



# *How to Teach with Games*

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At Filament Games, we spend a lot of time thinking about the best ways to use games in the classroom - our designers, engineers, and artists are all tirelessly invested in uncovering new ways that games can shine in a formal education setting. By far, our most reliable sources of inspiration are the teachers who are doing the hard day-to-day work of running a classroom that uses games as part of the pedagogical mix.

While learning games are still not quite a dominant classroom technology, their use is steadily on the rise. The [A-Games project](#) conducted by the University of Michigan found that 50% of teachers self-identified as “very comfortable” using games in the classroom. Of those teachers, a staggering 80% were found to use digital games weekly or more often. This was reflected in our recent interview with our friend [Kara Roisum, principal at St. Ann’s school](#) in Stoughton, WI - she placed a strong emphasis on a lack of familiarity being a barrier to adoption for many educators. Clearly, a level of comfort with the technology leads to greater use, and there’s a [mountain of research](#) showing that using more games improves classroom engagement and achievement.

But how do educators build up that sense of familiarity and affinity with game-based learning? Oftentimes an educator that uses games in the classroom is a gamer themselves, and is looking to extend their passion for games into their professional life. But that isn’t the case with everyone! For educators that aren’t gamers, there are lots of great resources to get you started.

We’ve reached out to game-based learning pioneers to find out exactly how they’re using games in the classroom. *How to Teach with Games* is a collection of their thoughts, ideas, and experiences, along with some fun activities that will help you get started in game-based learning. We would like to extend our deepest thanks to the amazing educators who contributed to this book. We are inspired and energized by the work that you’re doing to improve the lives of the students in your class.

We hope you find this collection of resources useful. Don’t hesitate to reach out to us if you have any questions or would like to share a resource that’s worked for you.

Enjoy!

**- THE FILAMENT GAMES TEAM**

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# Teambuilding & Leadership Embedded in Play

## 21<sup>st</sup> Century Skills Mandatory for Video Game Success



**AUTHOR: CONOR O'MALLEY**

Conor O'Malley is a preservice teacher studying elementary education at the University of Wisconsin-Whitewater. He is entering into his final semester of teacher education in the fall of 2016. Conor is minoring in science education, and through his internship with UW-W's "ArtReach" Art Education grant, he seeks to integrate both subjects (and passions) through STEAM into his future classroom. Through ArtReach, he has been able to pursue different educational and artistic avenues for technology, such as blogging, game design, and 3D printing. Conor served as the Founder and twice-elected President of the student organization EdIT (*Education - Innovation - Technology*), which has hosted the campus' Playful Learning Conference for multiple years. Conor volunteered at Lincoln Inquiry Charter School in Whitewater for two years before being placed there for field study.

*During my angsty teenage years, I found solace in playing the online video game, World of Warcraft. World of Warcraft is a massive online game in a fantasy setting that has an endless number of goals and objectives to pursue. One of the most popular forms of play for committed players was "raiding," which requires teams of up to 40 real-life players. These players would come together to defeat difficult monsters using unique strategies and skills. As the teams were comprised of different roles, leadership naturally arose as a method of managing the massive team. There was a player assigned to recruit other players for the raid, someone assigned to distributing the post-victory treasure, and team leaders for the damage dealers and the healers. At the head of these, and many other roles, was the Raid Leader, a player that needed to work with other leaders while boosting player morale. Effective communication, preparedness, and organization were paramount to a Raid Leader's success, and as a result, the raid's success. At age 15, I stepped into the role of the Raid Leader.*

As the Raid Leader, I faced significant challenges. My team included not only real-life friends, but also college students, mothers and fathers, and one memorable grandfather that lived in Egypt. They didn't follow a 15-year-old's leadership week after week on a whim. The fact that they followed me at all was a reflection of the in-game skills I had developed and the leadership skills that emerged through coordinating these raids. I was faced with many real-life challenges that were outside the realm of the game. Interpersonal challenges such as a highly skilled player that was perpetually late, a frustrated player storming out in the middle of the raid, drama between players, and no-shows as a result of real-life emergencies were all too common. The ability to work with and support other players was never a leadership skill I was consciously developing during my four years of play, but these leadership skills paid off when I became the conference chair of University of Wisconsin-Whitewater's Playful Learning Conference in 2015. I discovered that running a conference was nearly the same as leading a raid, with similar unforeseeable challenges and interpersonal conflict. *World of Warcraft* had been teaching me for years, but it was more about how to effectively collaborate, instead of the "Giants of Gruul's Lair."

## Skills Needed for Success



21st Century Skills are a hot topic in education today, but in terms of what can be gained from game-based learning, I cannot think of a more fitting phrase. While playing *World of Warcraft*, I was developing the skills that it took to be successful in the real-life work I was doing. I would argue that those skills have been the most useful ones I developed in my teens - in or outside of school. If we want our students to truly be successful in their futures, settling for testing proficiency and other work that can be easily automated is setting the bar far too low.

What I learned after reflecting on my gameplay was that while I was gaming I went above and beyond to research the best methods to succeed. Many other players had already created guides to best assist their community. These guides allow players to understand all aspects of the game, from where the best resources were located, to complex math equations of how to optimize armor efficiencies. These approaches to becoming better at *World of Warcraft* (researching and analyzing information, working in teams, contributing to a community) align with the kinds of skills students need today. Students need to collect knowledge, but they also need to apply it in a variety of authentic ways. In a game, recalling what types of attacks a monster will use isn't enough to defeat it, the player actually has to display the ability to use that knowledge to defeat it, which parallels life.

## Sharing & Spreading Ideas

Children are natural imitators - they experiment with behaviors through what they observe. When working together on blogs, a small group of 5th graders I was teaching immediately began sharing strategies on how to do the "coolest" things within the software. As soon as one student shared a new technique, the rest of the group would be imitating that technique and finding new ways to expand on it.

When students are excited about a topic, they share what they've learned. When playing games, students want to see their peers succeed, and this manifests through sharing their own learning. During in-class gameplay it's not uncommon to see a student teaching their classmates. Often times students will share skills and guides so that other students can benefit from their experiences. These 21st Century collaborative skills are embedded into the human condition, and games draw these approaches out more frequently and constructively than other schoolwork.

University of Wisconsin Games-Based Learning Scholar Constance Steinkuehler found these trends in teenage boys when her team hosted an after school *World of Warcraft* gaming club for struggling readers. You can learn more about this study in her video "[Interest Driven Learning.](#)"

## The Many Roles of the Teacher

With students' interests and passions flowing freely, the exchange of information cannot be matched. This can be incredibly intimidating for teachers that are accustomed to being the center of attention in the classroom. Having students as the experts creates an interesting role for teachers where they become the resource-holders for the students. The students may be experts on a specific topic (like a strategy within a video game), but the teacher knows how students interact with the community surrounding that game. This can take the form of a wiki, fanwork, planning and executing a written or video tutorial, or other synthesis of game knowledge that

reflects the use of real-world skills. These projects will help them succeed later in life, and more than likely encourage them to pursue the material even further, as I did with leadership in *World of Warcraft*. Students need mentors who challenge them and help them develop the 21st Century Skills.

Beyond 21st Century Skills and the abstractions of learning through games, there is substantial educational content embedded into games. Steinkuehler argues in her research, [Massively Multiplayer Online Gaming as a Constellation of Literacy Practices](#), that online games aren't competing with literacy activities, but that they actually are themselves literacy activities. Games within the classroom are like any other kind of media, in that it needs a teacher to unpack the content. Other edtech resources and videos transfer content in one direction, from media to student, but games are interactive and modifiable. Where other technologies can stagnate, games are engaging because of the interaction between the player and the game content.

Great games blend learning and entertainment in a way that makes discovering new content enjoyable. Teachers need to unpack the content by drawing attention to the learning taking place and making students aware of the learning that they've experienced. This can be done through a variety of ways, such as discussions directed at pairing the content with the gameplay experience. This requires the teachers to have played the games and to know the game experiences well. The experiences learned through a game can impact a student's life, but unless there is a mentor to tie the implicit learning to the explicit, games don't translate to growth on a multiple choice test.

Each teacher has their own methods of probing students for their understanding. Adding games to the classroom can be a challenge as it changes the dynamic with students. Even while I was playing *World of Warcraft*, I wasn't as aware of the learning that was taking place because the skills were so implicitly placed within the game. With each game, educators will have some blind spots; whether they are familiar with the game or not. This is why I've included with my article a series of decision trees that help bring attention to how a game may promote certain skills that may have otherwise been overlooked. Every game engages the player in some form of learning, and it's my hope that students playing games in the classroom are developing authentic skills that they'll use for their careers and life.

## Games in the Era of Testing & Standards

Scott Nicholson, a "Break Out Rooms" host and professor of game design and development at Wilfrid Laurier University, tweeted that his secret to good game design is to always be testing. I find that I reflect those same practices as a teacher. Games challenge players in a variety of ways, and as a teacher, I aim to keep my students constantly on the edge of their zone of proximal development. Standardized testing isn't equitably challenging to all students, but when students are consistently challenged, that growth is often shown by the tests. A variety of assessments, both formal and informal, are key to making the best use of games.



