Can Gamification Augment Formal Learning and Assist Both Learners and Teachers

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Introduction

While it can be argued that technology in education has a long history, rapid innovations have led to educational technologies becoming increasingly mainstream (Bates, 2014). There is some current interest and debate about whether or not gamification will become a trend in mainstream K-12 education. The CEO of the NMC Horizon Report K-12 2015 edition recently explained that gamification did not make it into the 2015 report as a viable trend because, “For most people, it's just too hard to integrate and there are no tools to make it easier" (Smith, 2015). However, gamification did make the Hanover Research’s report *Emerging and Future Trends in K-12 Education*. At present then, it is useful to explore how gamification can be used to augment traditional K-12 face-to-face learning, and the arguments for why it may or may not become a mainstream trend. To this end, the following case-studies explore how games can augment formal knowledge and assist both the student and teacher in learning about ecosystems.

Methods

The case studies were developed by two elementary teachers who collaborated on a mini-ecosystems unit. The unit includes four lessons with traditional face-to-face discussion, paper and pen activities, play-based learning activities and online games. More than twenty games were analysed before final selections were made for the unit. The unit includes ongoing assessments and lessons about ecosystems, food chains, food webs and disruptions to ecosystems. The researchers also surveyed students about the learning activities.

To address the first part of the inquiry question, ‘Can games augment the formal knowledge of students in learning about ecosystems?’ the teachers collected data in the form of assessments, anecdotal observations, and a qualitative survey from students. In order to address the second part of the inquiry question the teachers identified features that were

useful in terms of reinforcement, assessment and time as they considered, ‘How games can assist the teacher when designing and facilitating a mini-unit on ecosystems?’

Procedures

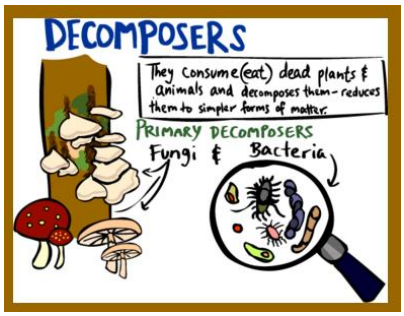
The mini-unit spans four days and includes an introduction to ecosystems, basic food chains, food webs and balanced ecosystems.

Day 1 Intro to ecosystems and Basic Food Chains: producers / consumers / decomposers

Students watch a Bill Nye food chains video. They play a tag game in which the class is divided into producers, herbivores, carnivores and decomposers. They also complete a crossword. Additionally the unit is integrated into art activities. This formal face-to-face learning was augmented by playing online games. The games are The Producer, Consumer, Decomposer Game, Animal Diet Game, and Carnivore Herbivore Omnivore – Sorting Game

Day 1 Basic Food Chains: Game 1 The Producer, Consumer, Decomposer Game

The Producer, Consumer, Decomposer Game allows for students to gain knowledge about producers, consumers, and decomposers before they start the game. Students can click on the link to read about the new vocabulary.



This is a sample of the information provided on decomposers.

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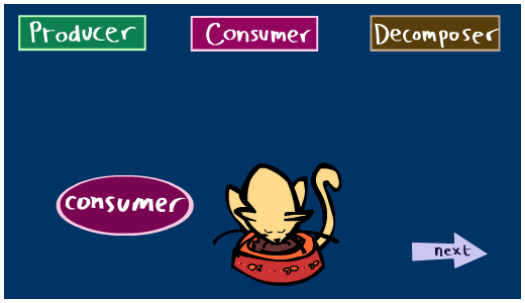
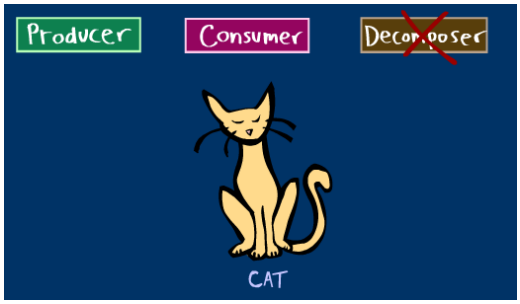
Once the game starts, players must decide if the organism is a producer, consumer, or decomposer. If the player gets it right a new screen shows the organism in action.

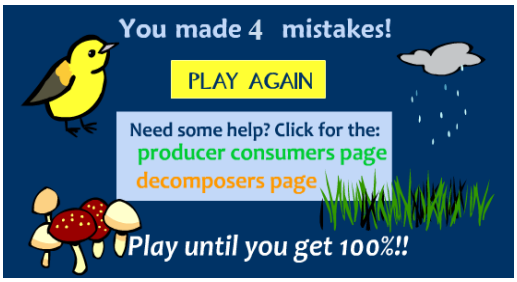


If the player gets it wrong an “X” will appear over their answer and the player can choose again.



Halfway through the game the player is shown what they have learned, given their score so far, asked if they would like to review, or if they are ready for more.

Once the students have finished the game a final score is given. The player is asked if they would like help. They are also prompted to continue until they get 100%. This activity should take approximately 10 minutes.



The student proudly shows the teacher when they receive 100%. The teacher records this information.

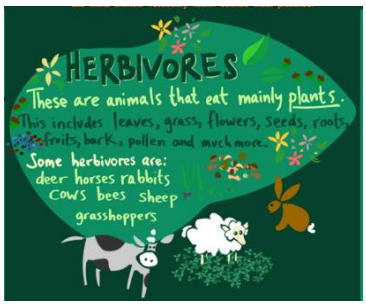
Day 1 Carnivore, Herbivores and Omnivores: Game 2 Animal Diet Game

This is a simple testing game where students must decide if the animal is an herbivore, carnivore, or an omnivore. If you get the answer right the animal begins eating and a new animal appears. I you get it wrong then an “X” is placed over your choice and you try again.

