Seeing Math Course Syllabus

Title

Seeing Math™**:** Data Analysis

Target Audience

This course is intended for pre-service and in-service teachers of mathematics grades 6-12.

Prerequisites

Learners taking this course should be:

- Familiar with calculating and interpreting the three measures of center (mean, median, and mode) as set out by national and state standards and identifying range and outliers within a data set.
- Familiar with different ways of representing data: bar charts, circle graphs, stem-and-leafs, box-and-whisker plots, stacked dot plots, histograms, and scatter plots.

Course Description

What do the measures of central tendency—mean, median, and mode—tell you about the data? Even high school students who can expertly determine mean, median, and mode often miss the larger picture: interpreting the *meaning* of these simple measures and the ways they characterize the data set as a whole. This course focuses on this hidden gap in understanding. It is designed to help learners and their students learn to look beyond calculations and individual data points to how the measures are related to the whole set. This course looks at the importance of seeing the data as an aggregate. It also examines how the teacher's choices can help students learn to analyze data and draw reasonable conclusions—and thus move from merely calculating measures to higher order statistical thinking.

Instructor/Facilitator

See instructor/facilitator sheet

Credits

To be determined by college or university

Goals and Objectives

Learners will understand and distinguish among tools used to analyze data.

Learners will be able to:

- Distinguish between using an algorithm and understanding the underlying mathematical relationships among measures of center in a data set
- Identify how different representations highlight particular characteristics of a set of data
- Describe the relationships among the measures of center, and show how they reflect changes in individual values

Learners will guide the development of understanding from individual case to aggregate.

Learners will be able to:

- Identify, in their work and discussion, students' developing sense of the aggregate.
- Select graphic representations that direct students' attention to specific attributes of a data set, particularly those of the aggregate.

- Create their own activities to teach students how to interpret the measures of center, identify the characteristics they highlight, or use particular representations to highlight characteristics of a data set.

Learners will describe and interpret data in real world contexts.

Learners will be able to:

- Interpret data that is generated by a real world situation, and choose the measure or measures of center that best describe the data.
- Present and discuss alternative interpretations of data sets generated by real world situations.
- Use both written activities and the Plop It! software to interpret information about a data set.

Outline of Content and Assignments

After previewing the documents in the Course Information area, learners proceed to Course Content to complete the five sessions, working through each session in order. Throughout the sessions, learners are asked to articulate their ideas in various forms: they are encouraged to reflect on their ideas and experiences in their online journal; the discussions in the discussion forum are designed to allow learners to glean information from other learners' experiences.

This five-week course is taken entirely over the Internet. Learners should expect to spend 4-6 hours per week completing assignments and discussions, and to log in to class and submit work or join discussions at least three times a week. Each week learners complete assignments such as solving problems, observing videos, reading, adapting problems for the classroom, and taking part in online discussions. In the last week of the course learners focus on creating and completing a final project.

Learners also come away with a tangible benefit—interactive software and activities to use with students. These tools are used within the course, such that learners are thoroughly familiar with them. In addition, learners are provided with alternative activities that do not require computers if computer resources are not available for classroom use.

Week 1: Orientation

Much of the *Orientation* session is spent getting to know the courseware and meeting colleagues online. Learners also read about our approach to learning and teaching data analysis, look at the NCTM Standards as well as their own state standards, and begin entering notes and reflections in their course journals.

Learners will:

Read:

- *The Landscape of Learning* – A discussion on the underlying principles behind the learning in this course and what they should expect.
- *The Landscape of Data Analysis* – A discussion about the challenge in helping students learn to reason statistically.
- National Council of Teachers of Mathematics Data Analysis and Algebra Standards.
- Local state standards

Write in journal:

- Reflect on insights and ideas related to national and local standards on center, representation, and interpretation.
- Reflect on personal experience, as well as teaching experiences with data analysis and identify areas of difficulty.

- Identify aspects of data analysis that students should find most useful and aspects that they must know.

