

Mathematics: The Language of STEM
Data Analysis and Statistics
UNIT OVERVIEW
Janna Simcoe, Rachel Jensen, Tori Reneker

CONTENT AND TASK DECISIONS

Grade Level(s): 5

Description of the Task: Students will work in groups to generate and predict data driven questions, plan and collect data, and create various graphs (line plots, line graphs, bar graphs, and frequency tables) that represent the data collected. Students will also explore mean, median, and mode in context with their data. In culmination, students will present their graphs and reflections about their data collection to their peers using posters, power points, or other media.

Indiana Mathematics Content Standards:

5.DS.1: Formulate questions that can be addressed with data and make predictions about the data. Use observations, surveys, and experiments to collect, represent, and interpret the data using tables (including frequency tables), line plots, bar graphs, and line graphs. Recognize the differences in representing categorical and numerical data.

5.DS.2: Understand and use measures of center (mean and median) and frequency (mode) to describe a data set.

Indiana Mathematics Process Standards:

PS.1: Make sense of problems and persevere in solving them.

- Students will create a question and determine a way to collect and continually revise their predictions and methods (to collect their data) used throughout the unit.

PS.4: Model with mathematics.

- Students will activate prior knowledge and continually explore bar graphs, line graphs, line plots, and frequency tables.

PS.5: Use appropriate tools strategically.

- Students will utilize books or iPads to research their question and select an appropriate table for that represents their data.

PS.8: Look for and express regularity in repeated reasoning.

- After exploration, students will discover the formulas for the mean, median, and mode.

Mathematics Content Goals: Students will understand that data collection includes asking a researchable question, formulating a prediction, determining various methods of data collection (including mean, median, and mode), and creating the most appropriate graph for their data.

Language Objectives:

Students will work collaboratively and engage in discussions that promote exploration, deeper thinking, problem solving, and perseverance while collecting data.

All learners will build vocabulary including mean, median, mode, bar graph, line graph, line plot, frequency table, average, and data.

Mathematics: The Language of STEM
Data Analysis and Statistics
Day 1 Lesson
Janna Simcoe, Rachel Jensen, Tori Reneker

CONTENT AND TASK DECISIONS

Grade Level(s): 5

Description of the Task: Students will work in groups to create a detailed plan explaining how they will research an answer to the question, *What is the most common color in a bag of regular M&Ms.* They will make a prediction about the answer, present their ideas to the class, and then determine the best method for researching the answer. Lastly, students will collect data about the most common color in a bag of M&Ms and record their findings.

Indiana Mathematics Content Standards:

5.DS.1: Formulate questions that can be addressed with data and make predictions about the data. Use observations, surveys, and experiments to collect, represent, and interpret the data using tables (including frequency tables), line plots, bar graphs, and line graphs. Recognize the differences in representing categorical and numerical data.

Indiana Mathematics Process Standards:

PS.1: Make sense of problems and persevere in solving them.

- Students will create a question and determine a way to collect and continually revise their predictions and methods (to collect their data) used throughout the unit.

PS.5: Use appropriate tools strategically.

- Students will utilize books or iPads to research their question and select an appropriate table for that represents their data.

Mathematics Content Goals: Students will understand that the first steps in data collection include asking a researchable question and formulating a prediction. They will apply that knowledge to conduct research about a data-drive question.

Language Objectives:

- Students will make predictions about the outcome of a teacher-posed question by discussing their ideas in pairs.
- Students will listen to the ideas presented by their peers and make adjustments to their original predictions in written form.

Materials:

- Brainstorming Record Sheets (one per group)
- M&M bags (one per group)
- Exit Ticket forms

THE LESSON

Before:

- **Activate prior knowledge:** Share some interesting statistics about 5th grade students with the class. (ex. Sixty-five percent of the class has their own Instagram account, The average 5th grader spends 6 hours a week watching YouTube videos, etc.) Ask the class how the teacher knows this information. Encourage students to think about how a person would research the answer. Ask students to share some statistical questions they would like to learn the answers to. Next, tell the class that the teacher has a question that he/she would like the class to research: What is the most common color in a bag of M&Ms. *See *Establish Clear Expectations* for specific instructions.
- **Be sure the problem is understood:** Allow students to ask questions about the task to a table partner or to the teacher.
- **Establish clear expectations:** Students will work in small groups to brainstorm their prediction about the most common M&M color and create a plan for implementing their research. After sharing their ideas with the class, they will carry out their plan. (Make certain that students count any broken pieces of M&Ms as halves. *See *During Phase*.)

