Target Zombies with Plants and Math

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What do plants, zombies, and video games have in common? Mathematics and critical thinking. Students, inundated with technology, often access various software and hardware for play. Therefore, using video games as a vehicle for implementing technology in math class may help motivate students and pique their interests. *Plants vs. Zombies*™ (PopCap Games 2009) is one such video game.

Video games can provide a context for mathematical problem solving and may help make mathematics more meaningful for students (Nicol and Crespo 2005). This article explores middle school level questions set in the context of the *Plants vs. Zombies* video game. The goal is to give teachers a context that is familiar to students when investigating the topics of rate, cost effectiveness, and proportional reasoning.

GAME DETAILS

Each game level begins with the player deciding what plants should be selected to fight the zombie invasion on the basis of the types of zombies in that level. After the plants are selected, the game begins. The plants that produce sun, which is the game's currency, must be planted immediately. The suns should be picked up and used to purchase other plants as they fall. The various plants cost different amounts of suns. Generally, the better the plant, the more suns it costs.

Forty different plants can be used to fight twenty-six different zombies (nine additional bonus plants can be earned throughout the game). As the game progresses, it becomes more and more difficult to prevent a zombie invasion. Students must analyze the features of both zombies and plants to strategize how best to fight off a zombie invasion. **Figure 1** displays a game state toward the end of an invasion, or level, when many zombies are entering the yard.

THE EXPLORATIONS

Some of the more common types of plants used to fight the zombies are Peashooters, Snow Peas, and Repeaters (see **fig. 2**). Because these plants are commonly used, they will be the focus of the mathematics presented in these explorations. These plants also fire at specific intervals, allowing for comparisons.

The more common types of zombies are Zombie, Conehead Zombie, Buckethead Zombie, and Football Zombie. The zombies are listed in order of difficulty. Zombie is the easiest to stop; Football Zombie is the most difficult. See **figure 3** for more zombie attributes.

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Fig. 1 This screenshot displays a zombie invasion. The Peashooter, Snow Pea, and Repeater plants try to hold the line on zombies invading the house.

The Accessibility of *Plants vs. Zombies*

Plants vs. Zombies is a computer strategy game designed for students ages ten and up. Players must use logic, reasoning, and mathematics to prevent zombies from invading by sowing plants with various defensive features. The game has received awards, including the Strategy Game of the Year (by USAToday.com) and the Puzzle Game of the Year (by PC Gamer).

Plants vs. Zombies is available for many platforms: PC, Mac®, Android, iPad®, iPod®, Kindle Fire®, Nintendo®, PlayStation®, and Xbox®. A sixty-minute free trial is available from the PopCap website (http://www.popcap.com/all-games/plants-vs-zombies). Students can download the game on their personal electronic devices, making it fruitful for situating mathematical learning in a familiar context.

WHERE'S THE MATH?

Many different mathematical questions can be posed to middle school students using these plants and zombies:

- How many peas from a Peashooter (a Snow Pea or a Repeater) are needed to stop a Zombie (a Conehead Zombie, a Buckethead Zombie, or a Football Zombie)? How do these plants compare in their effectiveness?
- Here are the toughness ratings of the zombies: A Zombie (low), a Conehead Zombie (medium), a Buckethead Zombie (high), and a Football Zombie (very high). Are the zombie toughness ratings accurate? Explain.
- Is the Conehead Zombie really twice as tough as a Zombie? How do you know? Are the toughness ratings of all the zombies proportional? Explain.
- If each block of grass measures 2 inches long, how fast is the Zombie moving in feet per second? How fast is the Zombie moving in miles per hour? Compare this rate with other zombies (a Conehead Zombie, a Buckethead Zombie, or a Football Zombie). Which zombie moves the fastest? Which zombie moves the slowest? What are the rates of the zombies?
- The Snow Peas slow down zombies. How does the Snow Pea affect the movement rate of the Zombie? What about the Conehead Zombie, the Buckethead Zombie, and the Football Zombie? Does planting several Snow Peas in a row slow down the Zombie's rate more than just planting one? Explain.
- A Peashooter costs 100 suns and a Repeater costs 200 suns. The game states that a Repeater shoots twice as many peas as a Peashooter. Is this true? Does it cut the time needed to stop a specific zombie in half? Is it cost effective? Explain.