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When a student enters into an exam, their schema doesn't dissolve into purely academic knowledge. Students have been making associations and neural connections for their entire lives. As we see more babies playing with iPads, we will continue to see students that have incredible tech literacies. With such a strong skillset, educators need to tap into their backgrounds and leverage it for their learning. They can do this by allowing students to pursue self-driven learning, encouraging them to interact with digital communities, and providing them with access to games and digital content. Their experiences with games can be a boon to scores if they are made aware of what content areas within the games are accurate and what content areas needed to be adjusted to suit the game. These memories and experiences are great discussion pieces that will help students analyze their time spent playing.

Finally, students learn by doing. Testing for abstraction on an exam can't be the only way we're evaluating student learning. If I had taken an exam on leadership in *World of Warcraft*, I would have likely failed, because the way I was engaged was through the practice of performing the leadership, not by talking or quizzing on it. Thought leader within the game-based learning movement, James Paul Gee, refers to this type of learning as "Situated and Embodied Learning," where the learning is evident by the product. Productive gaming experiences should be the core of game-based learning, creating a wealth of memories to draw upon, tempered by a teacher to guide, and inspired and challenged beyond the confines of these productive experiences. Students will challenge and encourage each other, but a class with games needs a thoughtful teacher that can tease out the explicit from implicit learning that the gameplay provides.



*Video games provide memorable and (usually) amazing experiences for the players. Playing World of Warcraft in high school taught me what it means to be part of a team and take ownership for your actions. The skills and strategies I learned from gaming are still serving me today. As a teacher, I want to provide the same opportunities for students to take learning with them into their adult lives, something that will leave an impact on them and make an impact on others. I see games as the medium for lifelong learning for students. Video games are full of diversity, there's something for everyone. If you're a teacher new to the world of gaming, or nervous to start, give it a chance. You might just learn a thing or two!*

Teacher Resource



Click here to access the "Should I Use Games in My Classroom" decision tree!



# Let's play!

## *Transforming My Teaching to Match My Students*



**AUTHOR: MIRANDA SALGUERO**

DUAL LANGUAGE IMMERSION TEACHER, MADISON METROPOLITAN SCHOOL DISTRICT

Miranda Salguero is a sixth year Dual Language Immersion teacher in the Madison Metropolitan School District. She graduated from the University of Wisconsin-Madison Elementary Education program with a minor in French in 2009 and received her Master's Degree in Bilingual Education from the same institution in 2014. Miranda has been actively involved in developing and refining curriculum for the Dual Language Immersion program and is passionate about addressing the needs of English Language Learners. For the last four years, Miranda has been working in a school with a strong focus on addressing the Common Core State Standards and technology implementation in the classroom. Miranda has served on the Madison Metropolitan School District's Bilingual Leadership Team and the Strategic Framework Planning Group, which helped use data and root cause analysis to determine the path of the school district for the last three years. Along with colleagues, she has provided district-wide Professional Development in the area of technology implementation, particularly as it relates to student engagement and the Common Core State Standards. Miranda serves as a chair on the Board of the Madison Civics Club. The organization's mission is to educate and engage in the community by promoting civic engagement.

*Children love to learn about new things, they memorize every name and fact about dinosaurs and can explain in amazing detail the intricacies of the world of Pokémon. The first day of kindergarten, students come to school thrilled and ready to learn. Yet, not long after that, we see students who are disengaged, who struggle with learning new content, or who seem reluctant to attempt new challenging tasks. When we see this, as educators, we have to wonder what we are doing to make learning into a chore rather than something children cannot wait to do.*

Walking into the classroom every morning, I have many things in mind. I think about learning objectives, each student's learning needs and how to address them, and most importantly, how I will engage students in this learning. Engagement comes first - no matter the skill of a teacher, knowledge of content, or intention to provide students with the highest quality education available to us - if we cannot engage students in learning, we have failed. I know how crucial it is that I successfully communicate to students my passion for the things we learn about, and that I show them how this learning is relevant in their own lives.

One way to achieve genuine engagement in students is to provide them with the opportunity to experiment with scenarios in which they can examine complex issues and interactions. Games provide a safe and interactive way for kids to engage with complex ideas, put themselves in others' roles and analyze issues from a perspective different from their own. This gives game-based learning incredible potential to provide students with a reason to engage with difficult content and to feel invested in the outcome of their work. The game can provide a space in which students become protagonists and in which learning will give them the tools to succeed, both inside and outside the game.

I have used games in the classroom to engage students in understanding complex systems and the interactions between their parts, to introduce new topics that may be unfamiliar, and to experiment with mathematics before we begin a unit that might lead to misconceptions. Using games in the classroom is still a relatively new practice, and as such, educators who engage in it have to justify their thinking and implementation.

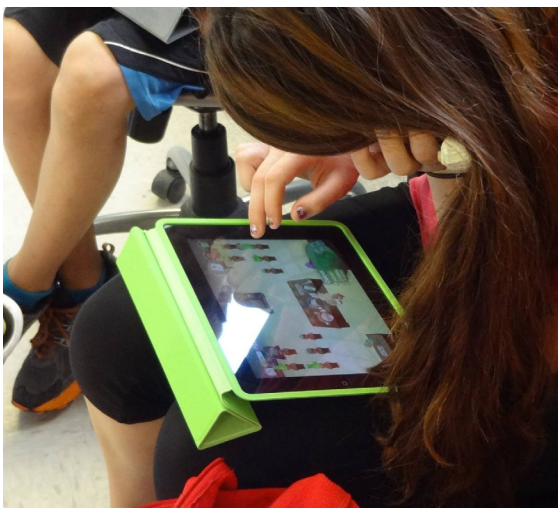
## Standards Alignment

We live in the era of standards and accountability, and while certainly the impact of these ideas has not been ideal in classrooms, the framework of the standards does provide unique opportunities to transform our practice. The Common Core Standards provide us with a framework of what to teach, but not how to teach it. This can be a powerful tool as we make instructional choices, such as utilizing games in the classroom. As a teacher, it is my responsibility to understand the standards and how they develop from grade to grade. This knowledge is also my best tool to justify my use of instructional strategies. My goal is to ensure that students know what our objective is, why we are using a game to address it, and how it is helping us achieve the grade level standard we are working towards. By being transparent with students and making them aware of what and why we are learning, they become co-creators in their learning, as well as advocates for the kinds of teaching that will help them learn.

When we make the standards and objectives transparent for students, we empower them to be active in our learning choices as well. I have found that when students know what the previous year's standard is and where we were headed in our learning, they are eager to co-construct our learning. Students care about being able to demonstrate what they know because they understand the journey. This kind of transparency also makes it much easier for students to advocate for themselves and explain why a particular project will help them show their progress in a way that makes sense for them.

This kind of engagement is what we want from our future citizens. I would much rather have a student who disagrees with me and feels empowered to advocate for the learning and the work that will best help them achieve their goals. We are making a choice, as a class, to reward engagement over compliance, and students appreciate that kind of respect and agency.

## When to Use Games



One of the concerns I have heard from families is in regards to screen time. Parents and administrators worry that students will be placed in front of a screen and allowed to play games as their only learning experience. I have found that students who understand our goals as a class, as well as the purpose of what we do, can be the best at explaining how and why we choose to play games in the classroom. My students were able to explain to me and to parents why the game was successful in our class. "It really showed all of the relationships in the lake system," said one of my 9-year-old students. "I liked how it helps you build arguments, just like persuasive writing," said another; when explaining our use of Citizen Science in our 4th grade classroom as part of our unit on systems and relationships.

I make it my goal that students and families understand that the game provides us with an opportunity to learn better, rather than it being a way to make boring things more palatable. We want a genuine dialogue with students in which we explain why this approach will help us learn, and why it may be the best option for learning in some instances but not in others.



*If a game is providing only entertainment, or if it is a worksheet disguised as a game, I would much rather have students interact with each other than with a game.*

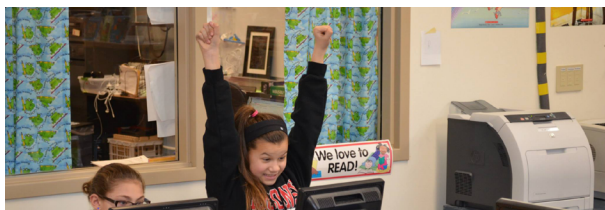
My thinking behind using a game is based on whether the game provides something that other learning experiences might not. In some cases I have found that games can illustrate complex relationships in ways that I could not otherwise provide. In other instances, I shy away from games that don't enhance the students' experience. If a game is providing only entertainment, or if it is a worksheet disguised as a game, I would much rather have students interact with each other than with a game. In this area, the way games are designed makes a huge difference. There are many games in the market that try to disguise traditional content into something more palatable. This kind of game design makes one crucial mistake - it underestimates our students. We do not need to trick students into learning. We need to remind them of what they already knew before they came to school; that learning is exciting, interesting, a social activity, and that the skills they learn at school apply to their lives and enable them to learn more about the things that are interesting to them.

