

# Annotated Examples: M100 Quantitative Reasoning

The examples that follow are intended to illustrate how the learning principles are used to support students' engagement with the content and practices outlined in this badge. These examples do not provide comprehensive coverage of those expectations, but rather elevate some of the learning principles that are less likely to be part of published curricular materials for mathematics instruction. The examples that follow were developed by the Math Badging writing team, unless otherwise specified. These are a small sample of types of learning activities that can be done with students, both in and out of a traditional classroom setting.

## Example 1: When Math Gives You Lemons...



Students are given a task like this:

*Ayhan found his great grandmother's recipe for lemon cake. He mixed all the ingredients together in his 3-quart mixing bowl and noticed the batter almost filled up the bowl.*

*Now he has to determine which baking pan to use. He has a set of pans that include the following:*

- *A loaf pan that measures 8.5 inches by 4.5 inches by 2.5 inches*
- *A square pan that measures 8 inches by 8 inches by 2 inches*
- *An oblong pan that measures 13 inches by 9 inches by 1.75 inches*

*Which pan(s) should he use?*

### Sample Learning Activity

Launch this prompt by asking students to share what they know about baking. Do they have any recipes that are really important to them personally or to their families? Chart ideas that surface so that students can reference later. Allow students to search baking tips as needed.

Give students some quiet work time to consider their approach and response. Monitor students as they

work. Look for students who make simplifying assumptions, as well as students who use expressions and equations to reason about this prompt. Look for students who recognize baking pans should not be filled to the brim, since the batter will spill over in the baking process. Select students with varied approaches to share their thinking with the class.

**Consider the following questions to engage students in their own and each other’s work:**

- *What’s promising about your approach?*
- *What additional questions does your approach bring up for you?*
- *Do you think your own approach is reasonable? Why or why not?*
- *Engage with a peer. What’s promising about their approach?*
- *What additional questions does your peer’s approach bring up for you?*
- *What do you notice about your own thinking and the thinking of your peers?*

Be sure to make visible any simplifying assumptions students make, as well as any insights offered about baking that come from student experience and research. Prompt students to explain the meaning of the numbers and any other relevant quantities used in their model.

Once different approaches have been shared, students could be given an opportunity to revise their work.

In this example, students are:

- given a cognitively demanding task. It requires that students model with geometry using an authentic real-world situation (LP 1).
- set up to have social interactions, working both individually and in partnership with others, as well as share and compare their methods (LP 2).
- deepening their understanding of the conservation of volume, considering the geometric attributes of everyday objects, and looking for the relationship between various measures of volume (LP 3).
- able to bring in lived experiences grounded in baking and use that knowledge to solve mathematical problems (LP 4).
- able to develop an appreciation of mathematics as a human endeavor, as students see simple things like recipes as both mathematical and generational (LP 5).
- able to engage with mathematics in ways that authentically involve real-world situations as well as have the opportunity to recognize that mathematical modeling is something we do even when it comes to finding the right container to bake a cake (LP 6).
- able to use technology as a tool, as they use computational aids such as software or calculators to aid in making calculations (LP 7).

Through the implementation of this learning activity, look for opportunities to support students’ growth and development on this XQ Competency:



**Computational Thinking:** [Using computational tools \(FL.MST.1.b\)](#)

## Example 2: Designing a Fitness App

Students are given a problem like this:

Your school is sponsoring a walk-a-thon to raise funds for a new computer lab. You have been asked to work with an app developer to create a new fitness app for participants to use before, during, and after the walk-a-thon.

The app developer needs you to complete the following tasks before the actual programming for the app can begin.

1. Draft a flowchart which outlines how a fitness app will work for the walk-a-thon.
2. Design a table which organizes key quantities of interest for a walk-a-thon participant using your favorite tech tool.
3. Finalize a flowchart with all the features the app should include.

**Note:** A flowchart is a picture of the separate steps of a process in sequential order. It is a generic tool that can be adapted for a wide variety of purposes, and can be used to describe various processes, such as a manufacturing process or a project plan.

### Part A: Let's make sense of the task.

- What things do you think people do to prepare for a walk-a-thon?
- What kinds of questions do you think people will want the app to be able to answer?
- What kinds of information will you need to answer these questions?
- What measurable quantities do you think the app should be able to capture and record?
- What are the mathematical relationships between the various quantities you've identified and the questions folks might have?
- What additional factors do you think need to be considered when creating an app that helps folks prepare for this walk-a-thon?

