may create your own activity. If you borrow an activity from somewhere else (even if you modify it somewhat), provide a reference for the original source. Write up the activity in your own words in the following format:

Title
Grade level
GPS addressed
Time needed to do the activity
Materials needed
Description of activity
Reference (if activity is borrowed)

Your write-up should not exceed one page. I will compile all of the activities and distribute a packet to each person in the class. This assignment **MUST** be turned in electronically. Due 6/18 (10 points)

7. I will read the book *Spaghetti and Meatballs for All* by Marilyn Burns in class. Your task is to write a plan for a measurement lesson that includes this book. Your lesson

should be prepared for a 3rd grade class of heterogeneously grouped students. Identify the GPS objective(s) that your lesson addresses. Your lesson plan should be thorough enough that a substitute teacher could pick it up and implement it successfully. Due 6/18 (10 points)

8. Select and provide a copy of a published geometry activity/task and modify it so that it is at a higher cognitive level. Your new activity should address the same mathematical content as the original. In other words, if the original activity is about symmetry, the new activity should also be about symmetry. Explain why your new activity is at a higher cognitive level. Describe the new activity in narrative form in enough detail that a substitute teacher could conduct the activity successfully. Also, develop a list of 3-5 hints/scaffolds you would provide for students who are struggling with this new activity. The hints/scaffolds should be specific to the activity. In other words, do not say you will allow students to work in pairs as a scaffold. Due 6/25 (10 points)

9. Create Geometry Unit appropriate for the grade level you teach. See attached information and rubric. **Due 6/25 (40 points)**

Tentative Schedule

6/4 Introductions, expectations, time, money, temperature

6/5 Nonstandard and standard measurements for weight, linear, and capacity

6/11 Plane Figures - Characteristics, comparisons, area, perimeter, angle measures, positions (Due: Article summary; What time is it?; Zeroes aren't important)

6/12 Continued

6/18 Solid Figures - Characteristics, comparisons, volume, parallel and perpendicular lines, positions (Due: Web resource reviews; Teaching the metric system; Metric system activity; Spaghetti and Meatballs)

6/19 Continued

6/25 Circles, Composing and decomposing plane and solid figures (Due: Geometry Activity; Geometry Unit)

6/26 Corresponding parts of congruent figures, similar figures, complete the uncompleted.

Note: The course syllabus is a general plan for the course; deviations announced to the class by the instructor may be necessary.

What Time Is It?

My second graders had been studying time for over a week, and I was really thinking that they were understanding what they were doing. Nearly all of my students were consistently giving the time to the nearest 5 minutes. They could count 5-10-15-20-25-30-35-40-45-50-55 around the face of the clock to name the minutes. Counting by 5 is something they've been able to do since first grade, so this seems really easy for them.

I was ready to wrap up our lessons on time and move on to something new, so I decided that we would play a game for our last lesson. I gave half of the class index cards showing a digital time and half of the class index cards showing an analog clock with hands drawn on to show the time. They were supposed to find the partner who had the time that matched theirs. Then, I had another set of cards to repeat the activity with the kids who had digital times in the first round getting analog times in the second round.

After about 5 minutes of the first round, most of the kids had found their partners. But two children with analog clocks approached me saying that they thought I had made a mistake because there weren't any children with their times on index cards. Mike had a clock showing 1:50, and Megan had a clock showing 4:55. Mike insisted that his clock said 2:50, and Megan thought her clock said 5:55. I thought that it would be best to have other children in the class explain to them what time they should be looking for and why. When I asked for volunteers to tell what time Mike's clock said, there was a chorus of voices that answered 2:50. I was shocked by this response because I thought they knew how to tell time. I got out the class clock and moved the hands around and had them count the minutes with me. We got to 50 minutes, and then I asked them what time the clock showed, and they STILL said 2:50! At this point, I was running out of time, and I didn't really know what to do, so I told them that Mike's clock said 1:50 and Megan's clock said 4:55. They found their partners with the matching digital times, and I ended the lesson.