This pattern continues until you have labelled all the animals.

Upon completion students are given a final score. They are asked if they would like to learn more about the three consumer groups. They are also prompted play again until they get them all right.

The help is easy for the students to read and understand.



This game should take about 10 minutes to complete. Students will be required to get 100% before showing the teacher their results.

Day 1: Game 3 [Carnivore Herbivore Omnivore – Sorting Game]

In this game, students are asked to drag each animal into the correct bin before the time runs out. If the students need help, examples are given at the bottom of the game page. The game begins with animals moving across the screen. As players drag animals into the correct bin they are rewarded points. More and more animals appear to be sorted. If you make a mistake you lose points and the animal is returned to the screen. The game continues until all 30 animals have been sorted or your 3 minutes are up.

Students will be required to score at least 200 points before showing their results to the teacher. They will, however, be encouraged to go for the top score of 300. The game only takes a few minutes to play, but the students will be trying to beat their own and partner's scores.

Day 2 Food Chains and Balanced Ecosystems

Students watch a BrainPop video on food chains and complete a worksheet. They play online games and, in closing, students watch a Studyjams video. The games for day 2 are: Food Chains (BBC), and Food Chains (Sheppard).

Day 2 Game 1 Food Chains (BBC)

Food Chains is an interactive video to help students learn about food chains. First students are given information about food chains and then they use this information answer questions. Students learn about food chains on land and sea.

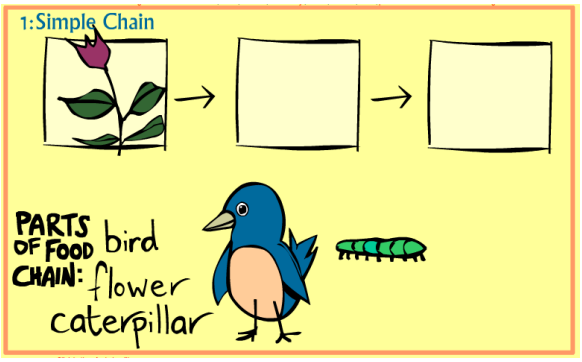
As they learn about sea food chains, Students answer questions about what eats plankton, herring, cod, and seals. The final slide includes information about the orca whale.

As they learn about land food chains, Students continue to engage with video and questions. This food chain includes grass, grasshopper, toad, adder, and finally, the common buzzard. The game takes about 5-10 minutes to play.

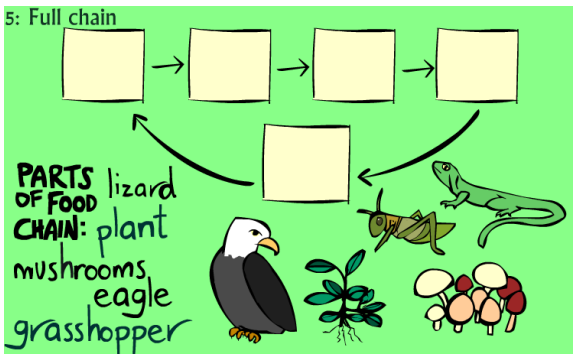
There is no score at the end of this interactive video. Students will simply be marked as completing the interactive video.

Day 2 Game 2 [The food chain game](#) **(Sheppard)**

Information about how to play the food chain game is very clear. This game lets students complete a variety of food chains. The food chains start out fairly simple, but become progressively harder as the game goes on.



At first, the chains are very short. After the students drag the pictures into the correct boxes the food chain comes alive. The caterpillar eats the plant and then the bird eats the caterpillar.



As the students work their way through game, the food chains become more complex.

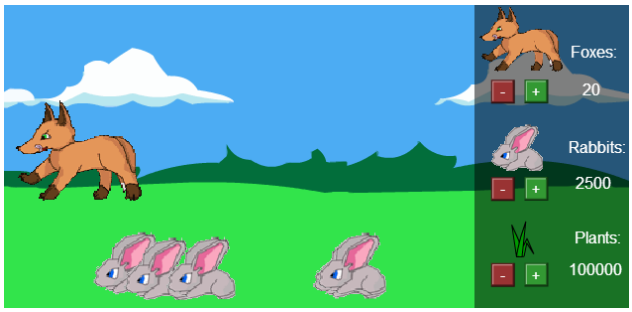
Help is available if students feel they need it. There are two more food chains to complete before the students get their final score. Since they can play the game many times, they will be expected to score 100%. The games takes about 5 to 10 minutes to complete.

Day 3 Food Chains

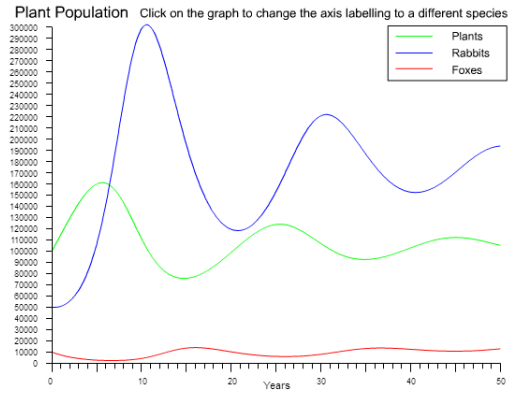
Students play online games followed by a reading comprehension activity and a food chain sort. The game for day 3 is and Sunny Meadows.