### Part B: Explore existing fitness apps and draft the flow of your new app.

- Take some time to learn more about popular fitness apps currently available. Try out free apps [<https://www.garagegymreviews.com/best-free-workout-apps>] or interview people you know who use fitness apps to learn more about this product.
  - What new understandings do you have about how these apps function?
  - What quantities do you see displayed for the user?
  - How are relationships between quantities used to provide information that is useful to the user?
  - What new understandings about the relationships between the quantities identified in Part A do you have?
- Based on your current understanding of apps, preparing for physical activity, the quantities you identified, and the relationships between those quantities, what kind of information do you think would be helpful to capture and record?
- Create a draft of a flowchart which shows the steps of how the app you envision would work

### Part C: Design a table and a second draft of your app flowchart.

- Use spreadsheets or other tech tools to design a table or program that could be used within your app to capture information from the user to produce quantities of interest. Describe the mathematical relationships your table is designed to use.
- Test out your table or program with people you know. What new insights do you have?

**Part D: Reflect and revise.**

- What worked well about the table or program you designed? What did not? How would you modify what you have? Create a sample screenshot of how you envision this aspect of your app to work. Describe the mathematical relationships in play. What are the limitations of the model you designed? What ideas for future development do you recommend?
- Revisit the flowchart you drafted earlier in the process. What modifications would you make? Make a third draft of the flow of your app.
- What surprised you about this process?

**Extending the Learning** (Optional)

1. Explore the work of software engineers, architects, and developers. [[Principal Software Engineer vs Architect vs Developer | NCube](#) ] What elements of what you accomplished fit under each of these roles? What new insights do you have about this field?
2. One approach to app development is to build apps that have a wide range of applications. Having the ability to reuse core aspects of a program for different functions gives programs the ability to increase their earning potential. Consider the following group of possible participants. What would you add or modify to your app to make this something every person could continue to use beyond the walk-a-thon event?

Name	Age (years)	Height (feet)	Weight (lbs.)	Activities	Workout 1	Workout 2	Workout 3
Nico	15	5'10"	120	Cross country running, track and field	5k run 18:36 min.	5k run 20:01 min.	5k run 17:46 min.
Raj	44	6'0"	175	Tennis, swim	Tennis 2 hrs.	Tennis 2 hrs.	Tennis 2 hrs.
Maura	51	5'4"	140	Walking, dancing	Walk 30 min.	Dance 1 hr.	Walk 40 min.

**Sample Learning Activity**

As students work through the different parts of this task, they could be prompted to discuss their approaches in small groups or partnerships. The teacher can select student work strategically and pose questions such as these:

- *What's promising about this approach?*
- *What questions does this approach surface for you?*
- *Do you think the model is reasonable? Why or why not?*

- *What can you take from this approach to apply to your own work?*
- *What additional questions could be answered about this context using some of the models we've seen? Are some models more helpful than others in answering these additional questions?*

Following the discussion, students are given an opportunity to reflect on and revise their work. As students share their work: elevate key mathematical aspects of their work, such as the relationships between the quantities they've chosen; bring to light any underlying assumptions in play; and as appropriate, probe about degree of accuracy in figures presented. Some questions are as follows: *When and how does your model round? To what degree? Does that make sense? Why or why not?*

Provide access to various tools as students put together a presentation of their designs. Once presentations have been shared, students could be given an opportunity to revise their work.

### **Additional Resources**

Part B: Exploring existing apps and drafting the flow of your app

- [Fitness App Development: Types, Features, and Costs | Mobindustry](#)
- [Best Fitness Apps Of 2022 – Forbes Health](#)
- [Best Fitness and Exercise Apps](#)
- [The Best Fitness Apps of 2022 - SI Showcase](#)
- [Best Workout Plan Apps to Learn From | Mobindustry](#)

Part C: Designing a table and second draft of app flowchart

- [Computer Science: Algorithms](#)
- [Computer Science: Sequences, Selections, and Loops](#)
- [Software Design Patterns in C++ & UML – Hi I'm Simon](#)

In this example, students are:

- given a cognitively demanding task. It requires students to develop a conceptual model for an app that utilizes user data as the basis of mathematical computations for the purposes of predicting quantities of interest (LP 1).
- set up to have social interactions, as they share and discuss their work with each other. These interactions may happen live in a physical classroom or asynchronously in a remote setting (LP 2).
- deepening their understanding of identifying key quantities and mathematical relationships needed to make useful models for fitness choices (LP 3).
- able to explore areas of interest and develop a lens for aspirations, as they consider the work of programmers, developers, and architects (LP 4).
- able to develop an appreciation of mathematics as a human endeavor, as students see how the application of ratio reasoning is used to make fitness choices (LP 5).
- able to engage with mathematics in ways that authentically involve real-world situations as well as have the opportunity to develop a conceptual model for a fitness app (LP 6).
- able to use technology as a tool, as they use computational aids such as software or calculators to aid in making calculations (LP 7).