During:

- **Let go:** Students will record their thinking on the Brainstorming Record Sheet. Teacher will monitor groups and circulate among the class, providing support as needed.
- **Listen actively:** Students will effectively collaborate within their groups, share their reasoning, and record their ideas.
- **Provide appropriate support:** What do you think is the most common color and why? List at least 4 ways you could research the answer. Which is the most reliable method and why do you think that? Which is the least reliable method and why do you think that? Record all the steps of your plan for your research? What will you do if there is a tie?
- **Provide worthwhile extensions:** Ask students to create other questions they could research using their bag of M&Ms. What would happen to your results if you had more bags of candy? What about a smaller bag of candy?

After: **Students will gather together after completing their Brainstorming Record sheet to discuss their ideas. Then they will go back to their groups and carry out their revised plan based on the suggestions of the classmates.

- **Promote a mathematical community of learners:** Students will present the work on their Brainstorming sheets with the class. Classmates will be permitted to ask questions or make comments about the presentations.
- **Listen actively without evaluation:** Thank students for offering their ideas and ask follow-up questions.
- **Make connections:** The teacher will guide students into making connections with the thinking of their peers. Point out similarities between research plans and predictions.
- **Summarize main ideas:** Guide students into understanding that combining results of their research with other groups would provide more accurate data due to the larger sample size.

ASSESSMENT

Observe: Observe that students are engaged in a collaborative discussion about the process of collecting data.

Ask: Exit Ticket: In your opinion, explain the best way to display or share your results with other classes on a notecard.

Mathematics: The Language of STEM
Data Analysis and Statistics
Day 2 Lesson
Janna Simcoe, Rachel Jensen, Tori Reneker

CONTENT AND TASK DECISIONS

Grade Level(s): 5

Description of the Task: Students will work in groups to generate and predict data driven questions, plan and collect data, and use a frequency table to display their results.

Indiana Mathematics Content Standards:

5.DS.1: Formulate questions that can be addressed with data and make predictions about the data. Use observations, surveys, and experiments to collect, represent, and interpret the data using tables (including frequency tables), line plots, bar graphs, and line graphs. Recognize the differences in representing categorical and numerical data.

Indiana Mathematics Process Standards:

PS.1: Make sense of problems and persevere in solving them.

- Students will create a question and determine a way to collect and continually revise their predictions and methods (to collect their data) used throughout the unit.

PS.4: Model with mathematics.

- Students will activate prior knowledge and continually explore frequency tables.

PS.5: Use appropriate tools strategically.

- Students will utilize books or iPads to research their question and select an appropriate table for that represents their data.

Mathematics Content Goals: Students will understand that data collection includes asking a researchable question, formulating a prediction, determining various methods of data collection, and creating a frequency table to organize their results.

Language Objectives:

- Students will discuss their ideas for a data-driven question that they want to research using surveys and outside research with a partner.
- Students will listen to the ideas presented by their partners and make agreements about their research methods.
- Students will record their research on a frequency table.
- All learners will build vocabulary including: *frequency table (shows the total for each category or group of data)* and *data (facts and statistics collected together)*.

Materials:

- Data collection results from Day 1
- Student Exit Tickets from Day 1
- Day 2 Exit Tickets

THE LESSON

Before:

- **Activate prior knowledge:** Create a discussion about the results of yesterday's data collection on the most common color in a bag of M&Ms. Lead the class to discover that an efficient way to display the entire class's data is necessary. Select student Exit Tickets from Day 1 to share with the class in order to generate ideas.
- **Be sure the problem is understood:** Allow students to ask questions about the task to a table partner or to the teacher.
- **Establish clear expectations:** Introduce the term, *frequency table*, and select several volunteers to create a frequency table that depicts the entire class's results from yesterday's data collection.
 - Teacher will introduce the directions for completing the data collection project that will be completed throughout the remainder of the week. ****See separate instruction page****
 - Today students are expected to determine a question to research, create a plan for collecting data, and complete a frequency table displaying their results.