Participate in online discussions:

- Post messages in the Discussion Board, Week 1, *Introduction* forum by sharing "get to know you messages." Read what colleagues have to say and respond to at least two other posts.
- Post messages in the Discussion Board, Week 1, *Meeting the Standards by sharing some of their thoughts about the standards and reflections recorded in their journals.* Read what colleagues have to say and respond to at least two other posts.

Week 2: Math Focus

In this session learners look at the standard approach to teaching measures of center—and some possible, unintended stumbling blocks to deeper understanding. Next, they dive into a data analysis activity of their own by exploring the use of the *Plop It!* interactive to look at new ways of organizing and interpreting data. Finally, learners review common methods of representing data through graphs.

Learners will:

Read:

- *Snapshots from the Curriculum*: Common approaches to data analysis, their limitations, and stumbling blocks they may create.
- *Observing Your Processes*: Guidelines on observing personal problem solving.
- *Picturing the Data: Graphical Options:* Common methods of graphically representing data.

Complete activities and assignments:

- Warm Up: Get to know the Plop It! Interactive software tool
- Diving In: Work on challenges using both paper and pencil and similar challenges and activities using Plop It!
- Using Plop It and the same data from two of the challenges, create *three new ways* to represent the data. Learners can choose between the stem-and-leaf, circle graph, bar graph, histogram, scatter plot, and box-and-whisker.

Write in journal (not required):

- Reflect on approaches used to solve the *Diving In* challenges such as:
  - If the familiar algorithm for calculating mean is not used, what other methods could be used for estimating its value? Learners evaluate if the method used provided any new insights into how they look at the mean?
  - A description of the patterns observed in solving these problems. How did using Plop It! influence their thinking?
  - A description of any patterns that helped them solve each problem. (For instance, when the mean is lower than the median, what does this say about the distribution of the data set?)
  - How did they construct their data sets? In what ways did they think about the relationship between mean, median, and mode—and how they characterize the distribution of data?
  - What does it mean to "best characterize" the data? Could the data have been characterized differently, either using a different measure of center or by using some other description? (And at any point did they forget that measures of center describe the set, but aren't data points themselves?)
- Reflect on approaches used to solve the *Picturing the Data* assignment such as:

- What difference does the presence or absence of gaps make in the representation of a data set?
- Pie and bar charts are commonly used in advertising or newspaper and governmental reports. How can they be misleading?
- What does it mean to "interpret" a data set?

Participate in online discussions:

- Post comments on reflections on two of the challenges: *A Prescription for Data* and *Interpreting the Data*, in the Discussion Board, Week 2, *Diving In: Data Analysis.* Read what colleagues have to say and respond to at least two other posts.
- Summarize answers to the questions from the *Picturing the Data* activities and share thoughts in the Discussion Board, Week 2, *Picturing the Data*. Read what colleagues have to say and respond to at least two other posts.

Week 3: Student Thinking

The focus of this session is student thinking. In a series of videos, learners observe high school students wrestling with the same data analysis challenges that they studied in the previous session's *Diving In* activity. Learners observe students' efforts to grasp the mean and median without the use of formulas, and listen to their language to gain insight into their understanding of the measures of center as they talk about the problems.

Learners also listen to commentary by mathematics education specialist, Aisling Leavy. In her commentary, Leavy suggests that an intuitive sense of "balance" may be a key to developing a deeper sense of the measures of center, and a greater feel for the data set as a whole.

Learners will:

Read:

- *Meet the Students* –Background information about the students in the videos.
- *Don't Miss* - Items from student video
- *Don't Miss* - Items from Specialist Commentary

View videos:

- Students working on problems similar to those in the *Diving In* activities from the previous session.
- Mathematics specialist, Aisling Leavy, describing the underlying mathematical themes in the students' work.

Complete activities and assignments:

- *Finding Your Balance* – Keeping the Mean activity provides opportunities for learners to explore their understanding of the meaning of the mean.