Through the implementation of this learning activity, look for opportunities to support students' growth and development on this XQ competency:



**Interpreting Information:** [Information management \(OT.Crit.1.c\)](#)

**Example 3: Care to Compost**

Students are given a task like this:

*The United States Environmental Protection Agency (EPA) “estimates that more food reaches landfills and incinerators than any other single material in our everyday trash, constituting 24 percent of the amount landfilled and 22 percent of the amount combusted with energy recovery.” [source: [Regional Resources to Reduce and Divert Wasted Food Across the United States | US EPA](#) ]*

*A study completed by The Drawdown Review: Climate Solutions for a New Decade shared “composting organic waste versus landfilling can reduce more than 50% of carbon dioxide-equivalent greenhouse gas emissions, for a total of 2.1 gigatons between now (2020) and 2050 if climate change is curbed to a 2 degree Celsius rise in the average global temperature.” [source: [The ComPOSTer: How much can composting help in solving the climate challenge? \[UPDATED\]](#) ]*

How do you organize your waste at home? Prepare to share with your classmates.

Watch this video on landfills and waste to understand how our waste accumulates and what challenges exist.

<https://thinktv.pbslearningmedia.org/resource/930d15c4-5137-46f3-a9d8-39b8cd8d27f9/930d15c4-5137-46f3-a9d8-39b8cd8d27f9/>

We have learned about challenges and solutions with food waste from the New Jersey and Seattle examples. Let's now consider food waste in your community. Search for articles and videos on food waste from where you live. Find and record important data about food waste management (or waste management in general) and the resulting costs, monetary and otherwise.

- *What resonates with you?*
- *What questions do you have now?*
- *What information is helpful to design your Public Service Announcement (PSA)?*
- *How can you persuade community members to take your advice?*

*Develop a public service announcement (PSA) in the form of an infographic or advertisement (suitable for radio, social media, or television) to inform your community about ways they can help minimize the amount of food and organic waste that goes into landfills.*

*Your PSA should include information that informs your community about:*

- *waste trends in your local area*
- *the long-term impact of current trends*

- *ways to change current trends for positive impact*

Your PSA should:

- *identify relevant quantities*
- *use appropriate graphical displays of these quantities*

### **Additional Resources**

Part 1: Making sense of waste management

- [Wasted Food Programs and Resources Across the United States | US EPA](#)
- [National Overview: Facts and Figures on Materials, Wastes and Recycling | US EPA](#)
- [The ComPOSTer: How much can composting help in solving the climate challenge? \[UPDATED\]](#)

Part 2: Making sense of infographics

- [Food Waste — Information is Beautiful](#)
- [Consumers | USDA](#)

Part 3: Making sense of composting efforts

- [Composting efforts gain traction across the United States - The Washington Post](#)
- [Beginner's Guide to Composting | One Small Step | NowThis](#)
- [Composting for Beginners | The Dirt | Better Homes & Gardens](#)
- [6 Different Ways To Compost, No Matter Where You Live](#)
- [Why is composting so hard in the United States? | Greenbiz](#)
- [https://achievethecore.org/content/upload/Modeling-Task\\_Landfill\\_Final\\_2\\_6\\_20.pdf](https://achievethecore.org/content/upload/Modeling-Task_Landfill_Final_2_6_20.pdf)

In this example, students are:

- given a cognitively demanding task. It requires that students make sense of the waste management process, human impact on climate change, and the quantities involved in communicating these relationships (LP 1).
- set up to have social interactions, as they develop, share, and compare their approaches (LP 2).
- deepening their understanding of number, quantities, and mathematical modeling in order to design a product that informs community members. As students make sense of these phenomena and apply their understanding of math concepts, like proportional reasoning, students have the opportunity to represent their findings in a way that educates community members (LP 3).
- able to make visible the ways mathematics is used to quantify and describe the actions and impact of waste and waste management, as they explore quantities of interest within this context (LP 4).
- able to develop a sense of belonging and ability to make an impact in their communities as they share their products through various outlets. This process offers students opportunities to broaden their ideas about what mathematics is, how it is used, and who it is for (LP 5).
- able to engage with mathematics in ways that authentically involve real-world situations as well as have the opportunity to recognize simple cases of mathematical modeling (LP 6).
- able to use technology as a tool, as they use computational aids such as software or calculators to aid in making calculations (LP 7).

Through the implementation of this learning activity, look for opportunities to support students' growth and development on this XQ Competency:



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