Teaching Middle School Math with TinkerPlots

COURSE DESCRIPTION
This is a professional level, moderated, online course in the use of TinkerPlots Dynamic Data Exploration Version 2 for teaching middle school mathematics. In addition to instruction in how to use the software, the course will offer participants pedagogical guidance on how to implement the use of TinkerPlots in their classrooms and promote a discussion of how dynamic mathematics affects the teaching and learning of statistics and probability. The course runs for six weeks with a scheduled start and end date and is structured into six weeklong units. While participants have flexibility within each week, the course is synchronous, meaning that participants are expected to begin and complete the activities for each week during the week they are assigned. This course is primarily intended for teachers.

COURSE OBJECTIVES
After participants complete this course, they will be comfortable using TinkerPlots both as an investigation tool and as a demonstration tool. Participants will be able to:

- Create line plots, histograms, box plots and scatter plots
- Represent and interpret measures of center
- Use a formula to define an attribute
- Use the ruler and other tools to make comparative inferences
- Informally analyze bivariate data using the color meter, brush tool, and diagonal reference line
- Interpret the slope of a line of fit in the context of a specific data set
- Observe variation in data over multiple samples
- Use a sampler to simulate data
- Use a sampler to create and investigate a probability model
- Appreciate the pedagogical implications of exploring mathematics in a dynamic environment

INTENDED AUDIENCE
This course is intended for middle school mathematics teachers and instructors of pre-service teachers. Although the course content focuses on middle school concepts, any current or prospective teacher can learn how to use TinkerPlots to supplement their mathematics curriculum.

PREREQUISITES
Participants should be familiar with middle school mathematics concepts. They should also be comfortable using computers and must have access to the Internet and TinkerPlots Dynamic Data Exploration Version 2.

METHODS OF INSTRUCTION
Each week follows the same structure in which participants complete these activities:

- Watch one or two interview videos of TinkerPlots developers and classroom teachers (each about 5 to 10 minutes long)
- Read and reflect on two or three curriculum standards
- View one or two tutorial videos (each about 5 to 8 minutes long)
- Read three to six student worksheets and activity notes of TinkerPlots activities
- Complete these activities offline using TinkerPlots
- Participate in an asynchronous discussion forum
- Complete a project
- Reflect by responding to specific prompts in an online journal

GRADE BREAKDOWN
In order to receive credit for the course, participants must complete all TinkerPlots activities, turn in all six projects, respond to all six journal prompts, and participate in the discussion forums at least twice each week. Assessment is project-based and all six weeks are weighted equally.

The two units offered for this course are based upon the expectation that each week will require at least five hours of work (at least two hours for online activities including visual media, discussion forums, and the journal, and at least three hours for offline TinkerPlots activities including the project).

Participants will do a weekly activity check that determines their score for working on TinkerPlots activities. They will also receive a score for participating in the discussion forum. The moderator will evaluate and provide feedback for projects and journal entries. Grades will be assigned on a standard percent scale based on the following breakdown:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>TinkerPlots activities</td>
<td>20%</td>
</tr>
<tr>
<td>Discussion forums</td>
<td>20%</td>
</tr>
<tr>
<td>Journal entries</td>
<td>20%</td>
</tr>
<tr>
<td>Weekly projects</td>
<td>40%</td>
</tr>
</tbody>
</table>

REQUIRED TEXTS AND MATERIALS
All written materials are provided as PDF files. Participants are not required to purchase any books or materials other than TinkerPlots Dynamic Data Exploration software. Some common household items, such as paper, coins, or pencils are used in the activities. Participants may reproduce any materials provided in this course to use with their own students. Sources of PDF files include Digging into Data with TinkerPlots (2008, Key Curriculum Press).

SESSION-BY-SESSION SUMMARY

**Week 1: Analyzing Data**
Participants will learn how to represent data in different ways in TinkerPlots, and make observations about measures of center. For their project, they will use a data set included with TinkerPlots to create different graphs to illustrate the data. By the end of the week, participants should be comfortable making line plots and histograms, using the order and stack buttons, and displaying means, medians, and counts.

**Visual Media:**
- “Trusting Data” Ignite presentation by Tim Erickson
- TinkerPlots Help Movie “TinkerPlots Basics”
- TinkerPlots Help Movie “Making Common Graphs”

**Activities:**
- TinkerPlots Basics Tutorial
- Cats and Attributes
- Finding Cats
- What is Typical for this Group of Cats?
- Fireworks Safety Part I
- Fireworks Safety Part II

**Representing Data Project:**
Use a pre-made data set and construct a line plot, a histogram, and a circle graph to represent the data. Then choose one graph and use dividers to locate the center clump. Indicate the median and mean.