Write in journal (not required):

- Reflect on the students' processes as observed in the videos:
  - How does the organization of data influence students' perception of the data as a whole, or their understanding of the measures of center?
  - If a student believes that the mean or median must be a value present in the data, what does this tell you about his or her understanding of measures of center?
  - How does the students' talk of "balancing" compare to your own view of measures of center? Do you find it mathematically appropriate to use balancing strategies to determine the mean? Why, or why not?
- Address interesting or significant ideas from Leavy's commentaries:

- Why is Leavy concerned that the students' initial layouts don't show gaps in the data?
- What does Leavy mean when she says that the students' "balance" metaphor suggests a "more sophisticated" understanding of the mean?
- The students have a hard time figuring out how to add one more value while maintaining the mean at 4. Why does Leavy say that they wouldn't have had any trouble if they had "a center of gravity notion of the mean"?

Participate in online discussions:

- Review notes on what was considered significant in the videos (including issues raised in the "Don't Miss" sections), as well as students' responses Summarize your thoughts and post your summary to the Discussion Board, Week 3, *Observing Student Thinking, Part 1.* Read what colleagues have to say and respond to at least two other posts.
- Review notes from Leavy's commentary and answers to the Keeping the Mean activity and post comments in the Discussion Board, Week 3, *Finding Your Balance.* Read what colleagues have to say and respond to at least two other posts.

Week 4: Your Classroom

The focus of this session changes to the connection between the content of this course and what learners do in their classrooms. Learners view a video that shows how students' thinking changes when they're asked to interpret a familiar data set in the context of a real world application. Mathematics specialist, Aisling Leavy suggests activities and graphic representations that encourage focusing on the common characteristics of a data set.

Learners will:

Read:

- *Meet the Students* –Background information about the students in the videos.
- *Don't Miss* - Items from student video

Watch videos:

- Students building data sets and trying to interpret a data set in a real world context
- Mathematics specialist, Aisling Leavy, commenting on ways to draw students' attention to the aggregate

Complete activities and assignments:

- Explore Your Curriculum: Gather curriculum materials: textbook, curriculum unit(s), or math program materials, and your state's relevant algebra and data analysis and probability standards. Consider the following:
  - In what ways does your curriculum demonstrate how measures of center characterize a data set?
  - In what ways does the curriculum support a dynamic "what if?" approach, such as adding values to the data set to elicit predictions about changes in the measures of center?
  - How does the curriculum explore different graphical representations of a data set, and how some representations emphasize cases while others highlight characteristics of the aggregate?
  - How are real world cases used? Do the problems stimulate a discussion of representativeness? Do they require comparison between groups of data?
  - Select two problems that can be modified to integrate the concepts being studied.
- Adapt the two problems for students, building on the themes presented in this course.

- Write descriptions of their problems both before and after adaptation. Describe what they took into account as they adapted their problems. Comment on *at least two* of the ideas below. Additional ideas are acceptable.
    - What concepts does your problem address?
    - What aspects of the situation did you modify, and why?
    - Which strategies do you anticipate your students might use?
    - What strengths or difficulties have your students displayed around this topic, and how might this problem help them gain new perspectives?
    - How did you incorporate technology?
    - Do you already make adaptations to your curriculum? How did this experience compare to your current practice?

Write in journal (not required):

- Reflect on the students' processes as observed in the videos:
    - What are some different ways in which they might have been asked to interpret the final data set? To what extent might the interpretation be affected by its intended purpose (for example, marketing versus evaluation for effectiveness)?
    - How does the use of technology (Plop It!) affect the student's ability to demonstrate and communicate their understanding?
    - How does the choice of context (in this case, headache relief) affect one's interpretation of data? What if the data had been a tally of ratings of fan reaction to a new baseball team manager? Or if the data had reflected the number of cigarette-free months after a group of smokers started a Quit-Smoking program? Given a different context, might students have chosen differently when they picked the measure of center that best describes the data?
    - Have they ever given students the real world context before providing the data set (or asking them to collect it)? Do students respond differently? Do you think that this affects how they work with the data?
- Reflect on interesting or significant points in Dr. Leavy's commentaries:
    - What was the effect of waiting to provide real world context until after the students had created the data set?
    - Would Kiki, Evelis and Marlon have chosen the mean if the data were more skewed? Would Ben, Noble and Mychael have used the mode if they hadn't been focused on marketing?
    - What might happen if Ms. Crounse had asked the students to write up the data for a medical journal? What might be the best way to help students realize that multiple interpretations can be made of any one set of data?
    - What might lead students to realize that measures of center are not always the best way to describe a data set?