During:

- **Let go:** Allow students to form small groups and begin brainstorming and predicting the answers to data-driven questions. They will narrow down their choice to one question they will research.
- **Listen actively:** Students will effectively collaborate within their groups, share their reasoning, and record their ideas.
- **Provide appropriate support:** Guide groups who are struggling with generating a data-driven question by having them think about appropriate ways to collect data.
- **Provide worthwhile extensions:** Encourage students to think of deep-level questions that require both surveys and outside research.

After:

- **Promote a mathematical community of learners:** Students will present their questions and predictions to the class. Their classmates will make suggestions or comments about the quality of their data.
- **Listen actively without evaluation:** Thank students for sharing their work and ask follow-up questions.
- **Make connections:** The teacher will guide students into making connections with the thinking of their peers. Point out similarities between research plans, predictions, and frequency tables. Ask students to explain how they could use frequency tables outside of school.
- **Summarize main ideas:** Guide students into understanding that frequency tables are efficient tools for organizing collected data.

ASSESSMENT

Observe: Observe that students are engaged in a collaborative discussion about the process of collecting data. They should also participate in offering suggestions to other groups. Check for accuracy in data tables and that Brainstorming Record Sheet has been completed.

Ask: Exit Ticket: Create a frequency table and answer a question about the following information.

****See Exit Ticket Day 2***

Mathematics: The Language of STEM
Data Analysis and Statistics
Day 3 Lesson
Janna Simcoe, Rachel Jensen, Tori Reneker

CONTENT AND TASK DECISIONS

Grade Level(s): 5

Description of the Task: Students will work in groups to generate and predict data driven questions, plan and collect data, and create line plots.

Indiana Mathematics Content Standards:

5.DS.1: Formulate questions that can be addressed with data and make predictions about the data. Use observations, surveys, and experiments to collect, represent, and interpret the data using tables (including frequency tables), line plots, bar graphs, and line graphs. Recognize the differences in representing categorical and numerical data.

Indiana Mathematics Process Standards:

PS.1: Make sense of problems and persevere in solving them.

- Students will create a question and determine a way to collect and continually revise their predictions and methods (to collect their data) used throughout the unit.

PS.4: Model with mathematics.

- Students will activate prior knowledge and continually explore line plots and frequency tables.

PS.5: Use appropriate tools strategically.

- Students will utilize books or iPads to research their question and select an appropriate table for that represents their data.

Mathematics Content Goals: Students will understand that data collection includes asking a researchable question, formulating a prediction, determining various methods of data collection, and creating a line plot to organize their results.

Language Objectives:

- Students will listen to the ideas presented by their partners and make agreements about their research methods.
- Students will record their research on a line plot.
- All learners will build vocabulary including: *line plot (a graph that shows frequency of data along a number line)*

Materials:

- Day 2 Exit Ticket
- Data collection results from Day 2
- Data collection results from Day 1

THE LESSON

Before:

- **Activate prior knowledge:** Review the class frequency table from Day 2 about the most common color in a bag of M&Ms. Lead the class to discover that another efficient way to display the entire class's data is a line plot. Ask students about their previous experiences with line plots.
- **Be sure the problem is understood:** Allow students to ask questions about the task to a table partner or to the teacher.
- **Establish clear expectations:** Introduce the term, *line plot*, and select several volunteers to create a line plot that depicts the entire class's results from the M&M data collection.
 - Today students are expected to finish any incomplete tasks from yesterday's lesson and make a line plot to display the results of their research and surveys.

During:

- **Let go:** Allow students to continue conducting research about their chosen question and work collaboratively to design a line plot.
- **Listen actively:** Students will effectively collaborate within their groups, share their reasoning, and record their ideas.
- **Provide appropriate support:** Guide groups who are struggling with making a line plot by showing them more examples or explanations.
- **Provide worthwhile extensions:** Encourage students to explore real-world applications for making line plots.