Day 3: Game 1 Sunny Meadows

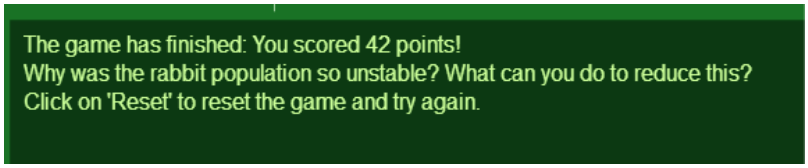
The game is played using a basic food chain. This chain includes plants, rabbits, and foxes. Plants grow (producers), rabbits eat plants (consumers), and foxes eat rabbits (consumers). The populations are dependent on each other. Too many rabbits will cause the fox population to increase. The rabbits will eat too many plants and will not have enough food. The rabbit population will decline because there is not enough food and because there are now more foxes. Less rabbits mean more plants, and the cycle continues.



At the start of the game, students add the number of plants, rabbits, and foxes they would like to start the game. There is a picture to represent the number of each species.



Students watch the screen to see the pictures of each species increase or decrease as the years go by. They may also watch the action in graph mode. They are able to read what is happening during the 50 year simulation of the game. Each round takes 15 seconds, but you can reset at any time.



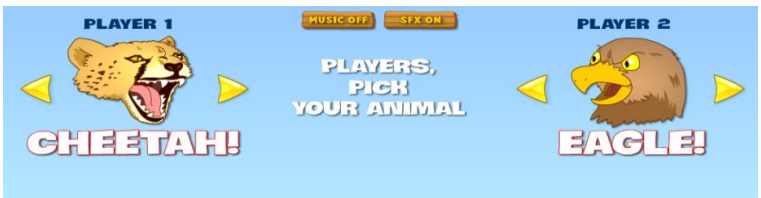
At the bottom of the screen, students read the questions to aid in their understanding of the food chain. The goal of the game is to achieve a stable population. The above graph was only worth 42 points. Students will be asked to try to achieve over 60 points.

Day 4 Food Chains in Food Webs and Balanced Ecosystems

Students watch a Studyjams Food Webs video, complete accompanying worksheet and play the online game Food Fight.

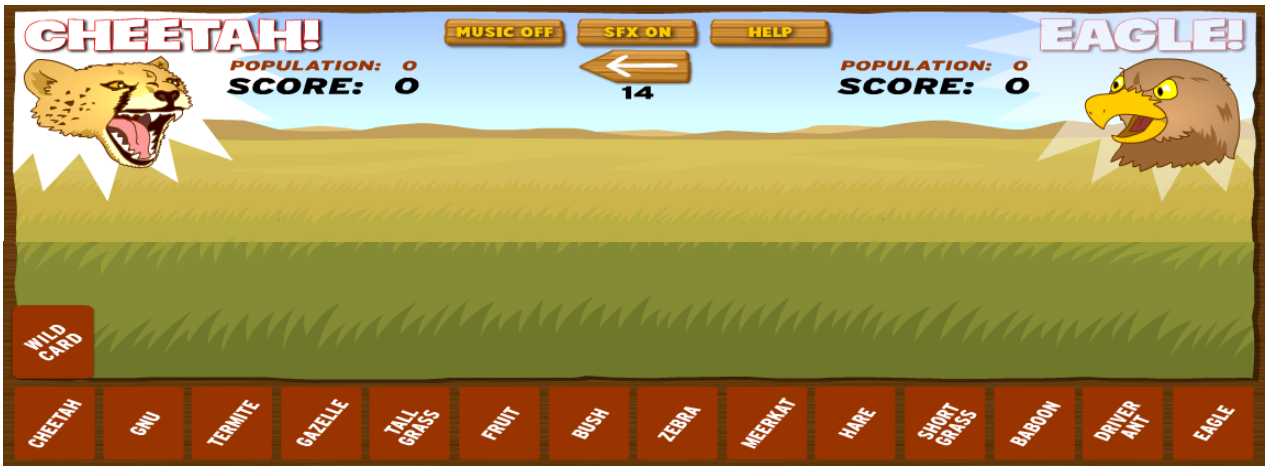
Lesson 4 Food Webs: Game 1 Food Fight

In the Food Fight game, students play against each other. They try to build a food web to support their animal. The more your animal's population grows, the more points you score.



First, each player picks the animal that they are going to try to support. There are 26 animals to pick from.

Students then choose the length of the game



The playing cards are at the bottom of the screen. Students pick cards that best support their animal's food web.

If a player puts a mouse over one of the cards, the game shows the predators and prey of that animal. This helps the student build the food web. Since the hare and the meerkat are prey for the eagle, this player should look to support those animals in their food web.

As the game progresses, the food web becomes more complex. Energy levels are shown for each animal, so the players know what needs to be supported.

The Food fight game might take the students awhile to learn how to play the game. Once they know how to play, the game will take about 5 to 10 minutes to play.