Participate in online discussions:

- Review notes on what they considered significant in the student videos (including issues raised in the "Don't Miss" sections), as well as their responses to the reflection questions related the student processes video and any issues that emerged. Post summaries to the Discussion Board, Week 4, *Observing Student Thinking, Part 2. .* Read what colleagues have to say and respond to at least two other posts.
- Review notes on what they considered significant in the Aisling Leavy videos as well as their responses to the reflection questions related the specialist commentary and any other issues that emerged. Post summaries to the Discussion Board, Week 4, *Specialist Commentary, Part 2.* Read what colleagues have to say and respond to at least two other posts.

Week 5: Your Plan

In this session learners look back over the landscape of ideas they explored during this course. They review their thoughts and records to consolidate their learning experiences and build upon the work completed over the past weeks. Learners create a final project designed to integrate the mathematical concepts developed throughout the course into their instructional program. Learners also celebrate their achievements and say goodbye to their peers and facilitator.

Learners will:

Read:

- A review of the major topics addressed in this course

Complete activities and assignments:

- Create either a lesson plan or action plan for applying what was learned to their instructional program:
  - Lesson plan – Select a specific activity (such as one of the "For Your Students" activities) that facilitates having students share mathematical ideas. Modify it to address the learning styles and characteristics of their students.
  - Action plan – Select a specific action or instructional strategy that the learner wants to address, such as focusing on specific kinds of questions that elicit student thinking or specific personal activities to cultivate their listening skills.
- Post in the Discussion Board, Week 5, *Gallery of Plans-learners' completed plans.*

Participate in an online discussion:

- Post their Aha!, Oops! and/or Whew! comments on the Discussion Board Week 5, *Aha! Oops! Whew!* Say goodbye to fellow learners, share their memories of this course experience, and plan for continued professional contact. Read what colleagues have to say and respond to at least two other posts.

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Write in journal (not required):

- Review written work and memories of what was learned and record a personal self-assessment and reflection.

Schedule

This course is scheduled for 5 weeks. Learners will spend 4 to 6 hours per week to complete assignments such as solving problems, observing videos, reading, adapting problems for the classroom, and taking part in online discussions. In the last week of the course, learners focus on creating and completing a final project.

Requirements

Learners are expected to:

- Complete all assignments.
- Maintain an online journal.
- Participate and actively engage in discussions with fellow learners while contributing to the social construction of knowledge.
- Be self-directed and self-motivated.
- Ask for assistance when they need it.

Materials (hardware, software, plug-ins for Windows and Macintosh)

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Operating System
For the best experience, use the newer operating systems: Mac OS X, Windows 98, Windows 2000 and Windows XP. Additional operating systems (for example Linux) appear to work, but are not tested.
Mac OS 9 does not support a current version of Java, which is needed to use the interactives.

Browser
Use Internet Explorer, Mozilla, or Netscape with Windows operating systems. MAC users should use Netscape or Mozilla. Browser must have cookies enabled to support course login.

Video Players

One of the following video players is required in order to view the videos. Seeing Math recommends QuickTime.

- QuickTime
- RealPlayer
- Windows Media Player

Java
This course contains "interactives" — software applications that focus on one particular math concept. These require Java 1.5 or higher.

Word processor
Internet service provider
E-mail

Academic Dishonesty Policy

To be inserted by university institution only

Evaluation

This course is evaluated on a letter grade basis, and may be available for graduate credit. See graduate credit details pertaining to specific graduate credit institutions.

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Rubrics for Discussion

The assessment rubrics fall into two categories: discussions and activities. Learners read these rubrics to get the "big picture" perspective of what's expected. They then refer to them from time to time during the course to remind them of the target, and to use as a self-assessment tool.

In an online course, participation means posting. Most activities in this course require learners to share their thoughts on a subject (such as a reading or a video), or to complete a hands-on assignment and discuss the experience with peers. This collaboration leads to insights unavailable to individuals alone—we all learn together.

