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Game Design as Authentic Science: Creating Low-Tech Games that Do Science

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LEARNING CONNECTIONS: Powering Up Homemade PowerPoint Games

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Many students love everything about video games, so teaching them to use technology to design their own games around content is an assignment that can offer built-in engagement. The problem, however, is that teachers often don't have the time or expertise to teach computer programming, let alone content and process skills. On top of that, installing game design software can create friction between the teaching staff and technology department.

That's where Microsoft PowerPoint comes in. Did you know you can help your students create—from scratch or from a template—a video game using PowerPoint?

Although PowerPoint is not a true programming platform, there are elements of computational thinking in the design of a homemade PowerPoint game. Linking a story to questions, creating and debugging multiple and nonlinear paths of the slides, and creating a logical flow to a game (checkpoints, increased difficulty, etc.) are all tasks that are complex, open ended, and ambiguous, and that require persistence, especially in the debugging process.

A game design project also meets the ISTE Standards for Students. After all, the game itself is a creative endeavor where groups of students build artifacts that demonstrate content knowledge in a novel format (Standard 1). This is especially true when designing a game using a platform that has limitations, such as PowerPoint. The same justifications for computational thinking are similar to Standard 4 (critical thinking, problem solving, decision making). In most games, players must achieve a goal by correctly answering a series of multiple-choice questions. Each choice is an action button that sends players to a slide indicating whether their answer was correct or incorrect. Action buttons send the players to a predetermined slide rather than the next slide in the deck. Therefore, the novel use of PowerPoint (learning about and applying the action button feature) and troubleshooting aspects of the game design project align with Standard 6 (technology operations and concepts).

Designing games develops many other valuable skills, such as writing in a clear and concise way. Games have rules and objectives, and students must describe the narrative and rules succinctly, just like commercial board games, which usually print the rules on the back of the box.

This type of project also requires students to develop planning and organization skills. They must choose whether their games will be completely contained within a PowerPoint file, or whether they will include game boards, scorecards, dice, and game pieces. If an external game board is required, students will need to paste images of the game board on slides with directions to print those slides before the game begins.

Leveling Up the Games

Over a three-year period, we taught game design to students in grades 10–12 in a science classroom at Clarkston High School in Clarkston, Michigan, USA. The course, Environmental Chemistry, was based on the American Chemical Society's Chemistry in the Community curriculum (often called ChemCom). Over the course of the school year, students created games during two of the seven units in the course. The units lasted approximately one month each, and we created games for a unit on the earth's resources and the periodic table as well as a unit on the atmosphere and gas laws. We made improvements to the implementation of the project each year. Here's a list of lesson tips and lessons learned to help you implement PowerPoint games to teach content:

Don't reinvent the wheel. Before you start, check out the University of Georgia's Homemade PowerPoint Games website, which offers resources, templates, and tips about how to pull this off in your classroom. Make it a project. For game design to be a constructionist activity, it has to be a unit project. A homemade PowerPoint game is not a Jeopardy-style review game. Students should learn the content while they work on all aspects of the game. Using a choose-your-own-adventure model rather than a drill-and-practice approach requires more rigor on the part of students and leads to more authentic science questioning and problem solving.

Limit computer lab time. Creating games across a longer stretch of time allows for more feedback and fewer days—both overall and consecutive—in the computer lab. When students spend multiple consecutive days in the lab, we noticed that "lab fatigue" sets in. Remember, if it can be done outside of the computer lab, do it outside of the computer lab.

Theme matters. Perhaps the most difficult part of designing a content-based game is tying the theme directly to the narrative. We've seen students spend too much time creating outlandish narratives that were unrelated to the content. We've also watched students create "save the princess" games, where the players never revisit the narrative once the students begin to play the game. Those games become nothing more than drill-and-practice exercises after the introductory slides.

Emphasize for your students the importance of integrating the theme into the game itself. Students should follow these steps:

1. Plan the narrative using a graphic organizer (see page 63 of this document).
2. Write a first draft of questions.
3. Revise and order the questions (by increasing difficulty) using the organizer to add context.

We told students to base their narratives on the themes in ChemCom. For example, one game focused on the design of a coin. ChemCom's materials unit covered topics such as physical and chemical properties, redox reactions, layers of the earth, and factors to consider when mining for resources.

Teach question writing—and answer writing. Offer question-writing tips and allow time for revision, editing, and teacher feedback on narratives and questions. Also, direct students to use the game to correct errors. We included requirements on the number of knowledge, comprehension, and application questions and made sure students included corrective feedback in their games. At first, student game designers merely indicated that the incorrect answer was wrong. Later, we asked students to explain why the answer was wrong. For example, in a question about Boyd's Law that required a calculation, players might be informed that instead of multiplying two variables, they should have divided them.

By doing this, students begin to create games that contain authentic practices and higher-order problem solving, rather than digital drill-and-practice exercises.

Benefits of Game Design

Although students were generally not excited about the project when it was introduced, they enjoyed it once they got started. We were surprised by the creativity of some of the students, especially as many of them were traditionally disengaged and considered at risk. Often students who in the past had not been engaged in class came up with very creative stories that nicely integrated science process skills.

We saw small increases in performance after each change to the protocol for the game-design project. Over time, those small gains added up, and at the end of the three-year research project, students who created games scored significantly higher on end-of-unit assessments than students who did not.

Game design projects can incorporate multiple disciplines for the content and writing of the narrative. For example, an elementary classroom could use elements of science and social studies in the games' content and narrative, with a focus on a particular writing style. As science education progresses toward more inquiry-based standards, educators will need to design a wide variety of experiences for students to express their abilities in authentic science practices. Designing a game may be one way for students to do so.

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