Questions to consider when writing your response:

What do you think was causing the children's confusion?

How would you explain to children why it is 1:50 instead of 2:50?

What do you do when children are confident in their wrong answers?

Zeroes Aren't Important

My fourth graders were sailing along in the money unit, so I decided to introduce them to writing amounts of money two ways—using the cents sign and using the dollar sign and decimal point. We practiced lots of examples such as $45¢ = \$.45$ and even $125¢ = \$1.25$. All of the children seemed to be successful, so I assigned some word problems for them to do using the dollar sign and decimal point notation. I thought this would be a good way to combine some much needed practice with word problems and practice a new skill. **WRONG!!!!**

The next day when we went over homework, there was one problem that nearly everyone seemed to have missed. The problem was: “John has 32 cents. He finds a nickel under his bed. How much money does he have now?” Over half of my students answered 82 cents! Unsure of how they got that answer, I asked for volunteers to come to the board and show how they arrived at their answers. Three students volunteered, and each one of them wrote:

$$\begin{array}{r} \$.32 \\ + \$.50 \\ \hline \$.82 \end{array}$$

I was really surprised to see the students writing $5¢$ as $\$.50$ until I realized that when we worked examples the previous day we didn't do any with single digit amounts. So, I asked the students how to write $50¢$. Everyone said $\$.50$. I showed them that they had written $\$.50$ to stand for both $50¢$ and $5¢$. Someone suggested that we write $5¢$ as $\$.5$ rather than $\$.50$. When I asked if these two were the same or different, there was a lot of disagreement. About half of the class thought they were the same because “zeroes aren't important” and half of the class thought they were different because one was missing a zero. They were missing the point!!!!

Questions to consider in responding to the case:

What is it that the children do not understand?

How would you go about helping them develop a better understanding of these ideas?

Culminating Activity: Developing a Geometry Unit

The teaching unit must include the following:

- Strategies addressing diversity (gender, ethnicity, learning styles, etc.) to support full participation by all students;
- Appropriate use of technology, print and electronic resources, and manipulative and visual materials;
- Interdisciplinary activities and problem solving;
- Effective uses of student groupings such as peer teaching and collaborative grouping;
- Varied instructional strategies based on current research and local, state, and national standards;
- Formative and summative assessments to determine student achievement;
- GPS Objectives and NCTM standards addressed.
- Develop essential questions for the unit Enduring understandings, knowledge and skills
- Develop concept map for the unit
- Design culminating activity (performance task)
- Design rubric for the culminating activity
- Develop the launch activity (capture attention and engage learners)
- Develop essential questions for each lesson
- Develop the lessons using research-based strategies including NCTM Principles and Standards (see rubric for specifics).
- Identify specific differentiation strategies used in the unit plan.
- List resources and materials used.

Learning Unit Rubric
(Geometry and Measurement)

