Final Thoughts: Snake Invaders

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EME6613.002S19 Development of Tech-Based Instruction

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May 03, 2019

*Reflection completed individually

Reflection of Snake Invaders Game Development Group Project Completed By:

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INTRODUCTION

There are many challenges in science education. I taught fifth grade for two years. For many of my students, science was their favorite subject. They liked the interesting topics, hands-on approach, and that they were learning about the world around them. Fifth grade year is also the year that students take the Science FSA. This was a big deal. I noticed that many of the students had gaps in their learning to fill in and after talking with other fifth grade teachers, I discovered this was a common occurrence. There is so much content and only so much time in the day, often science is pushed to the side in earlier grades.

Unfortunately, with the number of standards and the high stakes of testing teachers must be sure students are most proficient in the areas they are tested. In third grade, students must pass the FSA to matriculate, therefore reading curriculum is pushed. Teachers must take time from other non-tested subject areas to provide the level of support some students need. This holds true for fourth grade year as well. In fourth grade, students take the FSA Writes exam. Students must write an entire essay. Teachers spend most of the year on writing skills. Science is taught throughout elementary school, though not as thoroughly as other subject areas. This is established to stress the importance of science education in every grade. Utilizing technology-based instruction can provide learning opportunities that are engaging and can be easily incorporated into the curriculum. Many schools have begun to incorporate STEM, or Science, Technology, Engineering and Math curriculum, which integrates these concepts into other subject areas. For instance, science texts can be used in reading, writing prompts are based on a science topic, and geographic locations are matched with ecosystems and climate zones. By utilizing technology-based instruction and integrating subjects, it can be less of a challenge to incorporate science concepts into daily lessons.

Since Rachel and I are both teachers, we are aware that it can be a challenge to find time to incorporate technology-based instruction into the curriculum. Our background guided the project. The goal was to create an engaging game that met standards and objectives and could be utilized in a variety of ways. The game, Snake Invaders can be used in the classroom, as part of a flipped classroom environment, in which the student plays the game at home, then comes in to the class ready to discuss and use the content and vocabulary, the game can be used as a stand-alone lesson or as part of a science unit about ecosystems, food chains, or invasive verses native species.

Snake Invaders is an Earth Science game targeted for learners in 7th grade, though the content and objectives could meet the needs of students in grades 6-8. The project goals were to meet the following objectives: Explain and predict patterns in the Florida Everglades ecosystem, use evidence to predict change in the Everglades population, identify patterns and trends using graphs, and to use scientific understanding to carry out a scientific investigation. To meet these goals four learning modules were developed; Introduction and Vocabulary, Prey versus Predator, Mammal Population, and Graphs and Solutions. These modules are directly linked to the learning objectives. Throughout each module or level, students are guided through the content with the use of narration, images, and interactive games. Students drag and drop vocabulary

words over definitions, match questions and answers like puzzle pieces, put food chains in order, and ultimately catch snakes to earn the Burmese Python Expert badge.

Incorporating Snake Invaders into the curriculum will provide an engaging lesson aligned with state standards and lesson objectives. The game can was designed for individual play, however if technology is not available for all students it can be played with the entire class or for a small group. The narration, graphics, and interactions help leaners with a variety of learning styles; visual, auditory, and kinetic learners have their needs met throughout the game. While the game is great as a stand-alone lesson, it would be more fully impactful when part of a unit. Students can use the information about invasive species, ecosystems, and environments to explore more versatile content.

THEORETICAL FRAMEWORK

Snake Invaders uses science inquiry through problem-based learning as the overall instructional design approach. The problem that students face is that Burmese pythons are ruining the Florida Everglades ecosystem. Students learn what an ecosystem is, what invasive and native species are and how they affect the ecosystem. The main problem students must investigate and understand is how Burmese pythons are affecting the mammal population. Throughout the modules, students learn about where Burmese pythons originated, how they came to be in the Florida Everglades and that they are causing harm to the ecosystem by disrupting the natural food chain. As the number of Burmese pythons increases in the Everglades the mammal population is declining.

Students construct their knowledge of the Burmese Python through experiences in the interactive games and reflect on their knowledge at various intervals in the modules. This theory of constructivism is derived from Piaget's theory of cognitive development (Powell & Kalina, 2009, p. 241). Students must construct their knowledge through experiences, rather than by merely learning through lecture or reading (Powell & Kalina, 2009, p. 242). As the student progresses through the interactions within the game, they are building knowledge through the experience. By dragging vocabulary and dropping them over definitions, manipulating puzzle pieces to fit answers with questions, using a slider to demonstrate the rise of the number Burmese pythons and decline of the mammal population, and even by catching snakes and placing them in a simulated cage learners are manipulating the components of the game to answer the questions presented and build on the experience, while acquiring knowledge.