Results of Class A: Review of Procedures, Results, and Teacher Observations

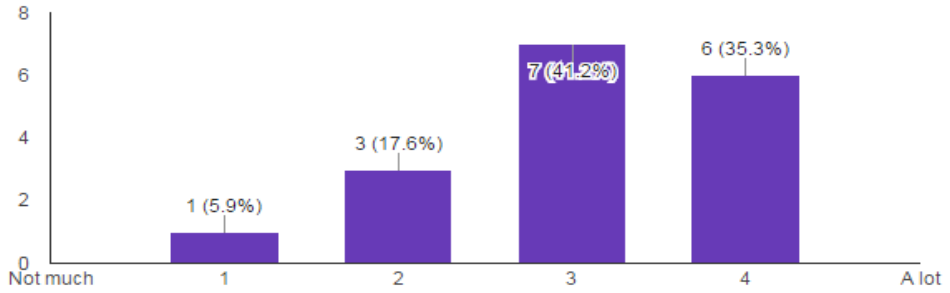
The proposed procedures were followed as much as possible. Some activities were completed out of order. For example the food chain tag game and forest ecosystem mural were done before watching the Bill Nye video. This was because of scheduling and school activities that could not be re-arranged such as class photos, assemblies, lock-down drills etc. There were also complications with the technology. Despite the fact that this class has 13 iPads and 8 laptops making one-to-one activities possible, the games did not work on the iPads (even with shockwave compatible software). Such complications are a normal part of any school week but they point to the difficulty of conducting comparable research that has a high degree of reliability.

The activities chosen were intended to meet a variety of learning needs. This class has a significant proportion of struggling readers and writers. At the start and throughout each lesson students were told that they were helping their teacher with an assignment and they were asked to think about their learning and what helps them with their learning. The students chose their own contributions to the art mural. Nearly all students were able to

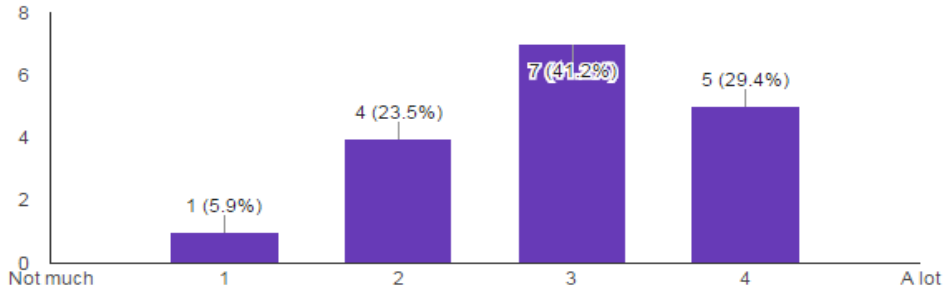
identify primary producers, herbivores, carnivores and decomposers that are native to BC forests. A few students asked if they could contribute non-native species. The students enjoyed food chain tag game and asked repeatedly throughout the week to play again. The reading comprehension and crossword activities were introduced and read aloud. These were the most challenging for the struggling readers and writers. Students completed the food chain cut-and sort activities independently. Videos were introduced with 'hooking' questions and stopped throughout for formative assessment and discussions. Paper and pen video activities were guided by the teacher and stopped so that students could answer questions as they were answered in the video. Games were played once students logged in. In general students appeared to enjoy activities.

The student survey was completed at the end of the week and teacher directed. The questions were read aloud and scaled choices were explained. Students completed the surveys on paper and the teacher input their surveys online after school. Three of the surveys had to be discarded because they were not completed correctly and one student was absent. 17 responses were collected. The majority of students believed that all of the activities helped their understanding of ecosystems. Most students believed that the online games helped the most. Their survey results are reflected in the following graphs.

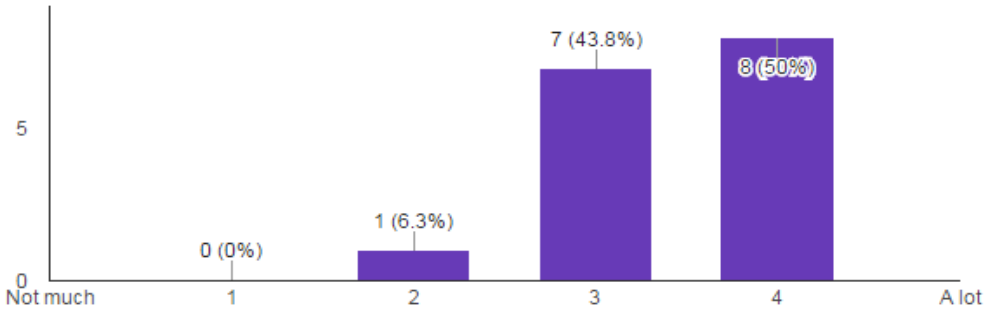
Did the class discussions help your understanding of ecosystems?
(17 responses)



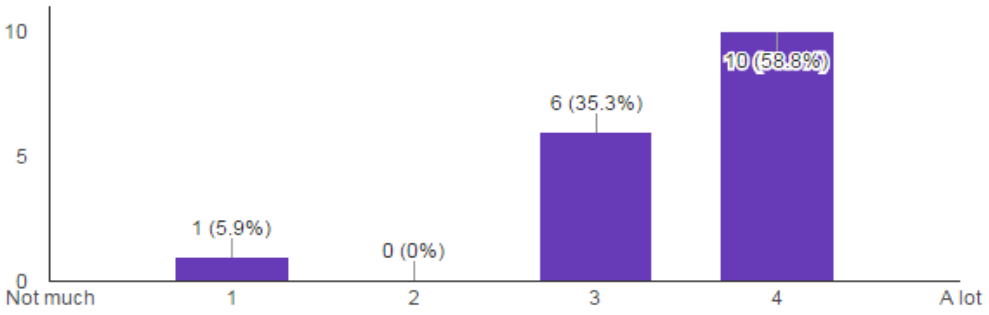
Did the paper and pen activities help your understanding of ecosystems?
(17 responses)