The facilitator will look for ***frequent*** and ***appropriate*** contributions to class discussions from all participants. "Frequent" means posting on at least three days each week. "Appropriate" is based on the level of contribution as a whole (rather than allotting specific points for content, style, particular solutions, etc.). The following characteristics make up an excellent body of discussion contributions:

- Is grounded in the ideas, readings, and activities of the course.
- Connects to and builds on the ideas of others, and advances the collective thinking about content and pedagogy.
- Shows respect for and integrates multiple views (even views that at first appear contradictory or unrelated).
- Achieves or reaches toward new insights about mathematics and teaching.
- Takes risks by sharing tentative or newly formed ideas, mistakes, or misconceptions.
- Expresses content clearly.
- Makes skillful connections between natural language, mathematical language, and student thinking.
- Elicits reflection and responses from other participants.
- Questions other participants in order to clarify and extend own ideas.

Rubric for Mathematical and Pedagogical Activities

Assignments ask learners to post written work in the course—for instance, when they solve a problem and describe their thought processes in working towards a solution. They are asked to wrestle with a math problem, interactive, or ideas. Then share this work with their facilitator and peers as a post in the Discussion Board.
The facilitator measures learners' effort, care, and understanding in reading and carrying out the assignments using the following criteria: The learner:

- Posts clear and detailed reports on assignments and observations of own learning processes.
- Focuses not on the "right answer," but on experiencing and observing learning processes.
- Makes connections among more than two representations (real-life, symbolic, graphic, numeric).
- Considers what different representations contribute to one's own and students' learning of algebra.
- Generates different real-life situations for the same mathematical setting, and conversely, generates different mathematical models to describe variations on the same real-life situation.
- Makes connections among mathematical concepts and describes them clearly.
- Explores the consequences of those connections to understanding and teaching mathematics.
- Clearly identifies, describes, and justifies the strategies used to solve problems.

While these rubrics may seem ambitious, learners are not required to meet every criterion for each assignment. The facilitator will apply individual criteria as necessary (for instance, not all activities require learners to use multiple representations of math concepts). Learners use these as a general guide to gauge the quality of their work.

Learners are also encouraged to keep a journal of their thoughts and rough drafts which serves as an automatic record of their work.

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Action Plan Rubric

Criteria	Does not meet expectations	Meets expectations	Exceeds expectations
Completion of Assignment and Timeliness	Assignment is not completed and/or submitted on time.	Assignment is completed and submitted on time.	N/A
Description of the instructional strategy	A specific action or instructional strategy is not included and/or reason(s) why this strategy was selected are not included.	A specific action or instructional strategy is included, along with the reason(s) why this strategy was selected.	A specific action or instructional strategy and reason(s) why this strategy was selected are included. In addition, specific examples from experiences in the course or from personal reflections that were instrumental in the selection of the stated strategy are included.
Goals	The goals for the teacher and/or the students based on the instructional strategy selected are not included.	The goals for both teacher and student based on the instructional strategy selected are included.	The goals for both teacher and student based on the instructional strategy selected are included. Goals are SMART (see note below).
Objectives	The specific performance objectives teacher will do to accomplish the stated goals for the selected strategy are absent.	The specific performance objectives the teacher will do to accomplish the stated goals for the selected strategy are clearly described.	The specific performance objectives the teacher will do to accomplish the stated goals for the selected strategy are clearly described. A rationale for each of the stated objectives is provided.
Potential activities	The plan does not delineate and/or describe the specific activities/tasks to be undertaken to meet the objectives.	The plan delineates and briefly describes the specific activities/tasks to be undertaken to meet the objectives.	The plan delineates and briefly describes the specific activities/tasks to be undertaken to meet the objectives. The activities indicate attention to ensuring the needs of all students are met.