## Supporting All Students

Games can provide powerful opportunities for differentiation as well as collaboration among students. When our learning targets enable students to be successful in the game, they provide students with a strong motivation to work collaboratively as well as to persevere through challenging tasks. In many cases, we see students work much harder on a game-based task than we do on traditional school tasks because they can see incremental progress much more clearly and tangibly than they do in school tasks. A student can see that they are closer to passing a level than they were before, and that progress towards mastery of a task makes them want to keep trying.

I have seen game-based learning increase motivation, help students by providing multi-sensory cues, and encourage collaboration between students who want to help their peers do better in the game.

## What We Have Learned



The measure of everything we do is in what our students have learned. Has their understanding of the topic increased? Are they better able to solve problems and explain relationships? Most importantly, are they able to apply what they have learned to new situations? Can they explain why a process works?

Utilizing game-based learning in the classroom also means that our thinking about how students learn and most importantly, how they think, needs to shift. When I have used games in the classroom, I have found that students are not only engaged in their learning; they are invested in the process and they understand the importance of showing what they know and explaining it to others. Furthermore, students became more interested in how they would show what they had learned in ways that made sense for them. Providing choice in assessing students' learnings not only showed me what students knew, it showed me a depth of understanding that a simple pencil and paper text could not have shown.

## Impact on Students



*Using game-based learning in my classroom has been a transformative journey, and one that I have only just begun. It has reminded me of what my role is as a teacher and it has helped me build a community of learners in which my students help me learn as much as I help them.*

Using game-based learning in my classroom has been a transformative journey, and one that I have only just begun. It has reminded me of what my role is as a teacher and it has helped me build a community of learners in which my students help me learn as much as I help them. Game-based learning is a powerful tool in the classroom, and as any new tool, it comes with its share of concern from parents and community members. It is important for everyone to understand that as a new tool, game-based learning does not become an educator's only tool for engagement, but rather one to be used when it fits the learning we are trying to achieve. At the end of each day, my students' learning, their engagement, and how they feel about coming to school is my best measure for whether I have done my job successfully. Game-based learning has helped me in all of these areas and I look forward to continuing to explore how it fits into our learning.

## SCHOOL OVERVIEW

*Miranda teaches at Sandburg Elementary, a 4k-5 elementary school in Madison, Wisconsin. The school has a very diverse population and is home to a Dual Language Immersion Program. This school has had iPads in the classroom since the 2012-2013 academic year, as part of a school district pilot. The pilot supplied three classrooms with a 1:1 implementation of iPads, and the principal utilized school funds to purchase devices for two more classrooms that same year.*

*During the 2013-2014 school year, the school made a larger investment and purchased enough devices for classrooms K-2 to have a 1:2 ratio and for grades 3-5 to have 1:1 iPads. This has enabled the school to implement technology-enabled content and explore the most meaningful ways to do so with students a few years before the rest of our district was afforded the same opportunity.*

*In addition, Sandburg Elementary was given a large grant during the 2013-2014 school year to enable school staff to work collaboratively in learning about the Common Core State Standards, and to create rubrics to assess students' development towards reaching proficiency in these standards. The school-based teams have created child-friendly rubrics to serve as pre and post assessments for these standards.*

**LESSON ACTIVITY:**

# Diffission

**BY: MIRANDA SALGUERO**

Diffission is a fractions learning game for all ages aligned to Common Core standards. Learn about fractions by slicing through deceptively simple shapes, manipulate swap and dissolve blocks, and earn the coveted title of Diffissionist. With endless procedurally generated puzzles, Diffission challenges even the most experienced learners. Educators will need to purchase one account per students in order to access Diffission. You can do so [here](#).

**MATERIALS:**

*For each student group:*

- Hexagons recording page
- Diffission screenshot workspace
- Pattern blocks

*For each student:*

- Computer or tablet with internet access

*For the Class:*

- Large piece of paper

**TIME REQUIRED:** 45 minutes

**LEARNING OBJECTIVE:**

Students will be able to create, name, and write fractions to build wholes in different ways.

**CONTENT SPECIFIC LANGUAGE AND DEFINITIONS:**

- Whole: the unit being partitioned into equal parts
- Equivalent: equal in value

**PREPARATION:**

Prepare two-sided copies of the hexagons recording sheet and Diffission screenshot workspace for each student.

## Warm Up: Making a Trapezoid

Show a picture of a trapezoid and ask students to make this shape with different pattern blocks. After a couple minutes, ask students to report on their strategies and models.

## Making the Whole

Next, show students a hexagon and ask them to make a prediction of how many ways they could combine the pattern blocks to make a hexagon. Students should then work in pairs to make as many combinations as they can of the different pattern blocks and record their results on their recording sheet.

## Finding Equivalent Fractions

Ask several pairs of students to share their strategy and work as a group on labelling these models as fractions to show that there are many ways to make the whole and that these fractions are equivalent.

## Connection to Diffission

Show students the screenshot of Diffission and ask them to look at the back of their paper, prompting them to think of how many ways they could divide that rectangle into fractions. How many ways can they label each solution?

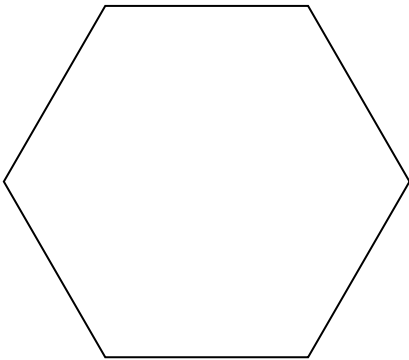


Note: While the making of hexagons may be easy for students, the labeling and explaining process might be more challenging. This could be a good experience to conduct as a class and then repeat with small groups.

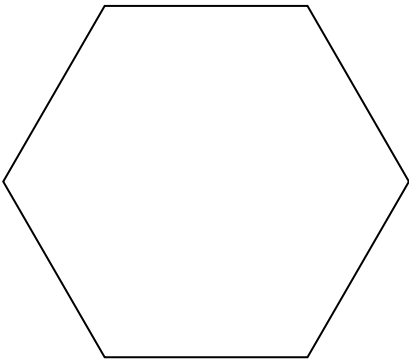
Dividing shapes into equal parts and labeling the fractions appropriately could also become a part of center work to provide students with more practice using the memory game included in this lesson plan.

# Hexagons Recording Page

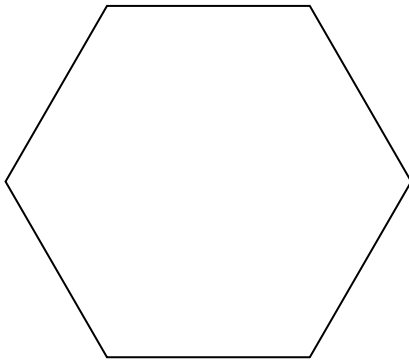
Record the different ways in which you built the hexagons. Write the fraction the whole represents.



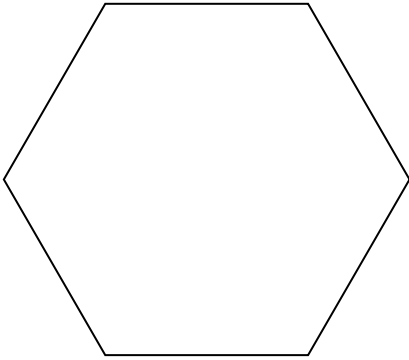
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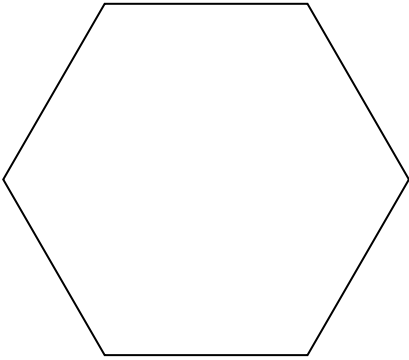
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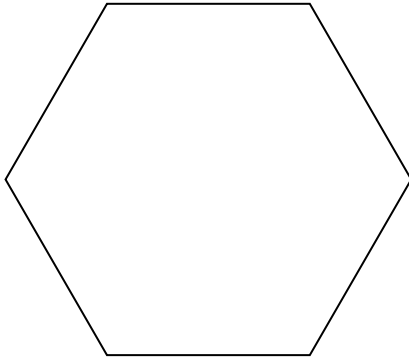
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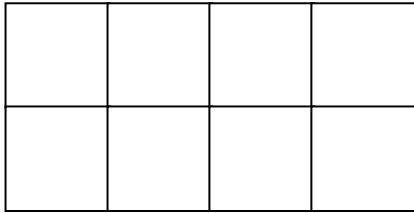
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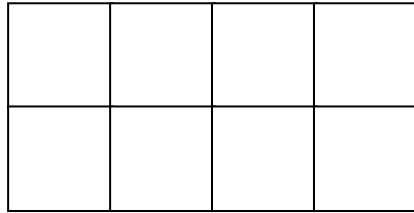
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# Diffission Screenshot Workspace

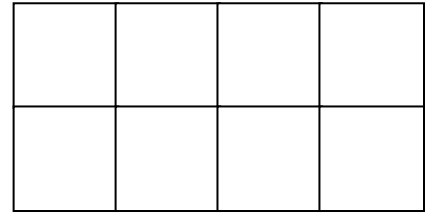
Record and label fractions of your rectangle.