After:

- **Promote a mathematical community of learners:** Students will present their line plots to the class. Their classmates will make suggestions or comments about the quality of their work.
- **Listen actively without evaluation:** Thank students for sharing their work and ask follow-up questions.
- **Make connections:** The teacher will guide students into making connections with the thinking of their peers. Point out similarities between frequency tables and line plots. Ask students to explain how they could use line plots outside of school.
- **Summarize main ideas:** Guide students into understanding that line plots are efficient tools for displaying collected data.

ASSESSMENT

Observe: Observe that students are engaged in a collaborative discussion about the process of collecting data. They should also participate in offering suggestions to other groups. Check for accuracy in line plots and that previous requirements have been completed.

Ask: Exit Ticket: Create a line and answer a question about the following information. **See Exit Ticket Day 3*

Mathematics: The Language of STEM
Data Analysis and Statistics
Day 4 Lesson
Janna Simcoe, Rachel Jensen, Tori Reneker

CONTENT AND TASK DECISIONS

Grade Level(s): 5

Description of the Task: Students will work in groups to collect data and create line graphs and bar graphs that represent the data collected.

Indiana Mathematics Content Standards:

5.DS.1: Formulate questions that can be addressed with data and make predictions about the data. Use observations, surveys, and experiments to collect, represent, and interpret the data using tables (including frequency tables), line plots, bar graphs, and line graphs. Recognize the differences in representing categorical and numerical data.

Indiana Mathematics Process Standards:

PS.1: Make sense of problems and persevere in solving them.

- Students will create a question and determine a way to collect and continually revise their predictions and methods (to collect their data) used throughout the unit.

PS.4: Model with mathematics.

- Students will activate prior knowledge and continually explore bar graphs and line graphs.

PS.5: Use appropriate tools strategically.

- Students will utilize books or iPads to research their question and select an appropriate table for that represents their data.

Mathematics Content Goals: Students will understand that data collection includes asking a researchable question, formulating a prediction, determining various methods of data collection, and creating line graphs and bar graphs.

Language Objectives:

- Students will listen to the ideas presented by their partners and make agreements about their research methods.
- Students will record their research on bar graphs and line graphs.
- All learners will build vocabulary including *bar graph* and *line graph*.

Materials:

- Day 3 Exit Ticket
- Graph paper
- Data collection results from Day 1-3
- Day 4 Exit Ticket

THE LESSON

Before:

- **Activate prior knowledge:** Review the class frequency table from Day 2 about the most common color in a bag of M&Ms. Lead the class to discover that another efficient way to display the entire class's data are line graphs and bar graphs. Ask students about their previous experiences with line graphs and bar graphs.
- **Be sure the problem is understood:** Allow students to ask questions about the task to a table partner or to the teacher.
- **Establish clear expectations:** Display a blank bar graph and a line graph. Instruct the class to determine appropriate labels and values for the graphs based on the results of the class M&M frequency table.
 - Upon completion, the students will be divided into two groups: *similarities* and *differences*. One group will explore the similarities between the bar graph and line graph, while the other group will explore the differences between the two. They will share their observations with a person from the opposite group.
 - Suggested questions: What are the benefits of using a line graph instead of a bar graph? What about a bar graph instead of a line graph?
 - Today students are expected to finish any incomplete tasks from yesterday's lesson and make a line graph and bar graph to display the results of their research and surveys.

During:

- **Let go:** Allow students to continue conducting research about their chosen question and work collaboratively to design a line graphs and bar graphs.
- **Listen actively:** Students will effectively collaborate within their groups, share their reasoning, and record their ideas.
- **Provide appropriate support:** Guide groups who are struggling with making a line graph and a bar graph by showing them more examples or explanations.
- **Provide worthwhile extensions:** Encourage students to explore real-world applications for making line graphs and bar graphs.

After:

- **Promote a mathematical community of learners:** Students will present their line graphs and bar graphs to the class. Their classmates will make suggestions or comments about the quality of their work.
- **Listen actively without evaluation:** Thank students for sharing their work and ask follow-up questions.
- **Make connections:** The teacher will guide students into making connections with the thinking of their peers. Point out similarities between line graphs and bar graphs. Ask students to explain how they could use the graphs outside of school.
- **Summarize main ideas:** Guide students into understanding that line graphs and bar graphs are efficient tools for displaying collected data.