Developing the game, Snake Invaders, was a group project, thus a more continuous instructional design approach was utilized to allow for group members to analyze, design, develop, implement, and evaluate in an unremitting cycle, therefore the AADIE model was used. This model permitted group members to constantly evaluate the game development. For each iteration of the project, Snake Invaders was reviewed by group members and peers. An SME and students also reviewed the game. Unfortunately, after the first iteration one of group members decided to drop the course. Remaining members continued forward with the plan, made all necessary corrections for the continued to design and develop the game.

Mayer's Principles of Multimedia Learning were used to guide the development, design, and revision of Snake Invaders. Throughout the game these principles are apparent. First and foremost, the multimedia principle resides, pictures were used in the game to promote learning (Mayer, 2017, p. 404). The coherence principle states that people learn better without extraneous words and material (Mayer, 2017, p. 407). During the game this was used where appropriate for slides providing information, like in Fast Facts, bullet points were used. This same slide also utilized the spatial contiguity principle which dictates that it is best for the learner if printed words are placed near the corresponding graphics (Mayer, 2017, p. 410). Vocabulary and Fast Facts also provided pre-training of the key elements within the game (Mayer, 2017, p. 412). The pre-training principle was also utilized to revise the food chain game. Interactive slides were added before the food chain game to deliver key information to assist students in completing the food chain interactivity. The personalization and voice principles coincide. The narrations during the game are human and are conversational in style, rather than formal (Mayer, 2017, p. 414). Mayer's multimedia, coherence, spatial contiguity, pre-training, personalization and voice principles aided in the development, design, and revision to foster learning, organize concepts and engage students (2017).

METHODS

How can the impact of the invasive species (Burmese Python) be taught through an interactive simulation in a virtual environment? This was the research question that was developed while analyzing the lesson and designing the game. This question guided the game development. To begin it was decided that vocabulary was a vital component to familiarize students with. It was important that the framework was laid out through vocabulary and facts about Burmese pythons, so students had enough background knowledge to investigate and come to understand the objectives. The pre-training component was vital to fill-in and activate necessary prior knowledge. While, many students in Florida may have knowledge about the Everglades, others may not. As stated previously, students often have gaps in their educational past that can hinder the retention of new concepts, therefore, it was vital to pre-train students to provide students with the best chance to understand the lesson objectives. To engage students and create more of a game-type feel narration, movement, and music is added. Students meet several characters throughout the game and interactions are utilized to entice participation.

Design-based research states that research must do more than just prove if the design works, the researcher must go beyond to determine the validity and to further expand theoretical knowledge (Barab & Squire, 2004, p. 6). To develop Snake Invaders a question was first proposed, from that question a game with interactivity and simulation was created to teach how an invasive species like the Burmese python can impact the environment. During the ADDIE iterations the group, peers, an SME, and students reviewed the game and provided feedback. Surveys were designed to generate evidence-based claims to address the components within the game. The surveys and responses were examined. It was vital to base revisions of the game on the feedback. It became apparent that while many theoretical methodologies were utilized there were still interactivity issues, the food chain game, especially needed an overhaul. Applying design-based research more than simply demonstrated if the game was a success or if the instructional design theories were employed properly, the evidence needed to determine the issues and revise the interactivity appropriately were provided.

As a group the brainstorming was completed over several Google Hangout sessions. During these conversations, the research question, basic design, and overall outcomes and objectives were developed. It was decided that objectives would be based on the various levels within the game and that each group member would take a level. However, this did not go according to plan once one group member decided to drop the course. The work was then reallocated and resumed. Ultimately, with Rachel completing the introduction and level three and myself developing levels two, four, and the badge simulation. It was determined that I had more patience with the software, Articulate Storyline, thus I took on more of the revisions, based on the surveys that Rachel developed with my assistance, she charted the feedback for the testing, while I conducted one-on-one consolations and she shared the game with a group of fifth-grade students. It is my opinion the work was evenly distributed. We worked well together, and game development was very organic. Dr. Prevost with the Department of Integrative Biology at USF was the SME (Subject Matter Expert), that also reviewed the Snake Invaders game and provided critical feedback. Each iteration and every bit of feedback was vital in discovering flaws, glitches, and errors within our design and interactivity.