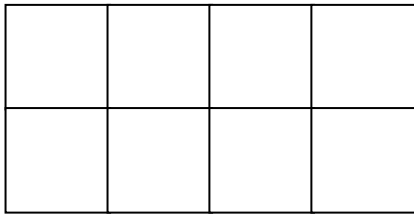
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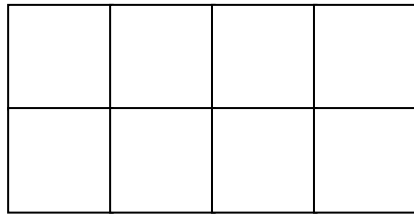
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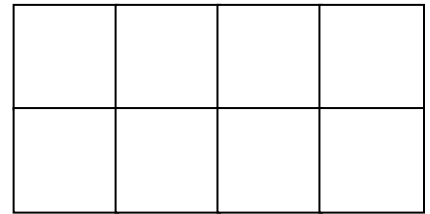
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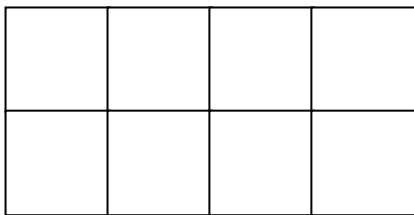
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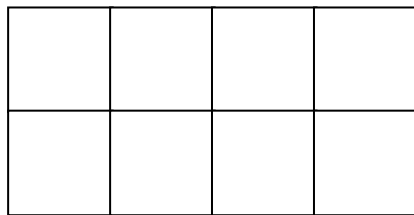
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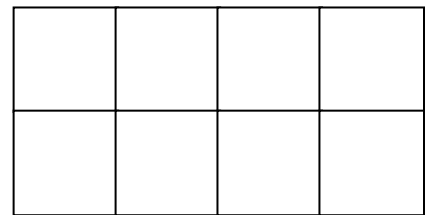
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# Pulling Back the Veil

## *Using Games to Let Students Explore the Impossible*



**AUTHOR: DAVE ROPA**

7TH GRADE SCIENCE TEACHER, SPRING HARBOR ENVIRONMENTAL MAGNET MIDDLE SCHOOL

David Ropa has more than 20 years of experience working in environmental science, education, conservation, research coordination, and technical writing. With advanced degrees in environmental science, business marketing, and teaching, he has spent the past sixteen years as the 7th grade science teacher at Spring Harbor Environmental Magnet Middle School in Madison, WI. His primary goal is to inspire students to investigate the natural world and get outside. He is the recipient of numerous grants and teaching awards.

*A teacher need not be a gamer in order to recognize the incredible opportunities provided to students through the use of educational games and learning objects. This is particularly evident when games allow students to explore worlds or scientific concepts that are impossible to demonstrate in a classroom due to geography, time, cost, safety, or scale. Games can transport students to space, provide a glimpse into the subatomic world, put them inside a nuclear reactor or near a deep-sea vent, and put state-of-the-art technology at their fingertips, even if only through a screen. Games can speed up time and allow students to analyze events that normally take days, weeks, or years in just a few seconds. The power of games to provide these interactive models is unrivaled.*

For the past 10 years, I have used a variety of computer games, learning objects, and simulations to enhance the work students conduct in the classroom. There are some games that don't apply to the content I'm trying to teach and while entertaining (and possibly useful), I don't use them, allowing my class to stay more focused throughout the year. While science has many great opportunities for exploring new concepts, I find that when teachers try to teach an extremely wide number of topics, students gain only the most cursory understanding of all of them. I prefer to focus on just three curricular areas throughout the year and allow students to explore these topics deeply, thereby making connections across disciplines due to their greater understanding. Although I use games in many scientific disciplines, it is these three areas in which I have developed the most curricular content and used games as an enhancement to our curriculum.

## Ecology & Environmental Science

During the first three months of the new school year, students spend as much time outside as possible, exploring the natural world, collecting data, and trying to explain various ecological processes. Many of these experiments are conducted in physical games that we play outside. The full-body, kinesthetic learning that these games employ allow students to remember these concepts for a long time and give them a chance to evaluate what parts of our games are accurate or need to be refined. The games give some students a chance to participate in a way that they may not normally, and they have observations to share based on their participation in the game, rather than in a concept found only in a text.

## Energy

During a month-long, integrated energy unit, students are asked to role-play as a professional in the Madison community who has a particular perspective on the use of electrical energy being used in the city. Students develop an energy portfolio proposal that combines multiple energy sources in order to create electricity in a low-cost, environmentally sustainable manner that does not harm tourism. Students are asked to identify the types of systems that should be used to create electricity in Madison, selecting the precise model of wind turbine, hydropower facility, IGCC power plant, or nuclear reactor.

To do this, students have a steep learning curve to figure out how these systems work. In class, students create experiments with small wind turbines, small hydropower models, and burn a variety of fuels to measure the energy released. However, they are also given the opportunity to use games that simulate the siting, size, and energy production of a variety of different wind turbines. They also get a chance to operate a nuclear reactor and compete to see which individual can operate a reactor for the greatest amount of time and generate the most profit.

## Forensic Science



During a two-month fictional crime scene investigation, students are given a chance to explore blood typing analysis, DNA analysis, cell replication, and genetics through a variety of games and simulations. In order to solve the crime, students need to gather, analyze, and link evidence from more than 12 different interrogations taken from 25 different suspects. While they are given a chance to conduct a variety of experiments, the background knowledge they need to fully understand complex biological systems can only be gained through repetition and scaffolded learning. Because the investigation goes on for two months, students need to be able to go back to a concept and explore it to refresh their understanding. Some of the game topics used in the simulation include blood typing, Punnett Squares, and RNA replication.

## An Evaluation Tool

Because students are constantly creating experiments to explain a particular scientific concept or process, their ability to evaluate models is extremely important. Games are a form of model and, therefore, worthy of analysis and criticism. When we use games, students are asked to explain the parts of the game that are realistic or those that were not. Through their ability to evaluate, I can measure just how much they understand a particular system and the game's ability to replicate that.

One example of a system analysis that my students complete is described after this article, whereby students evaluate the accuracy of two different simulations that address predator-prey relationships and natural selection. After the students play an outdoor predator and prey role-playing game, they come inside and investigate what happens in an electronic version of similar interactions. After completing these studies in a variety of contexts, their ability to provide extensive analysis of the game as well as explain their understanding of natural selection is quite remarkable. They can also very quickly identify flaws in the games' designs that don't function like organisms do in the wild.

## Always Within Context



*While I use a variety of games to give students a chance to explore and evaluate different concepts and models, I never use games as a stand-alone lesson without providing context or background. I want students to see the game as something that is a part of their learning, not just free-time.*

While I use a variety of games to give students a chance to explore and evaluate different concepts and models, I never use games as a stand-alone lesson without providing context or background. I want students to see the game as something that is a part of their learning, not just free-time. Interestingly, even after students have tried a game and completed a lesson, they will ask to return to certain games periodically to try their hand again. From this teacher's perspective, when students ask to repeat a lesson and further their understanding in the process, the value of the game is exemplified.

## SCHOOL OVERVIEW

*The mission of Spring Harbor Middle School, a magnet school with an emphasis on environmental studies, is to develop the personal, social, and academic potential of all students. We will accomplish this through an interactive, integrated, multicultural curriculum. Spring Harbor's small, caring atmosphere guided by shared involvement of students, parents, staff, and community promotes exploration and life-long learning.*

# Natural Selection Simulation

## STATION 1: RABBITS VS WOLVES

- ✓ Start the **game** settings by adding a “friend” to the lone rabbit on the screen
- ✓ Choose the “equator” environment
- ✓ Wait until the population reaches at least 10 rabbits and then add the mutation “brown fur” to the scenario
- ✓ Wait until the population reaches at least 50 and then choose the selection factor “wolves”

## Questions:

1. What color were the rabbits at the start of the game?

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2. Did the white rabbits ever fully disappear from the scenario? How?

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3. Did white rabbits ever reappear after being eaten by wolves? How did that happen?

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4. Play the game one more time. Include the variables in the table below and summarize what happened as a result.

Mutation Added	Selection Factor	Environment

## Summary of Results:

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### STATION 2: PEPPERED MOTHS VS BIRDS

- ✓ Open the [simulation](#) and choose “Birds Eye View”
- ✓ Play the game in both the dark and the light forest
- ✓ Try to behave as a bird would behave, choosing the moths that are the most obvious
- ✓ At the end of each simulation, record the percent of moths captured in the table below

	Dark Forest	Light Forest
Percent White Moths		
Percent Dark Moths		

## Final Analysis

1. Explain how the color of the moths increases or decreases the moths' chances of survival. Use data to support your thinking.

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2. Explain the concept of “natural selection” using your moths as an example.

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3. What would happen if there were no predators in the forest? Would the colors of the moths change over time? Defend your answer.