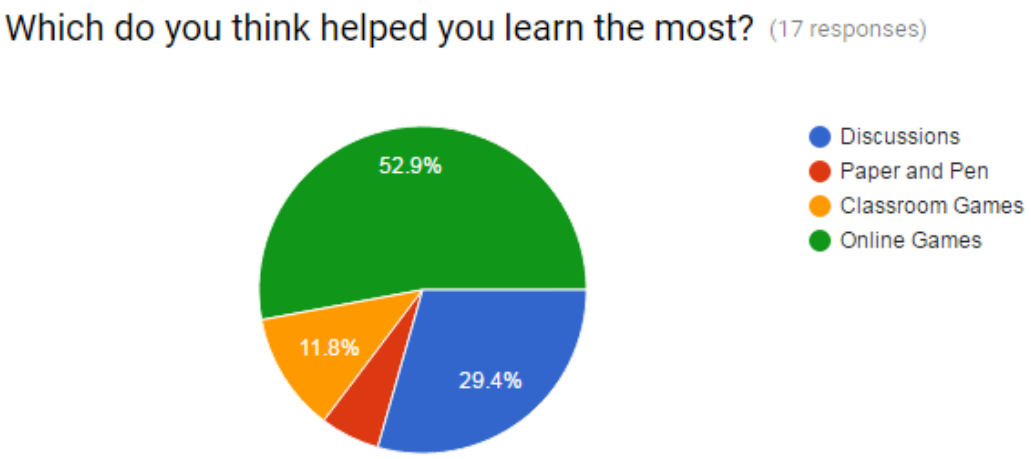


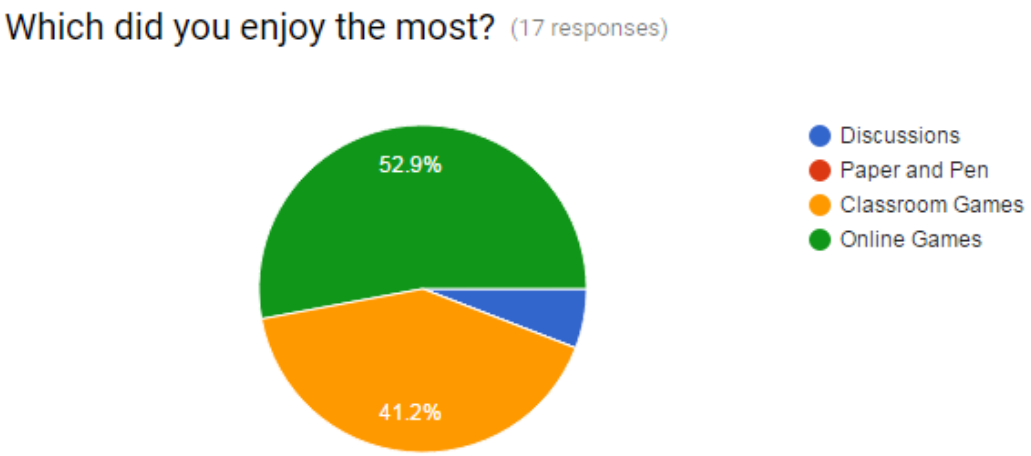
Did the classroom games help your understanding of ecosystems?
(16 responses)



Did the online games help your understanding of ecosystems? (17 responses)







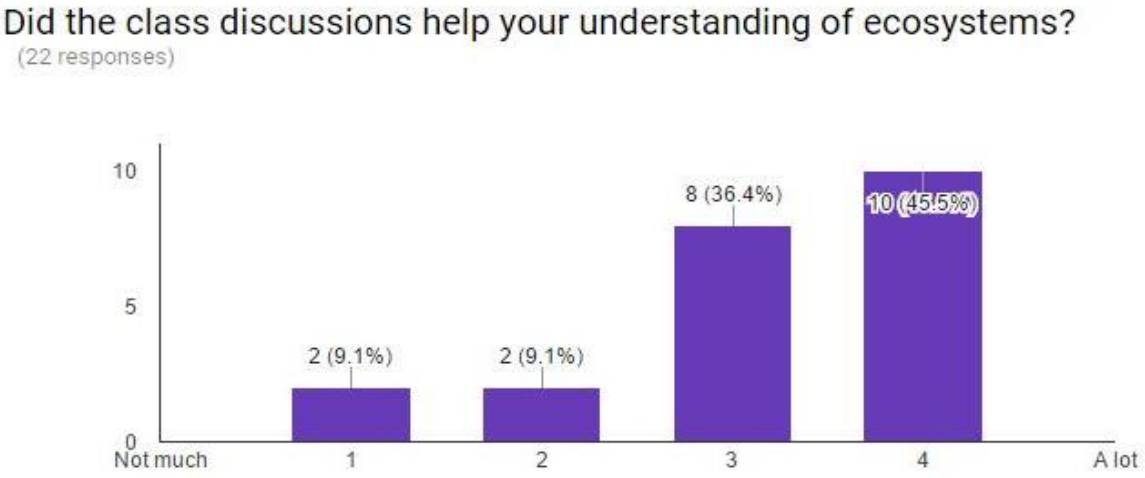
The validity of this data is debatable. Can 8,9,10 and 11 year olds be accurate judges of their learning? Were their selections based on what they thought the teacher wanted them to select? Surveys were not completed anonymously. The teacher noticed that by the end of the week, some students still struggled with the accurate comprehension of terms, but seemed to have a solid understanding of the 'big ideas.' The teacher felt discussions, reviews and questioning seemed to be most effective, although the games undoubtedly reinforced the content.