ASSESSMENT

Observe: Observe that students are engaged in a collaborative discussion about the process of collecting data. They should also participate in offering suggestions to other groups. Check for accuracy in line graphs and that previous requirements have been completed.

Ask: Exit Ticket: Create a line graph or bar graph and answer a question about the following information. **See Exit Ticket Day 4*

Mathematics: The Language of STEM
Data Analysis and Statistics
Day 5 Lesson
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CONTENT AND TASK DECISIONS

Grade Level(s): 5

Description of the Task: Students will work in groups to explore the concept of average by measuring the lengths of pencils and determining the center measure of all of them. They will create a method for determining the mean and median for a set of data.

Indiana Mathematics Content Standards:

5.DS.2: Understand and use measures of center (mean and median) and frequency (mode) to describe a data set.

Indiana Mathematics Process Standards:

PS.1: Make sense of problems and persevere in solving them.

- Students will create a question and determine a way to collect and continually revise their predictions and methods (to collect their data) used throughout the unit.

PS.8: Look for and express regularity in repeated reasoning.

- After exploration, students will discover the formulas for the mean, median, and mode.

Mathematics Content Goals: Students will understand that mean and median are measures of the center (middle) point in a set of data and that the average can be used to gain new insights about data.

Language Objectives:

- Students will justify their conjectures about finding average with partners and the whole group.
- Students will listen to the ideas presented by their partners and make agreements about how to determine average.
- Students will record their thinking in written form.
- All learners will build vocabulary including *mean*, *median*, and *average*.

Materials:

- Day 4 Exit Ticket
- Data collection results from Day 1-4
- Graph paper
- Day 5 Exit Ticket

THE LESSON

Before:

- **Activate prior knowledge:** Review the results of the Exit Tickets from Day 4. Have several students share their bar graphs and line graphs and ask the class to compare and contrast the

different properties of both. Return the papers and have the students work in pairs to determine the middle number in the data set.

- Re-collect students and have them share their methods for finding the middle number.
- Sample questions: How do you know that is the middle number? Is there another way to find the middle? How are the strategies that have been shared similar?
- **Be sure the problem is understood:** Allow students to ask questions about the task to a table partner or to the teacher.
- **Establish clear expectations:** Introduce the terms *average*, *median*, and *mean*. Explain today's task. They will work with a partner to find the mean of a data set about the lengths of various pencils. ****See Pencil Mean Sheet****

During:

- **Let go:** Allow students to practice productive struggle by working through the task with minimal direct instruction.
- **Listen actively:** Students will effectively collaborate within their groups, share their reasoning, and record their ideas.
- **Provide appropriate support:** Guide groups who are struggling to find the middle number by showing them more examples or explanations.
- **Provide worthwhile extensions:** Encourage students to explore real-world applications for finding mean.

After:

- **Promote a mathematical community of learners:** Students will present their solutions about the middle number in a set of data to the class. Their classmates will make suggestions or comments about the quality of their work.
- **Listen actively without evaluation:** Thank students for sharing their work and ask follow-up questions.
- **Make connections:** The teacher will guide students into making connections with the thinking of their peers. Point out similarities between methods. Ask students to explain how they could use mean outside of school.
- **Summarize main ideas:** Guide students into understanding that mean is the measure of the middle number in a set of data. The mean can be used to make assumptions about data.

ASSESSMENT

Observe: Observe that students are engaged in a collaborative discussion about the process of finding mean. They should also participate in offering suggestions to other groups. Check for accuracy in their thinking and that previous requirements have been completed.

Ask: Exit Ticket: Answer reflection questions about collecting data. ****See Exit Ticket Day 5***

Mathematics: The Language of STEM
Data Analysis and Statistics
Day 6 Lesson
Janna Simcoe, Rachel Jensen, Tori Reneker

CONTENT AND TASK DECISIONS

Grade Level(s): 5

Description of the Task: Students will work in groups to compete in a classroom Olympics activity. They will complete five physical tasks, record their data, and calculate the mean, median, and mode for their team. Teams will create one graph of their choice (line plot, line graph, bar graph) to present to the class. Classmates will provide feedback on the quality of their presentations in order to make improvements on their final presentations that will be conducted on Day 8.