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# Leveling the Playin' Field

## *Student Gaming in Middle School*



**AUTHOR: MARY HEADINGTON & CHAD JOHLL**  
SUN PRAIRIE SCHOOL DISTRICT

Mary Headington is a 6th grade science teacher in the Sun Prairie School District. She graduated from the University of Wisconsin-Whitewater with a Bachelors of Science in Education degree in 1992 and received a Master's Degree in Professional Development from the University of Wisconsin-La Crosse in 2005. Mary has been actively involved in the Sun Prairie School District's science curriculum for the past 21 years. During this time she has been a member of the Curriculum Leadership Counsel for Middle School Science as well as the Science Steering Committee, which is responsible for writing curriculum that aligns with the Next Generation Science Standards and obtaining resources for the 6-8 science curriculum.

Chad Johll is a 6th grade science teacher in the Sun Prairie School District. He graduated from the University of Wisconsin-Platteville in 1997 with a Bachelor's degree in Elementary and Middle School Education. He earned a Bachelor's degree in Special Education from Edgewood College in 2009. Chad has been teaching science and language arts at Patrick Marsh Middle School in Sun Prairie for the last 13 years.

*It is not about academic achievement or homework, which class is the most interesting, or making sure your homework is in on time. In a middle school student's head it is more about... Is my outfit the right one?... Did I part my hair on the right side?" or...If I volunteer in class because I know the answer, will others think that I am a nerd and forever banish me from the cool table at lunch? It is a daily challenge to instill some knowledge in the mind of an adolescent.*

Trying to find the key that unlocks interest, excitement, and a desire to learn in our students is something that middle school teachers struggle with each and every day. We play through our head the plan for the day at the same time wondering if we got enough sleep last night to perform our song and dance for six class periods. We attempt to determine what students we need to connect with or how many students we will have with us during lunch, so that we can try one more time to turn on that light bulb...that is, until now.

This past school year we were introduced, during a professional workday, to the simple idea of playing games in order to learn. The presenters from Filament Games in Madison came to our district and had us pull out our smartphones. We drew pictures and competed against each other in order to score points based on our drawings. When the game first started, some of us technically challenged teachers struggled. We looked at each other, at younger teachers trying to gather some insight. Round one started and we didn't know what to expect. It was a disaster, but we laughed. Round two, we started to loosen up a little and ask questions of one another. Round three, the alliances started to form. Round four, it was becoming cut throat. Round five, we were so absorbed in the game that we did not realize we were learning. We sat there laughing, completely engaged, talking with other teachers in the district we had never met and completely forgot that it was professional development. It was at that moment we realized that if we were having fun and learning on a day we would rather be at home, maybe this would work for our middle school students.

How would we use the game idea? Would the engagement be as infectious with 12-year-olds as it was with the teachers? Would the interactions the teachers experienced while playing the game be of interest to the kids? So many questions. We had used games in the classroom before, but those were mainly vocabulary activities, toss and catch concept challenges, and bingo. The students enjoyed them, but they were more interested in winning the prize and not in learning the concepts. Most games were also not aligned with the Next Generation Science Standards (NGSS) and often incorporated little of what we wanted the students to learn.

## Standards

Reading and math. Teachers in this day and age cannot plan a lesson without thinking deeply about these two tested subjects. This makes teaching the standards that need to be addressed in other subjects such as science and social studies difficult. When the core theme of your lesson needs to align with the NGSS, but include a reading and math component that is aligned with the Common Core Standards, a simple concept such as identifying the difference between a solar and lunar eclipse can get lost and seem very overwhelming. Even though the standards are giving us the framework, we need to figure out how to engage the students and utilize the game process so that learning can be fun.

Making standards transparent to the students is the next important step. If they understand what we are moving towards, the process to get there makes more sense and holds meaning. Learning becomes a partnership between teacher and student. Dialogue about learning opens up and student learning becomes more personalized. Putting the students in charge of their learning in a game situation allows them to take ownership of the process that is usually reserved for the teacher.

This kind of engagement is what we want for the future of our students. Sitting in a classroom listening to the sage on the stage is not what the real world is about. Taking part in the learning process, as they would working on a project with a co-worker, is what they need to learn in order to be productive scientists as well as citizens. Giving students the chance to practice and refine these skills in the school setting is essential to their long-term growth and success.

## The Games We Play

In this modern classroom era of standards, assessments, and benchmarks, it is hard to plan a lesson that engages students at their level. Lessons are so packed with information that it turns kids off. Thankfully, with the adoption of the 1:1 classroom, teachers are finally gaining the upper hand, providing students with the opportunity to learn the content in a way that appeals to them. Digital learning platforms, emails that open up communication between student and teacher, and devices that put the information at the student's fingertips are just the start of where education is today. Students are more engaged with lessons because the lessons play right into their technology interests. As educators, it is our responsibility to plan using these tools in a responsible manner so that students can learn.

One of the best ways that we engage students in the classroom is through the use of games. The games can either be a quick vocabulary review, a drawing challenge on the smartboard, or an online game that they can play either independently or with a friend. Students learn more when they play games because they don't see it as learning as much as having fun. A teacher can weave the standards into this "play time" and get the kids to write, read, strategize, and collaborate with others in the classroom in a fun way.





*Planet Mechanic* is one of the resources that we have brought into our classroom to teach the standards and support the curriculum that we cover. To succeed in the game, students need to use the information and vocabulary provided and manipulate features of a planet. They work through 15 levels, each asking the students to fill orders to make the aliens happy. In order to enrich the curriculum and enhance the positive aspects of the game, we ask the students journal on each level. They summarize the level including content vocabulary, provide hints about being successful at each level, and then share this information with their classmates in a convention format. This allows us to evaluate the standards of NGSS and Common Core in a nonconventional and fun way.

This game, which is used in our science classroom, gives the students many learning advantages. When using this game we have found that it enhances learning because it gives students another way to practice and apply the concepts they have learned in class, showing us their understanding rather than taking a test. This makes it a less threatening way to assess student achievement. The game also enriches the curriculum by making something that is abstract more concrete. Students may never experience a solar eclipse, but they can manipulate the game in order to create one. Students also find success in the game format because they can try over and over again until they are successful unlike a common assessment where they get one shot at showing understanding.

Gaming in the classroom can present challenges. One of the challenges that we experience with any game is how much information needs to be provided to the students before they start. Research indicates that students can learn better when they struggle as opposed to being handed the information. Further challenging is the length of time we allow them to struggle before offering assistance. In any classroom, we struggle with the range of background knowledge/exposure the students bring to the classroom. One strategy that we found helpful is showing the students where the resources are in the game and reminding them throughout game playing time of those resources (they sometimes forget in the excitement of playing). Another great strategies is to create a parking lot. Students can write down questions they have in a central location that other students can see. If another student can help answer the question in a timely manner...problem solved. If the question is in the parking lot too long, the teacher needs to address the question to the whole group as many may be struggling, too. In the end, we found that we needed to continually remind the students that it was OK to not know everything before they get started. The game situation is a learning process and they need to work through it.

## Supporting the Students

Games, when played in the classroom, open up dialogue and collaboration with players. The students are able to take cues from their classmates while they play the game in order to gain understanding. Because games lend themselves to a non-threatening environment, students feel less anxiety when they ask for help and are not afraid to fail because it is just a game and not a graded assessment. Students that are successful in the game can take on a teaching role, which makes them think at a higher level because they have to explain and assist students that might struggle. The game affords students the opportunity to teach each other and, in turn, learn better on both the high and low end.

## What We Have Learned

We have found that students show higher mastery of the content when we added game playing to our more “traditional” teaching approach. When we provided students time to play games we found that they were highly motivated to achieve more because they wanted to keep “bettering their score.” In order to do this they asked more questions, researched more information, and collaborated in order to get that leg up. They took ownership of their learning and this allowed the teacher to become the facilitator of the learning environment instead of the lecturer. If we take this knowledge and allow the students to create their own games or personalize their learning, we are better preparing them for a future in the real world.

## Impact on Students



*Games are never going to replace the teacher, but games are changing how the teacher teaches.*

Games are never going to replace the teacher, but games are changing how the teacher teaches. In our classrooms we are finding out just how important this tool is. Traditional instruction focuses on providing students with the information we want them to know and then delivering it in a controlled manner. In a recent study we conducted, we witnessed students struggle with a concept and then determine what they needed to know. They then used this information to direct their own, personalized learning. This looked different for each student. Some students chose to conference with the teacher, some looked to classroom resources and internet links, while others went out on their own in search of the information. These skills teach students how to learn, as opposed to being told what to learn. If we provide situations for students to continually practice these skills, especially in a game environment, we will find that their motivation and thirst for knowledge increases. They seem to want to do more because it makes learning fun. Teachers are finding that education is become more of a partnership with the student and games foster this.

## SCHOOL OVERVIEW

*Mary and Chad teach at Patrick Marsh Middle School, a 6/7 building in Sun Prairie, Wisconsin. Sun Prairie is a rapidly growing school district and a suburb of Madison, Wisconsin. The district encourages teacher collaboration and provides the students with a variety of technological experiences. Patrick Marsh has been a 1:1 school for two years beginning in the 2014/2015 academic year. All students have been provided with a Chromebook that they are allowed to use at both school and home.*

*The district uses a standards-based grading system in grades K-7. Science curriculum, K-12, is aligned with The Next Generation Science Standards. Teachers are encouraged to develop their own materials to meet the standards.*

# Planet Mechanic Journal

Planet Mechanic is a learning game about planets aligned to Common Core and Next Generation Science standards. Meet the demands of fickle aliens who can't seem to make up their minds about what conditions they want on their homeworld. Experiment with a planet's core attributes, manipulating its atmosphere, tilt, rotation, and lunar cycles to learn how these factors change temperature, time, and seasons! Educators will need to purchase one account per student in order to access Planet Mechanic. You can do so [here](#).