The data collected was invaluable to the revision process. Many data sources contributed to the development of Snake Invaders. Since each group member completed a level, the level was first inspected by the other group member. This first check aided in catching vital mistakes in design, interactivity, and errors in general. We evaluated to be sure the game worked and that the interactions aligned with the objectives. It was also important to be sure all pertinent information was established in a way that would engage the learner and maintain game cohesion and flow. Peer discussion forums, comments from the practitioner and evaluation instruments, such as surveys were developed for the alpha and beta testing further assisted in the revision process.

The one-on-one evaluations were conducted in a comfortable setting to help the student to feel as ease. I sat with the fourth and eighth grade students individually. I explained the process of the one-on-one evaluation and asked that they please comment out loud while playing the game. I told them to pretend that they are YouTubers, as it is a trend to watch video game players on YouTube talk as they play their favorite video games. I listened and took notes as each played through Snake Invaders. I used the one-on-one observation protocol tool to direct and take notes. At the end I asked the end of session questions and asked the student to reflect on the game and what they learned. This information provided valuable feedback. The fourth grader found several errors in spelling, which was embarrassing, and he provided genuine comments during game play. The eighth grader as well, was helpful in pinpointing issues, such as the food chain game, and the puzzle interactive in level three. For the classroom implementation, Rachel led the way as she is the classroom daily. She shared the experience and feedback during a team meeting, and I aided in developing the evaluation results.

Feedback was based on quantitative and qualitative data. For quantitative research surveys and the one-on-one observation protocol tool were utilized. The surveys asked specific questions pertaining to the usability, grade level, objectives, concepts, content, and overall engagement of Snake Invaders. These surveys were conducted with clients and students. The outcomes demonstrated the need to revise the food chain game, fixing some navigation, correcting the length of time on the YouTube video, and adding more time to the riddle interaction. While the quantitative feedback did provide important insight, the qualitative data collected was vital as

well. Qualitative does not rely on pre-formulated questions, therefore the SME, Dr. Prevost expressed issues and even contributed input for revisions. This breakdown of the game based on expert opinion was invaluable to the revision process.

Results and Revisions

The results from the one-on-one piloting included typos and issues with some of the interactive components. There were several errors and typos throughout the game. These were a quick fix and included adding an apostrophe and a few spelling errors. The timing of the YouTube movie needed to be fixed to ensure the game did not move past the movie until the student finished watching it. Settings also had to be adjusted to allow the video to start upon entering the slide, rather than clicking on the web address. The most extensive revision was the food chain game. It needed to have the extra option from the game removed and to give more detailed instructions and feedback. The dates listed for the interactivity with the charts in level three was confusing due to the dates being the same. This was also easily adjusted by changing the dates, while still corresponding to the charts. It was also recommended that a more decorative badge at the end be added, however time and skills did not permit this.

One-on-One Evaluation Chart	Student 1 (4th Grader)	Student 2 (8th Grader)
Comments	"Oh, I have to click the URL first", "I see! I have to move the dark green ones! It just said I got it wrong, should it say a hint? I figured it out", "there I put the snake in the cage!", and "I like how is shows that when there are more pythons there are less raccoons".	"is one supposed to be left out?" and "I don't get why it says I'm incorrect? I got it right, I went by the charts."
Likes:	Graphics, game design, connection between each level, and the characters	enjoyed the design, notes the characters were good, interactivity was interesting
Improvements:	the food chain game, typos (Met to me, Naïve to Native)	food chain game, revise the interactivity with the chart, maybe add to the badge
Summary of revisions	• Fix a few errors and typos throughout the game • The timing of the moving, ensuring the game did not move past the movie until the student finishes watching it. • Adding a different way to interact with the food chain component. Potentially removing the extra option from the game and giving more detailed instructions. • Adding a more decorative badge at the end • Fix the dates listed for the interactivity with the charts in level 3	

The results of the classroom implementation stated many of the same issues as the one-on-one students addressed. The YouTube video timing, food chain game, the badge, and time for the riddle were areas for revision. Nine total fifth-graders ages 10-11 tested the game in the school computer lab. Observations and notes were taken as students completed the game. Students also completed a survey and feedback was compiled. The feedback focused on usability, content, positive comments and areas for improvement. The charts below provide a breakdown of the answers and areas for revision.