Indiana Mathematics Content Standards:

5.DS.2: Understand and use measures of center (mean and median) and frequency (mode) to describe a data set.

Indiana Mathematics Process Standards:

PS.1: Make sense of problems and persevere in solving them.

- Students will create a question and determine a way to collect and continually revise their predictions and methods (to collect their data) used throughout the unit.

PS.4: Model with mathematics.

- Students will use bar graphs, line graphs, and line plots to display data.

PS.8: Look for and express regularity in repeated reasoning.

- After exploration, students will use the formulas for the mean, median, and mode to present insights into a set of data.

Mathematics Content Goals: Students will understand that statistical information can be presented in a variety of ways, including bar graphs, line plots, and line graphs, and that selecting an appropriate graph depends on the type of data collected. Mean, median, and mode can be used to make determinations about the collected data.

Language Objectives:

- Students will justify their conjectures about finding average with partners.
- Students will listen to the ideas presented by their partners and make agreements about how to determine average.
- Students will record the results of the mean, median, and mode activity on a table.
- All learners will build vocabulary including *mean*, *median*, and *average*.

Materials:

- 3M Olympics Recording Sheet
- Jump ropes
- Tennis balls or racquet balls
- Graph paper

THE LESSON

Before:

- **Activate prior knowledge:** Reference the frequency table from the class M&M activity and have the students calculate the mean and median of the data. Have several students share their methods of finding the average amount of M&M color. Review the concept of mode as being the number that occurs most often in a set of data. Have students share their methods of determining the mode with the M&M data. Ask the students why finding mean, median, and mode are important in real-life situations.
- **Be sure the problem is understood:** Allow students to ask questions about the task to a table partner or to the teacher.
- **Establish clear expectations:** **See *During* explanation.

During: Students will work in groups to collect data about five different physical tasks. (3M Olympics) They will record the results for each group member on their 3M Olympics Record Sheet. Upon completion of all five tasks, the group members will work together to calculate the mean, median, and mode for each activity. Lastly, they will represent their data on one graph of their choice and present it to the class. They must also explain why their chosen graph was the best way to share their data.

- **Let go:** Allow students to practice productive struggle by working through the task with minimal direct instruction.
- **Listen actively:** Students will effectively collaborate within their groups, share their reasoning, and record their ideas.
- **Provide appropriate support:** Guide groups who are struggling to find the median or mean by reference the pencil measuring activity in the previous day's lesson.
- **Provide worthwhile extensions:** Encourage students to explore real-world applications for finding mean, median, and mode. Allow students who finish early to create another graph to share with the class.

After:

- **Promote a mathematical community of learners:** Students will present their graphs to the class, while the class provides feedback about the strengths and areas for improvement. Students can write their feedback on sticky notes.
- **Listen actively without evaluation:** Thank students for sharing their work and ask follow-up questions.
- **Make connections:** The teacher will guide students into making connections with the thinking of their peers. Point out similarities between methods. Ask students to explain how they could use mean, median, and mode outside of school.
- **Summarize main ideas:** Guide students into understanding that mean and median are both measures of the middle number in a set of data. Mode shows the most frequently occurring number. The mean, median, and mode can be used to make assumptions about data.

ASSESSMENT

Observe: Collect the graphs that students created today.

Ask: Exit Ticket: How will you improve your graph or presentation based on the feedback of your classmates?

Mathematics: The Language of STEM

Data Analysis and Statistics

Day 7 Lesson

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Today the students will make final preparations for their presentations about the question they researched throughout the unit. Students may be divided into groups based on their knowledge and ability to calculate mean, median, and mode, or with their ability to create various types of graphs. By the end of the lesson students should have rehearsed their presentations and finished all required graphs on poster board or other software.

Mathematics: The Language of STEM

Data Analysis and Statistics

Day 8 Lesson

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Today the students will present their research projects to the class and complete a personal reflection about their work throughout the unit.