**LEVEL NAME:** \_\_\_\_\_

**LEVEL SUMMARY:** \_\_\_\_\_

## Writing Prompts:

Key unit vocabulary I learned in class that would help me with this level (define):

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Tips or things on the screen that would help someone else with the level:

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Is there anything that I would need to research in order to understand this level:

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Draw a diagram in order to represent the level:

# Letting Go

## *Using Games to Empower Students*



**AUTHOR: CHRISTINE MARSH**

Christine Marsh is a Digital Learning Coordinator at The Field Museum with past experiences teaching in New York City and New Orleans public schools in both formal and informal educational settings. She concentrates on her work finding ways to connect learning for students of all ages and levels with emerging digital technologies, specifically, educational games

*You walk into a dark classroom, rows of desks are perfectly aligned and for a moment you're not sure if students are present as your eyes adjust to the light. Students are sitting quietly at their desks with headphones on, no one looks up from their computer screens as you enter the room, they are focused on their screens, completely unaware of their surroundings and their fellow classmates. The teacher paces through the rows of desks monitoring students, relinquishing their teaching to the screens in front of their students and thereby becoming the monitor.*

*This is not what teaching with games looks like.*

*A game should be viewed no differently than a lab activity, group project, or lecture in the classroom. It is a component of a bigger piece, it is not a replacement. My first foray into using games in the classroom was the use of Cell Command in my 7th grade life science class. I incorporated Cell Command into my unit on the basic structural units of life - cells. I did not have my students play the game and count that as all the teaching that needed to be done for them to understand cells. Cell Command enhanced my instruction by providing increased practice for students in an engaging manner.*

## Why Games

At the start of the new school year, my goal was to find new ways to engage students. Trying digital learning games was one of my experiments. Video games in my classroom were not a replacement for my teaching. They supported my instruction, engaging students in new and exciting ways.

In Peter Lang's book, *Children's Virtual Play Worlds: Culture, Learning and Participation*, he explains that video games allow for youth to learn by guided participation rather than through direct instruction. The classroom becomes student-focused, allowing them to work at their own pace and explore without the fear of failure. A worksheet full of red marks is discouraging to students, but a computer screen saying "Game Over: Try Again" is motivating. Who hasn't felt the satisfaction of finally beating that level you'd struggled with for hours?

There is no passive learning when playing educational games; they demand that all players are active participants. Pac Man isn't going to move forward without a player doing so. Video games also allow students to explore novel situations. My students commanded a ship the size of a human cell in order to help solve cellular crises in *Cell Command*, an experience they would be incapable of having without this digital learning.

## Exploring Cells

My students began the unit on cells by completing an organelle jigsaw activity. Student pairs were given an organelle and asked to become "experts" on that organelle. Then they created a mini poster which included a drawing of their organelle and 4-5 facts about it (including organelle structure and function). The jigsaw activity alleviated me from standing in front of my classroom for an hour lecturing on each organelle as my students completed notes, as this would be mundane for both myself and the students. The next day, following the creation of the organelle posters, students were given a [cut and paste activity](#) to learn more about organelles. They were allowed to use provided websites about organelles (pre-selected by myself to make sure they were at the middle school level), their fellow classmates posters (which were posted around the classroom) and a slide deck provided by me in order to correctly pair the organelle with its appropriate definition. (Notice the students had yet to play *Cell Command*.)

The classes were divided into two parts. During the first part, students worked on a laboratory activity (Carolina Inquiries in Science: Investigating Cell Types) using single-celled live organisms (Paramecium and Euglena representing animal cells) and Elodea leaves (plant cells). During the second half of class, students began to play *Cell Command*. I used the single cell laboratory activity to help students become more familiar with organelles through observing a living single-celled organism. With both the Paramecium and the Euglena, the students were able to observe the following organelles: nucleus, cell membrane, cytoplasm and nuclear membrane. *Cell Command* complements these hands-on microscope activities and fits in perfectly as the game reviewed organelles that students were unable to observe using the light microscope.



When students had completed the single-cell organism lab in tandem with playing *Cell Command*, they began to work on their Cell Analogy Project. In this classic life science project, students create an analogy for the cell and its organelles as a whole system. The analogy activity was met with some grumblings, but soon students became highly invested in their project. Students could more easily explain the functions of the organelles upon project completion. I gave students the example of comparing their cell to a city and then allowed them to come up with their own analogy. Their responses ranged from a cell is like Starbucks, the Smoothie King Center, or a castle to Pokemon. The analogy project was the culminating final component to the my cell unit.

After introducing students to the game, they came to class asking if they would be playing *Cell Command*. I have never had a student come to class asking if they were going to be completing multiple worksheets for practice. *Cell Command* allowed students to practice concepts in a grade-free (and thereby risk-free environment) and they were excited to do so.

Testing the students was done in a very informal manner, but it was clear that with the use of *Cell Command*, students' understanding of cell structures and functions increased. I had students complete a formative pre-assessment of a cell diagram prior to the start of the unit. This was done so I could determine how much information the students had retained from previous grades - the topic of cells was not novel to them in 7th grade. Overall, on the pre-assessment, students were only able to label the nucleus in the diagram of the animal cell. Throughout the cell unit I assessed students in various ways:

- ✓ Successful completion and presentation of their jigsaw activity
- ✓ Completion of the organelle cut and paste vocab review
- ✓ Completion of the investigating cell types laboratory
- ✓ Participation in playing *Cell Command*
- ✓ Completed Cell Analogy project
- ✓ Participation in group discussions

By the end of the unit students were able to label a cell diagram as well as pass a multiple choice quiz.

## Navigating Challenges

Challenges exist when incorporating games into the classroom, beyond the technical difficulties that may arise. Many parents are apprehensive about the increased use of digital media in the classroom, as they are under the assumption that screens are simply “used as electronic babysitters.” This concern can be met head-on by encouraging transparency in the classroom. When teachers inform parents from the outset of the digital media they hope to implement, and explain the benefits of using such tools, they tend to be more comfortable with the tools. SRI Research cited in a recent [Mindshift article](#) reported that students playing educational video games score 12% better on standardized tests.

To gain the support of parents, I sent a letter home with the students. In my letter to parents, I not only explained why I was using educational video games, but also encouraged them to play the games with their children at home. Parents often imagine playing video games as solitary acts, devoid of interactions with others. However, research has shown that video games do not weaken family interactions, but rather help foster them. Older siblings can help younger siblings with tips and tricks to defeating a game level, or tech-savvy children can explain gameplay to parents. When surveyed, the number one motivation for gamers to play games was the social component. This social component exists within educational games as well. They foster relationships between students who would not normally interact. Students with more gaming expertise are able to share their knowledge in a situation they may normally not encounter in the classroom.



Playing educational video games allows the child to show their knowledge and expertise to parents, introduces parents to what they are learning in class, and allows parents to monitor their child's learning in order to understand where they are struggling and what they are mastering. No family wants to sit home re-doing a worksheet together, but with educational video games, children can invite parents into their new world, asking for parents' help in completing quests and redoing levels to demonstrate their level of achievement.

## Getting Started



So how do I get started using games in the classroom? I would respond asking you how would you use a laboratory activity or group project in your classroom. A game is no different - it should include careful planning and testing things out ahead of time. There are also many great resources on the subject (and if you're already reading this book you're on the right path!), I would also suggest [Mindshift's Guide to Digital Games and Learning](#) as a beginner how-to guide as a supplement to get started with games in your own classroom.



## LESSON ACTIVITY:

# Cell Command

**BY: CHRISTINE MARSH**

Cell Command is a cell biology learning game aligned to Common Core and Next Generation Science standards. Captain a cell ship through the human body to explore cells while managing DNA duplication and other cellular processes. Learn the role of critical cell structures including the membrane, mitochondria, golgi complex, and ribosomes. Educators will need to purchase one account per student in order to access Cell Command. You can do so [here](#).

## MATERIALS:

Computers  
Projector  
Individual activities materials listed in documents

## PRIOR KNOWLEDGE INSTRUCTIONAL OVERVIEW:

*How to Use a Microscope:*

- [Virtual Microscope Lab](#)
- [Microscope Lab](#) - students create slides using their own cheek cells

## 7-9TH GRADE/LIFE SCIENCES

**TIME REQUIRED:** 40 minute class period

## LEARNING OBJECTIVES:

- Identify structures and functions of major animal cell organelles.
- Describe the functions performed by cells to sustain a living organism.