Relevance	How the scope of the plan is relevant to the study of algebra, or to the students, or the school or district, and to the quality of educational practice is not stated.	How the scope of the plan is relevant to the study of algebra, or to the students, the school or district goals, and to the quality of educational practice is stated.	How the scope of the plan is relevant to the study of algebra, to the students, the school or district goals, and to the quality of educational practice is stated.
Evaluation	The criteria to be used in determining the success of the objectives, including when and how the plan will be adjusted, if needed, are not described.	The criteria to be used in determining the success of the objectives, including when and how the plan will be adjusted, if needed, are described.	The criteria to be used in determining the success of the objectives, including when and how the plan will be adjusted, if needed, are described. A brief student evaluation survey is also included.
Portfolio	Pieces of evidence from the proposed activities that will be collected for each objective are not identified.	Pieces of evidence from the proposed activities that will be collected to support each objective are identified.	Pieces of evidence from the proposed activities that will be collected to support each objective are identified. Also included is a rationale statement for selecting at least four pieces of evidence.

Note: SMART refers to Specific, Measurable, Attainable, Relevant, Time-bound.

Lesson Plan Rubric

Criteria	Does not meet expectations	Meets expectations	Exceeds expectations
Completion of Assignment and Timeliness	Assignment is not completed and/or submitted on time.	Assignment is completed and submitted on time.	N/A
Goals	Goals are not provided.	Goals clearly state the purpose of the lesson. There is evidence of the alignment of the goals, objectives, learning activities, and assessment methods described in the lesson plan.	N/A
Objectives	Objectives are not provided.	Objectives are performance-based, state what students should know and be able to do as a result of learning instruction. Objectives are appropriate for the grade level and students identified. There is clear evidence of the alignment between the goals, objectives, learning activities, and assessment methods described in the lesson plan.	N/A
Standards Addressed	National and state content and technology standards are not addressed.	National and state content and technology standards are listed.	N/A

Prerequisites	Prerequisite knowledge and skills are not provided, or prerequisites are vague, or prerequisites are not appropriate.	Appropriate prerequisite knowledge and skills needed by students are provided.	Appropriate prerequisite knowledge and skills needed by students are provided. An explanation of their importance to the learning is provided.
Materials	Materials and resources are not listed, or only a partial list is provided.	A complete list of materials, resources, and detailed descriptions of any special considerations and/or advanced preparations are provided.	A complete list of materials, resources, and detailed descriptions of any special considerations and/or advanced preparations are provided. A list of additional/alternative materials and resources is also provided.
Lesson Overview	The lesson overview is not provided or lesson overview is incomplete, vague or unclear.	The lesson overview provides a brief statement that summarizes key aspects of the lesson.	N/A
Teaching Strategy	Lesson design does not document clearly the teaching strategy that needs to be implemented, whether it is direct instruction or learner-centered instruction.	Lesson plan documents clearly the appropriate teaching strategy needed for the lesson, whether it is direct instruction or learner-centered instruction.	Lesson plan documents clearly the appropriate teaching strategy needed for the lesson, whether it is direct instruction or learner-centered instruction. A rationale for the selection based on course readings and best practices is provided.

Lesson Procedures		Lesson procedures provide a detailed, step-by-step description of the lesson. They include: Introduction — how students will be introduced to the goals and what is expected of them Main activity — how the teacher will facilitate the learning experience Conclusion — how the teacher will bring closure for students and provide feedback Extension — how the lesson will be extended.	Lesson procedures provide a detailed, step-by-step description of the lesson. They include: Introduction — how students will be introduced to the goals and what is expected of them Main activity — how the teacher will facilitate the learning experience Conclusion — how the teacher will bring closure for students and provide feedback Extension — how the lesson will be extended. Procedures include strategies for differentiated instruction.
Assessment	Assessment is not provided, is incomplete, and/or vague. There is not a clear relationship between the assessment and the skills taught during the lesson.	Assessment(s) to be used to evaluate students' learning is (are) provided. There is a clear relationship between the assessment(s), the content, and the skills taught during the lesson.	Assessment(s) to be used to evaluate students' learning is (are) provided. There is a clear relationship between the assessment(s), the content, and the skills taught during the lesson. Assessment(s) incorporate(s) a consideration for diverse student needs. A rationale for the selection of the assessment technique(s) based on course readings and best practices is provided.