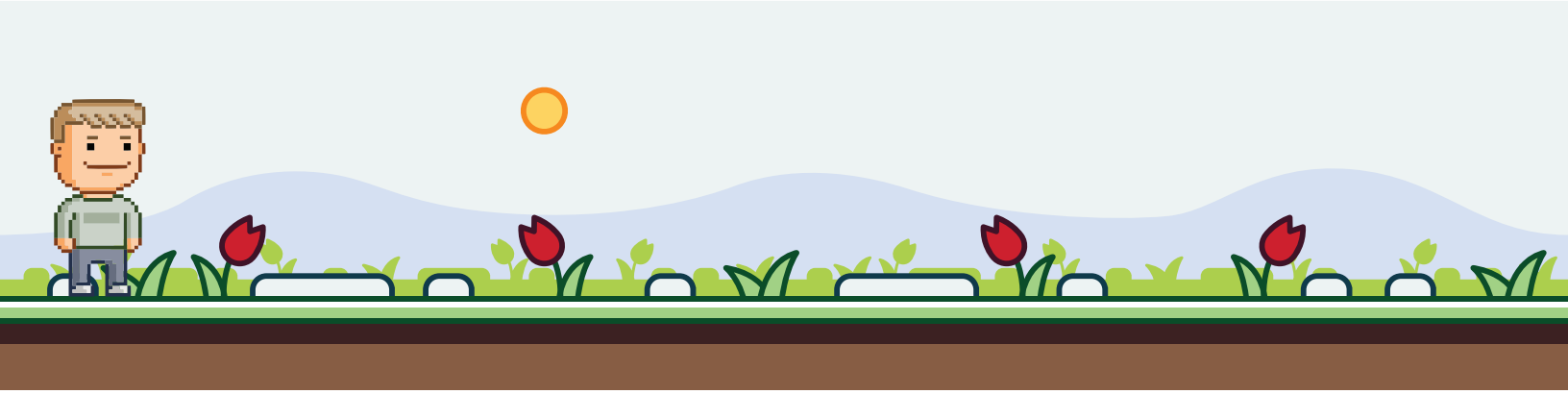

Understanding the Value of Game-based Learning in the K-12 Classroom

Are Games Good or Bad?

Video games have only recently entered the education arena. Understandably, many still associate them with the stereotypical video games that consume hours of students' home lives. Filled as they are with violent images, suggestive content, and captivating graphics, it's no wonder that educators can be apprehensive about game-based learning. Of course, big name console games were designed purely for entertainment, not education. As curriculum designers and pedagogy experts, it's our job to leverage students' love for games as a tool—hand-crafting games, or simulations as we call them in STEMscopes, that mesh the reward systems and graphics of the video game industry with STEM content and critical thinking challenges.

So, rather than thinking of games as good or bad, think about how, ultimately, they are used. Even big-name games can be "good" if they are used to springboard discussions and develop metacognitive skills such as strategy and planning. Still, educational games can be "better," because they are designed with these goals in mind.

Simulations vs. Games—What's the Difference?

The distinction between a simulation and a game stems from the pedagogical difference between game-based learning and gamified learning. A Google search for multiplication games will deliver hundreds of games that students can play straight from their web browser. Games like these ask students to answer questions, perhaps against a clock, in order to play. Essentially, proper demonstration of the content allows students to have fun—they are rewarded for their knowledge. This style of interactive is great for making a "quiz-like" atmosphere more enjoyable and less stressful, but they fail to engage students the more they play: they become routine, predictable, and formulaic. This is gamified learning, and research shows that it does have a place—in math, gamified learning leads to better student outcomes than its more elaborate cousin, game-based learning.

Yet game-based learning is better suited to education, particularly in STEM, because STEM proficiency involves creativity and literacy on top of content knowledge and specific skills. In game-based learning, students are immersed in a micro-world where they take on a role, serve a purpose, and use their knowledge and skills— a far cry from answering multiple choice questions in an application with the veneer of a video game.

STEMscopes had designed dozens of these rich experiences, called *simulations*, wherein students must learn new winning strategies, apply their content knowledge and skills in unique ways, and interact in an engaging story line in order to ultimately beat the simulation. While in gamified learning, teachers receive a report that simply states which questions students answered correctly, game-based learning simulations show students' decisions in ways that reveal their misunderstandings, help weed out guessing, and indicate where intervention and acceleration might be needed. These simulations

do not exist in a vacuum, either: they are integrally tied to the hands-on experiences, readings, and teacher explanations that accompany the content.

Building Student Capacity for STEM

Testing anxiety is a real thing for many of our students. Consider an ELL student who recently arrived in the United States: a 20-question multiple-choice test can be a terrifying experience. The dullness of the printout, the large quantity of dense text, small proportion of graphic images, and the overwhelming urge to guess are common problems for students suffering from this anxiety. A simulation can completely change this scenario by easing the stress of demonstrating what they know and unobtrusively alerting the teacher to what they don't know. The use of imagery, audio, and animation further helps ELLs to understand and digest content in ways that a purely language- based printed test or worksheet cannot.

Simulations can have a similar impact on girls and other population subgroups who often sense barriers – whether subtle or explicit – to learning STEM subjects. With game-based learning, students can play comfortably at home on any device, gaining equitable opportunities to practice knowledge and skills that they may be reluctant to use during classroom experiences.

Finally, as we all know, students have different learning styles—and this extends to different modalities as well. Some students are more invested when they get to use a device rather than learning STEM topics through a lecture, reading, or even hands-on activity. Simulations increase opportunities for differentiation, providing students more options to absorb the material in the way they learn best—all while engaging with the "T" in STEM by gaining exposure to new technological interfaces.

Addressing NGSS Science and Engineering Practices

The Next Generation Science Standards were designed to include both STEM content and a set of behaviors that synthesize content knowledge, called Science and Engineering Practices (SEPs):

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

These SEPs are notoriously difficult to assess, aside from direct observation of students' performance in hands-on learning. The STEMscopes simulations provide an alternative, enabling students to flex their SEP muscles and teachers to better assess their progress.

Each simulation is designed to address one SEP using the content of the module. For example, a middle school simulation on the properties of waves addresses SEP 5, Using Mathematics and Computational Thinking, through an immersive experience with a narrative about noise-cancelling headphones. This simulation not only exposes students to the basic measurements and terms associated with waves, but also allows them to demonstrate what they know through mathematical representations, specifically diagrams of sound waves. Students seek to produce waves with the same

period and amplitude as the supplied sound wave, but in the opposite phase. They are able to manipulate their representations until they reach the correct answer. This allows them to test and re-test their ideas in a low-risk environment, while providing valuable information to the teacher about their thought process as they attempt to reach the correct answer.

While no one wants to see the latest version of *Grand Theft Auto* in the classroom, educators are increasingly recognizing the many benefits of incorporating game-based learning into STEM education in particular. When designed with pedagogical intent and used thoughtfully, game-based learning can build students' STEM skills in engaging new ways and add a new tool to the contemporary teaching toolbox.