## NGSS STANDARDS:

*MS-LS1-2:* Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

*Disciplinary Core IDea:* LS1.A: Structure and Function

- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)

## Unit Overview

### ENGAGE:

- Microscope/Cheek Cell Lab

### EXPLORE:

- [Organelle Jigsaw](#) - In this activity, student pairs are given an organelle to become “experts” about. They then create a mini poster which will included a drawing of their organelle, and 4-5 facts about the organelle (including organelle structure and function).

### EXPLAIN:

- Student create self-study guides using the following [worksheet](#).



### ELABORATE:

- 2 classes divided into 2 parts:
  - » *First half:* [Carolina Inquires into Cell Types Lab](#) (edited)
  - » *Second half:* Cell Command gameplay. Follow these hands-on microscope activities with Cell Command gameplay. This fits the sequence perfectly as Cell Command reviews the organelles (with the exception of the membrane) that students were unable to observe using the light microscope.
    - Review with students the function of the organelles featured in the game

### EVALUATE:

- [Cell Analogy Project](#) Students create a poster that compares a living plant or animal cell and its organelles to a city, school, factory, ballpark, etc. The place students choose must use energy, produce substances and manage waste. The organelles will represent the parts of your place that carry out these processes.

# Using Video Games to Enhance Education



**AUTHOR: TAMMIE SCHRADER**

Tammie Schrader currently works for Educational Service District 101 and is a Regional Science Coordinator serving 59 school districts in Eastern Washington. Tammie was a science teacher at Cheney Middle School, in Cheney, Washington, as well as an adjunct science methods instructor at Gonzaga University. She taught life science as well as computer programming, gaming programming, and robotics, as well as coaching the Science Olympiad Team, Robotics Club, SeaPerch Team, and Future Business Leaders of America at her middle school. Tammie has her B.A. in Education as well as a B.S. in Biology. She earned her M.A. in Education and Teaching At Risk Students. Tammie is currently enrolled as a Ph.D. candidate and is writing her dissertation on Leadership and Policy in the Classroom, which is scheduled to be finished in May of 2017. Tammie currently works for the state of Washington on their Science Assessment Leadership Team and sits on the Education Board working on implementing video games into curriculum. She currently sits on the Professional Education Standards Board for the State of Washington.

*Students today are steeped in technology. It comes at them in all forms, from smartphones to video games. It is no secret that students spend an inordinate amount of time playing video games during their spare time. It is not unusual to see students between classes and at breaks on their phones, interacting with tablets and laptops, or filling the computer labs.*

*Technology is here to stay and as educators we need to harness the ability to capture kids' attention and use it in an educational way. In 2011, President Barack Obama addressed the need for investments in education technology that will help create digital tutors that are as effective as personal tutors, and educational software that is "as compelling as the best video game."*

## Games Increase Engagement



Games, in any form, increase motivation through engagement. Nowhere else is this more important than education. There are a variety of ways to introduce a classroom to the gamification of education and I have just a few ideas! My hope is to spark a discussion on gamifying education so that educators can discuss the topic more thoroughly and explore ideas that would work in their classrooms.

It started out as a science experiment. Can students really learn from interacting with educational concepts in the form of a video game? What I learned was nothing short of amazing. Students who could not, or would not, interact with science concepts were not only interacting with the concepts, but with each other. Within minutes of logging onto Cell Command, students were discussing messenger RNA and transfer RNA, concepts usually taught in high school, not at the middle school level, where I worked.

## Games in the Classroom

An example for a game implementation that worked in my classroom was a genetics lesson. I was teaching students about dominant and recessive genes and had started with an inquiry lesson. The lesson required that students evaluate yellow and green peas in a plastic sandwich bag. The students were asked what would happen if we combined the yellow pea plant with the green pea plant. Students worked in groups of two or three and made predictions. When they were finished, they came up with their sandwich bag and explained their reasoning. I then handed them a bag with the correct answer and they had to explain the answer. After that, they were asked to make more predictions on more crosses. We went over dominant and recessive traits and how the model works for inherited traits.

After giving them the initial experience with genetics, I introduced the game, *Crazy Plant Shop*. While I was concerned and thought the game would be quietly played (I am very much interested in discourse around subject matter), to my amazement and excitement, the students were more active than ever! They raced to create plants and shared ideas when they were successful. This created a bit of a competition, but also a feeling of camaraderie around getting everyone to learn how to make genetic crosses and why recessive traits and dominant traits were passed down in specific ways. Not only was the discourse amazing and authentic, the engagement was high as students worked through each challenge.

The follow up assessment asked specific questions about their inquiry experience as well as their gaming experience. They were asked to reflect on their entire experience. Surveys came back positive across content expertise. Higher level students as well as lower level students found the game challenging enough to keep them engaged with the problem until they could find the solution. Collaboration was authentic and genuine.

## Changes in Students

Educational gaming has been useful in a variety of ways. Students with behavior issues have been able to focus and interact with the standards and classmates. Collaboration occurred organically because students are trying to solve the same scientific problem. Video games give instant feedback so students get to constantly assess their progress. A huge impact was how students were able to articulate their learning conversationally, as well as writing about their learning.

Student engagement and motivation increase dramatically when they are challenged in a medium they are familiar with and enjoy. Three characteristics of games in the classroom that make them powerful are:

- ✔ Immediate feedback
- ✔ Student ownership of learning
- ✔ Teachers not playing the central role

According to Jane McGonigal, "Game developers know better than anyone else how to inspire extreme effort and reward hard work." Introducing games into classrooms intentionally helped improve students' understanding of content, while building a model to fully implement games into schools and districts in a successful manner.

One example is Conner. He was a student in my classroom who has Aspergers. Conner could not manage colored pencils and he could rarely do group work because he was a danger to other students and sometimes himself with science equipment. While I needed to educate Conner, I still had 28 other students that I was responsible for educating. When I introduced a cell video game, a medium that Conner was well versed in, he thrived. He not only was the king of the classroom, but it was possible for me to actually evaluate what he knew by having a conversation with him while he was playing the game.

## Standards Alignment

In addition to being a great way to keep students engaged, researchers have found that video games have potential as next-generation learning tools. Games use new technologies to incorporate principles crucial to human cognitive learning.

The gaming industry has figured out a way to enhance and capitalize on non-cognitive skills such as grit, tenacity, and perseverance that have been shown to be critical for success. These very skills can be taught along with content through gaming techniques and games. Integrating games into Next Generation Science Standards is necessary and a great way to have the NGSS come alive in an authentic way.

## Roadblocks



Using video games as an educational tool is not without roadblocks. Having computer access for all students or at least pairs of students is necessary. I would book computer labs weeks out, which presented an issue if students were not ready for that topic because they were taking more or less time learning specific content. Also, when you're trying to log in 30 students at one time, it can get interesting.

Mihaly Csikszentmihalyi supports the idea of gaming when he says, "Games are an obvious source of flow and play is the flow experience of excellence. Games teach us how to create opportunities for freely chosen, challenging work that keeps us at the limits of our abilities, and those lessons can be transferred to real life."

*Teacher Resource*



*Click here to download the genetics powerpoint Tammie used during her lesson!*

# Siege!

## *A Game-based Unit Focused on NGSS Engineering and Physical Science*



**AUTHOR: MICHELE HUPPERT**

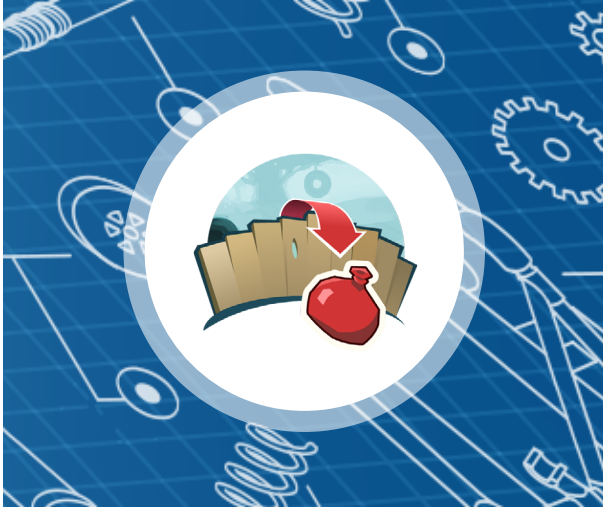
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Michele L. Huppert is a national board certified physics and earth science teacher in Wisconsin and a National Geographic Society Grosvenor Teacher Fellow. She is currently teaching Advanced Placement Physics at Nathan Hale High School in Wisconsin, but has experience teaching science and reading in the content area in middle school and high school. She has participated in several NSF Research Experience for Teachers programs, including one as a Teacher Fellow with Filament Games in Madison, WI. She holds a Master of Science in Secondary Education from University of Wisconsin-River Falls and is interested in expeditionary, project, and game-based curriculum which inspires students to take charge of their own learning.