**Journal Prompt:**
Participants are asked to reflect on what they learned from doing the Week 1 activities with TinkerPlots, including what they found challenging, and what students will find engaging.

**Week 2: Drawing Inferences**
Participants will learn how to use random samples to draw inferences about a population, and use a formula to create a new attribute. For their project, they will import data from the Internet into TinkerPlots, ask a question about the data, use a formula to compare two numeric attributes, and make a graph that helps them answer their question. By the end of the week, participants should be comfortable using the sampler to take multiple samples, creating a formula to define an attribute, and importing data into TinkerPlots.

**Visual Media:**
- Interview with Kathryn Shafer, “Representing Data”
- TinkerPlots Help Movie, “Adding Data”
Activities:
- Analyzing Data Tutorial, Steps 1–3
- Is Your Backpack Too Heavy for You?
- Tail Length and Body Length
- Fish Length Distributions
- How Do Outliers Affect Means and Medians
- Mystery Mixers

Importing Data and Making Inferences Project:
Import data from the Internet. Formulate a statistical question and create a graph of the data that illustrates the answer.

Journal Prompt:
Participants are asked to reflect on the benefits and drawbacks of using real data in the classroom.

Week 3: Comparative Inferences
Participants will learn how to compare groups and draw inferences from simulated group differences. For their project, participants will use TinkerPlots to determine whether rolling a pencil is an appropriate substitute for rolling a fair die. By the end of the week, they should be comfortable making box plots, using the ruler tool, and using the sampler to take and compare multiple samples.

Visual Media:
- Interview with Doug Roebuck, “Teaching with TinkerPlots”
- TinkerPlots Help Movie, “Comparing Groups”
- TinkerPlots Help Movie, “Simulating Group Differences”

Activities:
- Homework Time Across Grades
- Signatures of Males and Females
- Distributions Shift
- Paper Drop

Rolling Pencils Project:
Collect data by rolling a pencil and compare the results to rolling a standard fair die.

Journal Prompt:
Participants are asked to reflect on using a combination of hands-on activities and simulated data as tools for exploring data.

Week 4: Analyzing Bivariate Data
Participants will learn different ways to investigate patterns of association between two attributes. For their project, they will create a scatter plot and use TinkerPlots’ tools to interpret the relationship between two attributes. By the end of the week, participants should be comfortable creating scatter plots, using the brush tool and color meter, and creating a diagonal reference line.

Visual Media:
- Interview, “Learning to Read ScatterPlots”
• TinkerPlots Help Movie, “Exploring Relationships 1”
• TinkerPlots Help Movie, “Exploring Relationships 2”

Activities:
• Analyzing Data Tutorial, Steps 14–26
• How Have Olympic Results Changed Over Time
• Heights and Rebounds
• Scoring Points
• Free Throws and Field Goals
• Yo-Yo Mystery

Scatter plot Project:
Analyze two attributes in a data set using the color meter and brush tool. Then use a diagonal reference line to model the data, interpreting the slope in the context of the data.

Journal Prompt:
Participants are asked to reflect on the different methods they used in the Week 4 activities to analyze bivariate data. Which were most helpful?

**Week 5: Probability Models**

Participants learn how to build probability models to investigate chance. For their project, they will simulate a probability experiment and observe variability over repeated samples. By the end of the week, participants should be comfortable using the sampler to model a simple event and using the history tool.

Visual Media:
• Interview with Todd Lunsford, “Probability with TinkerPlots”
• TinkerPlots Help Movie, “Probability Simulation”
• TinkerPlots Help Movie, “Creating Sample Spaces”

Activities:
• Simulating Data Tutorial
• Modeling Probability Tutorial
• The Ants and the Aardvark
• Wink, Blink, and Stare
• Four-Child Families
• Sum of Two Dice

Probability Experiment Project:
Create a sampler to model a simple probability experiment, and measure variability between samples.

Journal Prompt:
Participants are asked to reflect on their experience with probability, as either a teacher, or a student. How might probability simulations impact student understanding?
**Week 6: Simulating Data**

Participants learn to simulate data using TinkerPlots. For their project, they will use what they have learned in this course to build a sampler for use as a classroom demonstration. By the end of the week, participants should be comfortable using the sampler to simulate data.

**Visual Media:**
- Interview with Vishakha Parvate, “Simulating Data”
- TinkerPlots Help Movie, “Building a Data Factory”

**Activities:**
- Simulating Data Tutorial
- Building a Data Factory
- Modeling a Candy Factory
- Modeling Challenges

**Final Project:**
Create a sampler that models that can be used as a demonstration tool in a mathematics class.

**Journal Prompt:**
Participants are asked to reflect on how they will use what they have learned in this course with their students, as well as what they found most challenging, and most engaging.