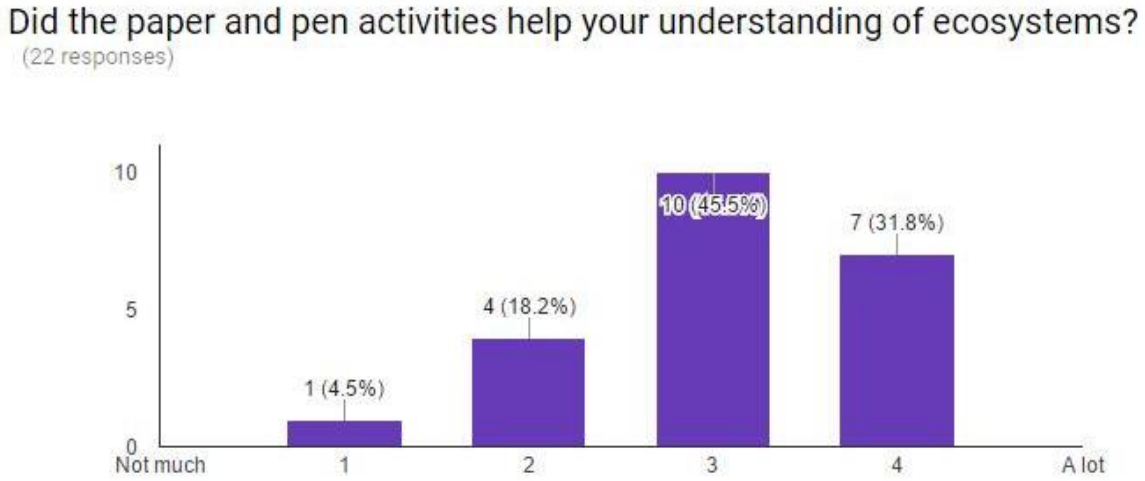
Results of Class B: Review of Procedures, Results, and Teacher Observations

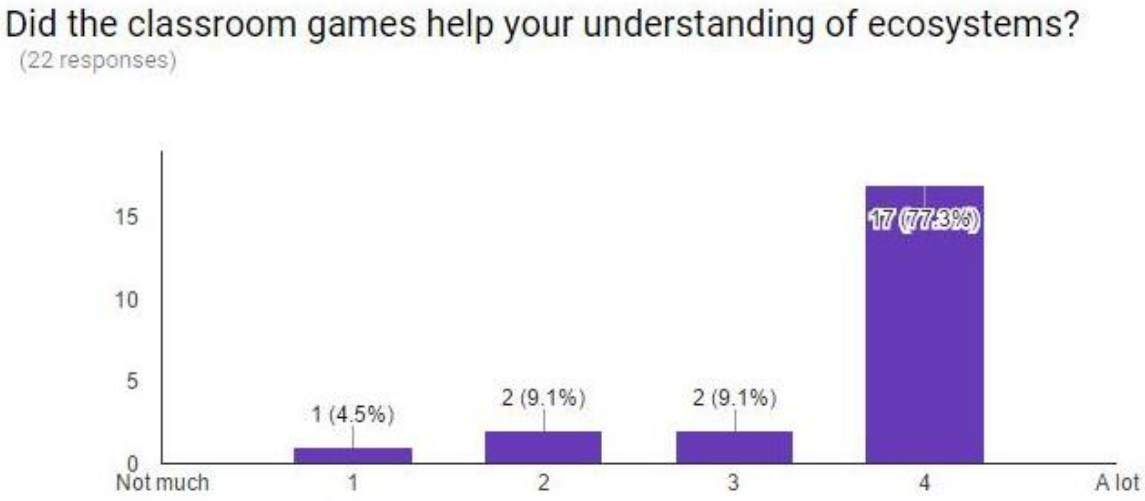
Class B has 19 in grade 3 and 5 in grade 4. As with Class A, the proposed procedures were followed as much as possible with some activities completed out of order. The online games were only useable in the computer lab as our iPads do not have flash loaded on them. The use of the online games was based on the computer schedule not the research or classroom schedule. The tag game with producers, herbivores, carnivores, decomposers was delayed because we had a lacrosse teacher using the gym and it was raining outside. Such complications, like Class A, are normal but make it difficult to compare results.

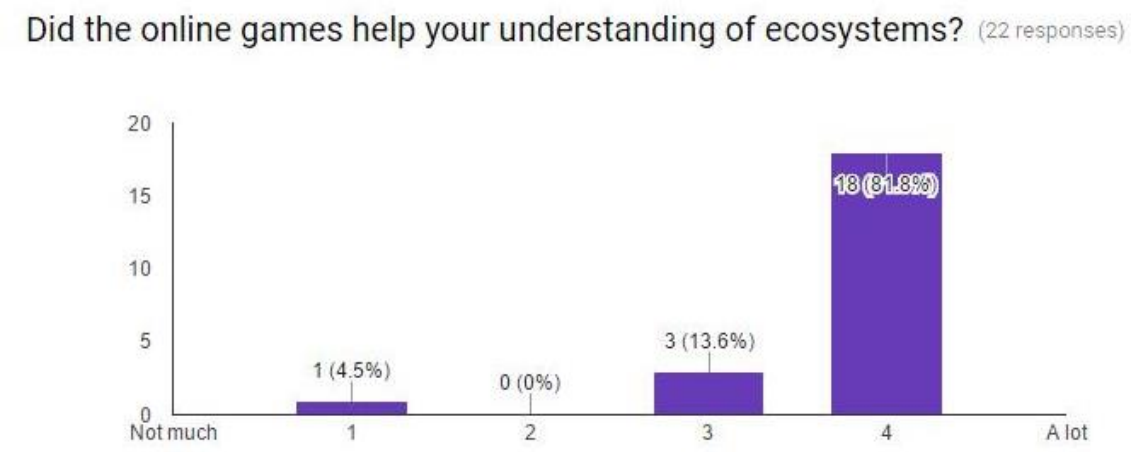
The clientele of Class B also offers many challenges. Providing a variety of lessons can have both positive and negative results. Some students need the consistency in their lessons. These students find change hard which can influence their behaviours. These behaviours may impact their personal ability to learn, but also the ability for other to learn too. Some love anything new and they thrive. The tag game, for example, was new. It was meant as a learning game. Some missed the point of the game and thought it was about winning or losing. Anytime something is new in a primary classroom, there is a learning curve. When blocks were introduced for showing ‘groups of’ in multiplication, some students built cars with them. The second time, doing something new, often works much better. Because our time frame was so short, doing the same or similar lessons was not possible. Both teachers believe it is important to provide a wide selection of activities for students to do and try to integrate Universal Design Principles when designing learning activities. In this mini unit, Class A and Class B did the same activities, and all lessons were successful.