Each time a zombie is hit by a pea, he faintly lights up. Students can use this information to help gather data. They may need to work in pairs or in groups of three, in which one guides the progress of the game and the other students gather data. Having two students gather data may help validate the findings. If students have different numbers (as will be the case), use averages. The teacher may wish to calculate the mean for all groups to obtain more accurate data. The game gets more complex as it progresses, and it may be difficult to count specific hits. At lower levels, it will be easier to gather data because fewer events happen within the game.

These questions focus on the use of the specific plants and zombies described in this article. It is important to note that other questions can be examined using additional plants and zombies:

Fig. 2 These brief descriptions, containing both shooting and cost information, explore the plants that must hold back the zombie tide.

	Peashooter can shoot 1 pea at a time. The peas slow down the rate of zombie encrouchment. This plant costs 100 suns.
	Snow Pea shoots 1 blue pea at a time. It costs 175 suns.
	Repeater is similar to Peashooter, but can shoot 2 peas at a time. It costs 200 suns.

- Which plants are most effective at stopping various zombies? Chose three different zombies to investigate. Then describe the defensive plants that are most effective at stopping each zombie. Why is the plant so effective? Use mathematics in your explanations.
- When a Buckethead Zombie's bucket has been removed by a Magnet-shroom, how many peas are necessary to stop it? How does this number compare with stopping a Buckethead Zombie without a Magnet-shroom? Is the Magnet-shroom cost effective at all levels? Explain.
- A Sunflower costs 50 suns. You can add a Twin Sunflower to a Sunflower for 150 additional suns. At what point will the Twin Sunflower become cost effective? Explain. (This question is unanswerable with the free version.)
- If you could only select four plants (other than a Sunflower) to use for defense, which plants would you choose? Use mathematics to rationalize your selections. You may want to discuss cost, power, recharging level, and effectiveness.

After students have had the opportunity to investigate some of these questions, ask them to formulate their own mathematical questions to pose to the class. There are also other possibilities, such as creating tables of values to demonstrate algebraic relationships. The rates of the zombies could also be graphed on a coordinate grid.

ACCESS TO THE GAME

One difficulty that a teacher may face in implementing this game is access to the game itself because most schools will not have the money to buy it. However, a one-hour free version is available. In addition, embedding the explorations as an at-home project would allow students who have access to the game to work with students who do not. Because the game is common and available on many platforms, a number of students may have access to it.

Another difficulty may be that students become so caught up in the game that the mathematics within the lesson is lost. The teacher should give students fifteen minutes of play before the mathematics is investigated. Student monitoring, perhaps using an observational rubric, is also necessary. If students are using the free trial version, only one hour is permitted, so it is imperative that students stay on task. By reminding students, using observational rubrics, and having plans in place for data collection, this concern should be minimized.

OTHER GAMES

With its popularity, *Plants vs. Zombies* provides a familiar medium for investigating mathematical questions in context. It is not enough to simply teach mathematics from the textbook. Mathematics lessons must be designed to embrace technology and other tools to support student learning beyond textbook lessons (Nicol and Crespo 2005). The explorations presented in this article can guide teachers in moving beyond

Fig. 3 The four zombies, sporting a variety of headgear, exhibit different behaviors, thus allowing for strategy and decision making that require mathematics.

	Zombie, the most common, has a low toughness rating and is generally easy to stop.
	Conehead Zombie has a medium toughness rating and is twice as tough as Zombie.
	Buckethead Zombie has a high toughness rating. Its bucket makes this character very resistant to damage.
	Football Zombie is fast and has a very high toughness rating. Out of all the zombies, it is the most difficult to stop.

the textbook by integrating a popular computer game into their middle school mathematics courses.

As teachers continue to guide their students, other electronic games could be factored into lesson planning. Students play many games but often neglect to see the math. For example, *Mario Brothers* games, such as "Mario Kart"® and "Super Mario Brothers"® (Nintendo 2012), can be used to support math instruction. If teachers take advantage of students' interests in technology and games to guide their lessons, students might become more motivated and interested in mathematics.

REFERENCES

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