	Exemplary	Acceptable	Not Acceptable
Connection to Standards	Unit directly relates to state and national standards	At least 90% of the unit activities and assessments relate to state and national standards	Less than 90% of the unit activities and assessments relate to state and national standards
Incorporation of research based exemplary instructional practices	Unit includes best practices of vocabulary, essential questions, activating strategies, distributed practice and summarizing, graphic organizers, student collaboration, extending/refining activities	Unit includes 6-7 of exemplary instructional practices	Unit includes less than 6 exemplary instructional practices
Learning Tools	Appropriate use of manipulatives and visual aids throughout the unit	Some appropriate use of manipulatives and visual aids	Inappropriate or no use of manipulatives and visual aids
Culminating Project or Performance Assessment	Project or performance is an authentic application that requires complex thinking and is directly connected to the standards for the unit	Project or performance requires complex thinking and is directly connected to the standards for the unit but may lack authenticity	Project or performance measures student knowledge level without using complex thinking and/or the assessment is not directly linked to the standards
NCTM Principle: Equity	<ul style="list-style-type: none"> Unit sets high expectations for all students to understand mathematical concepts Unit addresses clear support for the differentiated needs of learners 	Unit sets high expectations for all students to understand mathematical concepts but support for the differentiated needs of learners only suggested, not clearly defined	Unit does not address high expectations and/or support for the differentiated needs of learners
NCTM Principle: Curriculum	<ul style="list-style-type: none"> Unit is coherent Unit is focused on important mathematics aligned to standards. 	<ul style="list-style-type: none"> Unit includes one or two activities that do not provide connection to a sequential progression of learning. Unit is based on important mathematics but one or two activities may not be aligned with the standards 	<ul style="list-style-type: none"> Unit is a collection of activities Unit is not focused on the standards
NCTM Principle: Teaching	<ul style="list-style-type: none"> Unit demonstrates teacher knowledge and understanding of mathematical content Unit provides students with appropriate and worthwhile mathematical tasks 	<ul style="list-style-type: none"> Unit has one or two minor errors in mathematical content Most tasks in the unit are appropriate and worthwhile for the level of the student 	<ul style="list-style-type: none"> Unit has significant errors in mathematical content Tasks in the unit are not at the appropriate level for students
NCTM Principle: Learning	Unit provides a plan for developing conceptual and procedural understanding for students by actively building new knowledge from experience and prior knowledge	Unit provides a plan for developing conceptual and procedural understanding but students may not be actively engaged throughout the unit	Unit provides a plan for developing either conceptual or procedural understanding but not both
NCTM Principle: Assessment	Unit has more than two opportunities for formative assessment with feedback and summative assessment that provides evidence of student learning of standards	Unit has summative assessment that provides evidence of student learning of standards and at least two opportunities for formative assessment with feedback	Unit has less than two opportunities for formative feedback.

	Exemplary	Acceptable	Not Acceptable
NCTM Principle: Technology	Unit incorporates the use of technology for enhancing student learning	Unit incorporates the use of technology but link to student learning is unclear	Unit does not incorporate technology or technology recommended will not increase student learning
NCTM Standard: Geometry/Measurement The Geometry or Measurement unit should enable students to <ul style="list-style-type: none"> Analyze characteristics and properties of two- and three-dimensional geometric shapes Specify locations and describe spatial relationships Apply transformations and use symmetry Develop mathematical arguments about geometric relationships Use visualization, spatial reasoning, and geometric modeling to solve problems Understand measurable attributes of objects and the units, systems, and processes of measurement Apply appropriate techniques, tools, and formulas to determine measurements 	Unit addresses two or more components of the NCTM Geometry or Measurement Standards.	Unit addresses one component of the NCTM Geometry or Measurements Standards.	Unit does not address a component of the NCTM Geometry or Measurement Standards.
NCTM Standard: Problem Solving	Unit provides a plan for building new mathematical knowledge through problem solving and includes problem solving throughout	Unit provides a plan for including problem solving throughout but new mathematical knowledge is not developed through problem solving	Unit includes a minimal amount of problem solving
NCTM Standard: Reasoning and Proof	Unit requires students to make and investigate mathematical conjectures and requires student reasoning from all students	Unit requires students to demonstrate reasoning but students may not be required to make and investigate mathematical conjectures	Unit does not require students to demonstrate reasoning
NCTM Standard: Communication	Unit requires students to communicate their mathematical thinking and use the language of mathematics	Unit requires students to communicate their mathematical thinking but does not clearly define the use of the language of mathematics	Unit does not require student communication about mathematical thinking
NCTM Standard: Connections	Unit includes opportunities for students to recognize connections among previously learned mathematical ideas and connections to contexts outside of mathematics	Unit includes opportunities for students to recognize connections among previously learned mathematical ideas but there are not connections outside of mathematics	Unit does not encourage connections to other concepts outside of the unit focus
NCTM Standard: Representation	Unit provides multiple opportunities for students to select, apply, and transfer among a variety of representations to organize, record, and communicate mathematical ideas	Unit provides only two opportunities for students to select, apply, and transfer among a variety of representations of mathematical ideas	Unit does not provide for an opportunity for students to demonstrate various representations of mathematical ideas