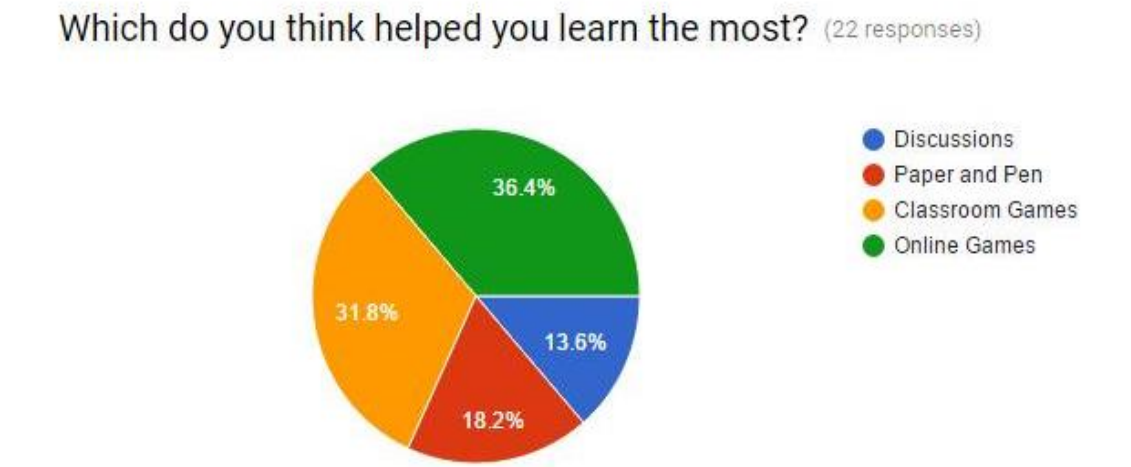
Survey for Class B Results

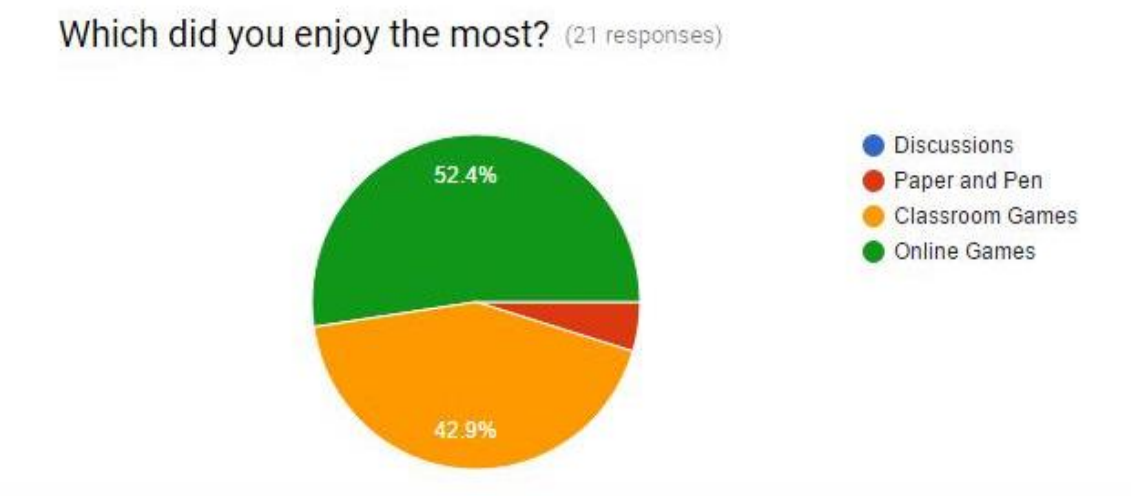












The data from Class B was collected by reading the survey to the students and explaining how the scales worked. All 22 of the students present that day completed the survey. Two students were absent. One student did not answer the last question. The results were

displayed in graph form. The majority of students believed that all of the activities helped their understanding of ecosystems. Online games was the most popular choice for both what the students thought helped them the most, and the activity they enjoyed the most. Playing classroom games was second in both those categories. Teacher from Class B was surprised by the popularity of the classroom game. It is questionable if the students really learned more playing the classroom game or if they felt that way because they had fun. The rest of the results were compatible with how the teacher perceived they would be.