*As a science teacher, I had a great opportunity to team-teach a project-based STREAM (STEM plus reading and art) class to 7th graders with art and technology teaching colleagues in my previous position. We developed and tested a game-based, interdisciplinary "Siege!" unit to teach NGSS engineering and physical science standards.*

We began the unit by having students complete a Google Forms pretest and setting up accounts for all 63 of our students to play *Backyard Engineers*. This digital water balloon fight was excellent for teaching students about engineering tradeoffs and constraints, optimizing solutions for varying criteria, and important aspects of catapult design and performance. *Backyard Engineers* was popular with students, and it spurred many spontaneous collaborations among students to find and share effective strategies for each challenge. We tracked each student's progress on the teacher dashboard through seven sessions of in-class gameplay. The gameplay sessions were integrated with reflective writing activities and interspersed with lab activity days. We observed that many students extended their learning by playing *Backyard Engineers* outside of class. The lab days, which were alternated with gameplay days, addressed topics such as criteria and constraints, structural design, forces, velocity and acceleration, work and energy, as well as accuracy and precision, statistics of central measure using hands-on games, data collection, data analysis, and close readings.

Our culminating event was a real-life, outdoor catapult and towers siege game for which students in our three home bases designed, built, and tested catapults, towers, and heraldic banners. We designed a hands-on, turn-based game, similar to students' *Backyard Engineers* experience, in which student teams attempted to defend their territory and destroy opponents' towers and banners. On their turn, a team chose to make repairs, move a catapult, or launch a chosen projectile (up to 3 marbles, up to 3 dice, 1 golf ball, or 1 spoonful of oatmeal) from a catapult. This game gave students ample opportunities to apply content, strategy, and engineering skills they learned in earlier learning activities.



We witnessed students designing some catapults for accuracy and others for distance, damage potential, or mobility. During each turn, they discussed the tradeoffs between design features such as base size, arm length, energy source and transfer, or projectile capacity. Students designed towers within the given material constraints to withstand enemy fire by constructing heavy bases and rounded exposed surfaces to deflect incoming projectiles. Students also developed social and collaborative skills as they elected leaders to fill positions such as production manager, materials manager, siege commander, assistant siege commander, repair technicians, and battle recorders. They worked in production teams to negotiate and construct multiple catapults, towers, and banners from a shared bin of limited building supplies.

After the siege, students participated in reflective writings and a [Kahoot review game](#) before finally completing a Google Forms post-test to assess their learning. This game-based unit proved successful at engaging students and developing mastery in NGSS engineering and physics science standards, so much so that I also used the unit to build and teach an effective curriculum for an Engineering Missions summer camp with the Wisconsin Center for Academically Talented Youth in the summer of 2015.

## Why We Use Games



The benefits of game-based learning are becoming more widely appreciated and utilized by educators who want their students to be engaged, problem solve, collaborate, and develop a deeper understanding of systems. Well-designed and skillfully implemented learning games provide students with fun, memorable, positive experiences in the classroom. Playful learning increases student motivation and engagement with academic content and skills. High quality games create opportunities for authentic strategic thinking, problem solving, and meaningful collaboration. Digital games have the added benefits of delivering pacing tailored to a variety of student needs with instantaneous feedback, the creation of “safe” places to fail, and allowing rapid iterations for learning through simulations that might be too resource-consuming or dangerous if executed in the real world. Producers of digital games are even beginning to incorporate meaningful assessment and reporting for teachers into gameplay, giving teachers access to valuable data on what students have mastered and in what areas students are struggling.

## Selecting Games for the Classroom

Whether creating a learning game or using pre-made physical or digital games in the classroom, there are a few criteria a game must meet in order for me to use it.

Firstly, a game needs to address and support standards and learning targets. Many games are simply fun to play, but it's difficult to justify classroom use if there is not direct correlation to standards. Students generally have plenty of "screen time" and exposure to games purely for fun outside of class, so classroom games need clear, robust ties to expected learning outcomes. If a game has built-in assessment and individual student progress reporting, that is a valuable addition.



*Digital games are ideal for experimentation with systems that are too fragile, complicated, expensive, or time-consuming to investigate efficiently in a hands-on style.*

Secondly, although I make games out of many learning activities, I only use digital games when the technology offers something I can't get without it. I would never use a digital game to teach students how to identify and classify minerals or collect data on how exercise affects heart rate because those skills are best learned hands-on with the real thing. However, digital games are ideal for experimentation with systems that are too fragile, complicated, expensive, or time-consuming to investigate efficiently in a hands-on style. For example, climate response to perturbations, genetic outcomes of generations of reproduction, or predicting catastrophic volcanic eruptions and mitigating its effects are excellent topics for digital learning games because they represent complex systems that are not easily manipulated by students in a classroom.



*Students appreciate and are engaged by interesting challenges that require them to think, collaborate, and develop strategies to be successful. Well-designed games provide just-in-time learning and inspire students to keep trying to find solutions, even when they struggle.*

Thirdly, learning games need to provide an honestly fun challenge and yet safe-to-fail learning environment that is accessible to a wide variety of learners. Students are highly skilled at sniffing out drill and practice activities wrapped in a "game" that isn't fun or challenging. In my experience, students appreciate and are engaged by interesting challenges that require them to think, collaborate, and develop strategies to be successful. Well-designed games provide just-in-time learning and inspire students to keep trying to find solutions, even when they struggle.

## Avoiding Pitfalls

Make sure students understand why a game is being played in class and that they know the learning targets the game is supporting. Students who report, “We’re not learning anything in class, we are just playing a game,” can cause problems with parents, teaching peers, and administrators.

Talented “gamers” may progress through a learning game much more quickly than struggling learners. Have a plan for extending the challenge and learning for students who master a game faster than other learners. Acknowledge with students when you are experimenting with teaching techniques and trying a new game in the classroom. I have found students are generally on board with a new adventure. If I find something isn’t working, I’m not afraid to change it or abandon it if needed.



*Well-implemented game-based learning in the classroom creates more engaged and self-directed learners who develop deeper understandings of complex systems, better collaboration skills, and more effective problem solving strategies.*

With thoughtful choices during planning and flexibility in execution, you can incorporate game-based learning into your teaching toolbox. Well-implemented game-based learning in the classroom creates more engaged and self-directed learners who develop deeper understandings of complex systems, better collaboration skills, and more effective problem solving strategies.

## SCHOOL OVERVIEW

*Nathan Hale is a public high school in the West Allis – West Milwaukee School District serving more than 1,600 urban students in grades 9-12. Nathan Hale has a focus on a rigorous, balanced curriculum, utilizing differentiated instruction and assessment so that students take responsibility for reaching their fullest potential in a safe, tolerant environment fostering the growth of respect and integrity, and enabling them to assume a productive role in the community.*



# Tower and Catapult Project

## INTRODUCTION:

Each STREAM group will be conducting a circular siege where you will be on a large circular area 58 meters in diameter. Each STREAM group will have 1/3 of the circle as their area to set up their towers and catapults. You will “shoot” your projectiles with your catapults into the other areas trying to damage or knock over the other teams towers, catapults, or banner.

## Building Your Siege Equipment:

As a team, your STREAM classroom will be building 3 towers, 3 catapults, and a banner that you will place in your “pie” section of the siege circle. You will receive a kit of materials that your team will be allowed to use for building. Each STREAM room will have the same kit of materials, and your team will decide how to best use it to meet all the different requirements.

### TOWER REQUIREMENTS:

- ✓ 3 towers constructed per home base, each on a separate provided base.
- ✓ High craftsmanship and neatness on finished towers.
- ✓ Displays efficiency in use of materials (not just a pile of stuff glued together).
- ✓ All tower walls must be “faced” with paper.
- ✓ Displays team crest and team colors.

### CATAPULT(CAT) REQUIREMENTS:

- ✓ 3 catapults constructed per home base, each on a separate provided base.
- ✓ Demonstrate smooth and efficient transfer of energy (potential to kinetic).
- ✓ Demonstrate *adjustability* — different shooting situations (distance, projectile, etc).
- ✓ *Durability* — built to fire repeatedly throughout the siege without repairs.
- ✓ High craftsmanship and neatness in construction.
- ✓ Displays team colors and crest.
- ✓ Mass of finished catapults is recorded on rubric.

### BANNER/CREST REQUIREMENTS:

- ✓ Banner is at least 150 square cm.
- ✓ Banner is displayed at least 90 cm above the ground at start of siege.
- ✓ Artistic design criteria are incorporated into crest.

## Gameplay:

Play will proceed in rounds in which each team will have one turn. Each team has a choice of how to use each turn. During your team's turn, the Siege Commander will have the final say as to how the turn is used, but the activity must be carried out by team members other than the Siege Commander. Each team's turn must be completed within 2 minutes of the end of the previous team's turn.

### **SIMILAR TO BACKYARD ENGINEERS YOU CAN USE YOUR TURN TO:**

- ✓ MOVE a catapult by turning it and/or moving up to 80 cm away from its current position if its empty mass is less than 50 g. You may change direction and/or move up to 30 cm away if the catapult has an empty mass of 50 g or greater.
- ✓ Choose, load, and SHOOT a projectile(s) without changing the position of a catapult. Projectile choice may be:
  - 13 marbles
  - 13 dice
  - 1 golf ball
  - 1 practice golf ball
  - 1 spoonful of cold oatmeal (if weather permits playing outside)
- ✓ Make up to one minute of REPAIRS to one catapult or tower using only masking tape without moving it from its current position or changing the direction it is facing.

Each team will use a Siege Engineering Journal to keep track of their choices each round, the damage they inflict on other teams, and the damage they receive from other teams.