Overview

A sim-based math lesson includes the sim as a central learning tool, an activity sheet to guide student thinking, and teacher facilitation moves to create a student-centered environment.

Students work directly with a sim using individual or shared devices, record their thinking on an activity sheet, and engage in discussion within groups while the teacher facilitates and leads whole-class discussions.

Preparing to design a lesson

- Play with the sim!
- Consider the number of devices and desk arrangement
- Consider 2-3 learning objectives over 1-2 days
- Brainstorm challenge prompts
- Think about how you will measure/assess student learning
- Consider how to differentiate and provide multiple entry points for all students to be successful

Goals of the lesson

- Student-centered: fosters an environment that values student ideas and promotes student agency
- Responsive: adapts to emergent student ideas
- Goal-oriented: includes clear learning objectives and summary
- Guided: uses an activity sheet to guide student inquiry

Goals of the activity sheet

- Student-centered: a place to record thoughts and discoveries
- Sim-focused: positions the sim as the central learning tool
- Scaffolded: uses open-ended challenge prompts and tables to keep ideas organized, but keeps the length manageable and avoids explicit instruction on how to use the sim
- Modular: has places to pause for discussion
### Sample lesson flow

<table>
<thead>
<tr>
<th>Timing</th>
<th>Students...</th>
<th>Teacher...</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-8 mins</td>
<td>(Optional) Work through warm-up problem, such as introduction to topic, hook, or opportunity to activate relevant prior knowledge.</td>
<td>(Optional) Conducts typical daily routines</td>
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<tr>
<td>3-8 mins</td>
<td>Freely explore the sim (open play).</td>
<td>Circulates, listening to student conversations and probing students to experiment with the sim</td>
</tr>
<tr>
<td>5-8 mins</td>
<td>Share discoveries from open play.</td>
<td>Allows students to drive the sim in front of the class</td>
</tr>
</tbody>
</table>
| 10-20 mins | Work through activity sheet part 1 in small groups (2-4 students), discussing ideas where indicated. | Circulates the room, helping students who might be stuck or need redirection. Listen for examples that students can share later in the discussion. Sample questions include:  
- “How do you know?”  
- “Can you share that later with the class?”  
- “I wonder…”  
- “What would happen if…”  
- “Wow! What do you think is happening there?”  
- “Does that tool help you answer this question?” | Checks for understanding: look at answers to the questions you’ve identified as checkpoints. Has informal, small-group discussions where appropriate, but save student ideas for the whole-class discussion as well. |
| 5-10 mins | Participate in whole-class discussion, engaging in argumentation and reasoning. | Facilitates whole-class discussion, calling on a variety of students to share ideas from part 1 of activity sheet.  
- Use sim to test predictions or provide evidence for claims  
- Highlight key ideas | Uses the discussion as a checkpoint for the class. |
| 10-20 mins | Work through activity sheet part 2 in small groups (2-4 students), discussing ideas where indicated. | Circulates the room, helping students who might be stuck or need redirection. Listen for examples that students can share later in the discussion. |
| 5-10 mins | Summarize key ideas from lesson, | Facilitates a whole-class discussion to address learning goals and summarize discoveries. |
| 5 mins | Complete exit ticket (optional). | Provides an exit ticket to check for individual student understanding. |
Activity sheet guidelines

- Keep it short so as not to overwhelm, with space for writing ideas (approximately 2 pages)
- Provide explicit stopping points for discussion(s) and prepare discussion questions
- Use sim-focused challenge prompts that generate discussion, support student autonomy, and encourage a variety of answers and approaches, allowing for peer comparison and discussion:
  - Find all the ways to... make a necklace with the same bead pattern.
  - What’s the largest... fraction you can make?
  - Create... an atom with a net charge of zero.
  - What are two ways to... combine coins?
  - How can you make... the outputs... bigger?
  - Develop a procedure for... solving equations with two variable terms.
  - Name... the different parts of the function builder.
  - Build... two ratios that are equivalent.
  - How do you know... your two ratios are equivalent?
  - Before & after example: (learning goal is for students to discover GCF)
    - Before: Build a necklace with 6 red beads and 8 blue beads. What do you notice about the number of times the pattern repeats?
    - After: Build a necklace with a pattern that repeats 2 times. Compare with your partner. What do you notice about both ratios?
- Scaffold with tables to provide structure and reduce drawing load

<table>
<thead>
<tr>
<th>Protons</th>
<th>Net Charge</th>
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<tbody>
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<td></td>
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</table>

2. Build two different atoms with a **positive net charge**, then record some information about your atoms in the tables and diagrams below.

<table>
<thead>
<tr>
<th>Patterns that repeat 3 times</th>
<th>My pattern</th>
<th>My partner’s pattern</th>
<th>Challenge: A third pattern!</th>
</tr>
</thead>
</table>

- Allow extra time for unexpected learning opportunities

Reflection strategies

- Consider inviting a colleague to observe
- Consider using a reflection rubric
- Make tweaks for the future (and update your activity on the PhET website!)

For more information, see:
- Activity sheet guidelines
- Facilitation strategies