Comparison

Both classes faced technology complications and struggled a little to complete the procedures as proposed. This again points to the challenge of conducting standardized, research, comparably in different settings. While debatable, the survey results revealed the students in both Class A and Class B preferred the online games. When the students were asked 'Which do you think helped you learn the most?' 58.8% of Class A and 81.8% of Class B said it helped a lot. Only two students, one from each class, said that it was not helpful. Class B uses more online games in general and could have shown signs of digital fatigue; they did not. Conversely, Class A has not integrated as many online games into learning activities and thus, the novelty of the games excited students. Despite the differences in how online games have been used in the past, both classes said they enjoyed learning using online games more than any of the other activities.

Both teachers have also adopted a skills focus versus a content focus. This mini-unit was designed for a graduate assignment and is more content focused. Most of the games were content driven (ecosystems vocabulary and concepts). Just two of the online games provided opportunities for critical thinking about balanced ecosystems (Food Fight and Sunny Meadow), but it is difficult to assess if they did indeed foster critical thinking and deeper understandings.

Analysis and Discussion

Does using online games work for students?

The results from the survey clearly suggest that students believe that online games help them learn. Students also enjoyed learning using online games. Because of our layered approach to teaching, one cannot isolate just what was learned online vs other activities. Even though the teachers spent hours looking for good games to help teach ecology, very few were found. The results may have been even more positive towards playing online games if the games were more exciting and taught more. Despite this, students still found using online games a very positive experience.

Does gamficiation work for the teacher?

Recently, there has been debate about whether or not gamification will become mainstream in K-12 Education. The CEO of the NMC Horizon Report K-12 2015 edition explained that gamification did not make it into the 2015 report as a viable trend because, “For most people, it's just too hard to integrate and there are no tools to make it easier." (Smith, 2015). Others have cited money, infrastructure, and policy as reasons why tech companies focus marketing towards parents rather than schools (Ambient Report, as cited in Lynch). It’s difficult to understand exactly what NMC CEO Larry Johnson meant when he said that it is too hard to integrate, but there were multiple challenges for Class A as online games were integrated into the mini-ecosystems unit.

Class A

One of the biggest challenges was the amount of total time spent on the online activities versus the amount of powerful learning and the other ways to achieve similar learning results. The two researchers looked at over twenty games related to ecosystems. Their

criteria for a ‘good’ game, was how well it presented concepts, tracking, and Universal Design for Learning features. They searched and played each game and this took at least five hours per person. Deploying the devices and returning them for one of the teachers also took time. Once it was determined that the games would not work on iPads even with shockwave compatible software, a laptop cart was required. They had to be booked, handed out, returned to the cart and returned to their homeroom. One day, another teacher had mistakenly taken the device cart, it had to be tracked down and retrieved. A number of students also needed assistance logging in. The time spent on preparation for the traditional / face-to-face activities was less than two hours. While many students in this Class A group, claimed the games helped their learning the most, it remains debatable if the games contributed significantly. The teacher believes that they liked the novelty of the games, but discussions were the most effective learning activities. Additionally, based on teacher observations the students enjoyed the other activities as well. They enjoyed the food chain tag game and making the mural very much. As NMC CEO Larry Johnson suggests, it was difficult to integrate online games to develop critical and higher level thinking and assess development, although it certainly helped with content practice and reinforcement.

In short, in terms of the second part of the inquiry question, “can games assist the teacher in learning about ecosystems”, they did not provide enough assistance with deep learning, tracking and ease of use for Class A’s teacher. A quote from Ian Bogost(2011) captures the gamification conundrum, “There just aren’t enough high-quality games that also serve serious purposes effectively. Making games is hard. Making good games is even harder. Making good games that hope to serve some external purpose is even harder.” All games will continue to be explored and integrated into Class A’s activities, however time spent finding online games will be limited until their effectiveness is more convincing.

Class B

The use of online games is part of the regular routine for Class B. Normally, this teacher uses an online game that supports any one of the elementary classroom subjects. These games support the teacher in educating the students. The preferred method is to use a station rotation approach. One group works on paper pencil activities while the other group is playing online games. The online station works independently enabling the teacher to work with a smaller number and, therefore, better support their learning. The confinement of the computer lab does not support this style of teaching. Finding games to assist the teacher in a very narrow subject area proved to be difficult. After researching over 700 websites, only about 20 different ecology games were found. Some of those games were meant for much higher grades and were not suitable for grades 3 to 5. In the end, the teachers had to settle for using the online games that were available. The games did not work on the iPad minis that were available for teacher B, so the computer lab was used.

Part of Teacher B's philosophy is that learning has to be fun. The students clearly enjoyed learning with online games. How much time is reasonable to look for online games and at what cost? Teachers need time to prepare materials for learning. Online searches take away from that preparation time. A good game, on the other hand, reinforces learning and frees the teacher to help smaller groups of students. It is a balancing act.

For teacher B, the use of online games will continue to be a normal part of the classroom routine. A reasonable amount of time will be spent looking for the perfect online game to support learning.

Conclusion

In the context of present debate around K-12 education trends and gamification, two case-studies were conducted to explore how games can augment formal knowledge and assist both the student and teacher in learning about ecosystems. The results clearly showed that students enjoyed the online games and this facilitated engagement with all activities in the unit. However, like current experts in the field the researchers felt somewhat divided about whether gamification can viably be integrated into the K-12 mainstream. The time spent searching and finding ‘good’ (enough) games was significant. Playing the games did not fit into routines seamlessly either. Online games clearly provided an opportunity to practice and reinforce learning. However, it remains unclear if they can promote deeper level understandings. Both teachers will continue to explore online programs that promote student engagement and also have tracking and data collection features to assist the teacher.

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