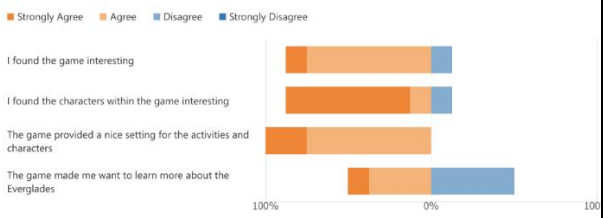
Classroom Implementation

2. I played the whole game?

More Details

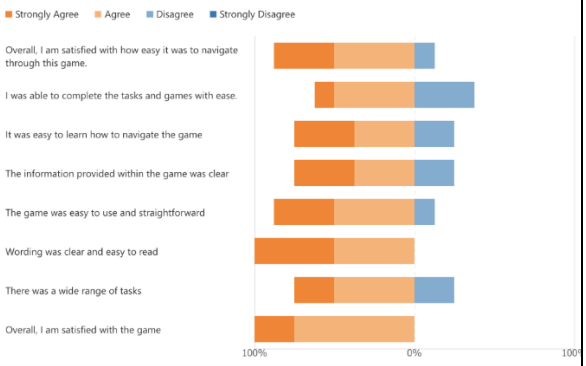
3. Answer the following statements about how you felt while playing the game 'Snake Invaders'

More Details



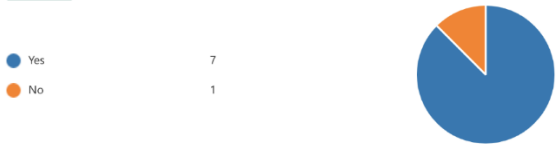
4. Answer the following statements below about the USABILITY of the game Snake Invaders, based on the 4 levels of strongly agree to strongly disagree.

More Details



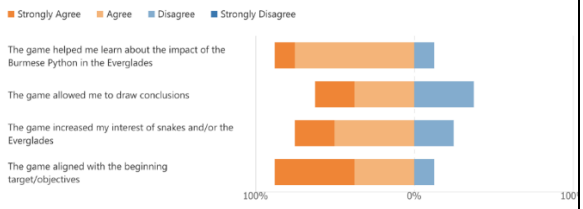
5. Do you feel this game is teaching science concepts?

More Details



6. Answer the following statements below about the CONTENT of the game Snake Invaders, based on the 4 levels of strongly agree to strongly disagree.

More Details



7. Write some positive feedback about the game.

8 Responses

ID ↑	Name	Responses
1	anonymous	there was a creative charecters and its was cool graphics
2	anonymous	I liked how the characters were all different.
3	anonymous	i liked the voices and the characters
4	anonymous	the game was very scientific and i loved it
5	anonymous	it was easy
6	anonymous	it was very great i loved it
7	anonymous	I learned a lot:)
8	anonymous	it was good and short but straight foward.

8. How would you improve the game?

8 Responses

ID	Name	Responses
1	anonymous	make the slides slower
2	anonymous	The questions were very unclear and hard, so you can improve that.
3	anonymous	make ms. borchardts class the main charaecters
4	anonymous	i would improve the game because with the video it didnt let me watch all the way through
5	anonymous	make it longer
6	anonymous	i would make it more animated like more player action
7	anonymous	Improve the qwestons/ chariters
8	anonymous	make the third character talk alot less.

9. On a scale of 1-10, how likely would you recommend the game 'Snake Invaders?'

8 Responses

ID	Name	Responses
1	anonymous	6
2	anonymous	6
3	anonymous	7
4	anonymous	8
5	anonymous	7
6	anonymous	7
7	anonymous	9
8	anonymous	8

10. Please leave additional comments below.

6 Responses

ID	Name	Responses
1	anonymous	hi miss martin
2	anonymous	Hey Ms. Martin, can you please put Gena, Joselynne, Kalie, and Ashton in it?
3	anonymous	make kalie, gena, ashton and joselynne the main characters.
4	anonymous	i am savage
5	anonymous	create more games like this
6	anonymous	Plessae make more with better chariters

Comments:

- There was trouble with the ‘food chain’ game component. They needed verbal directions and maybe the arrows pointing in a different direction (some thought the highest part of the food chain was at the beginning not the end)
- Students wanted more verbal feedback
- Video was not able to finish before the students were able to watch the entire thing.
- Riddle moved on after 1 try instead of 3, but the students really enjoyed this challenge
- Trouble with the quiz at the end.
- The graphs that are moveable are different sizes when in the middle
- Most students were not reading the extra facts on the correct screen.
- Some students thought that the characters talked too much

Areas for Revision:

1. Fixing the time allowed to watch the video within the game.
2. More direction and detail at each section of the food chain game.
3. Updating the badge at the end.

Allowing students to try the riddle three times instead of 1

Peer and SME feedback aligned as well. The food chain game needed the most in terms of revision. To assist the learner a review of native animals is provided through a drag and drop interaction. This was added to familiarize students with the animals that would be in food chain game and differentiate between the native species and the invasive Burmese python. Furthermore, a simple true/false interactive was added to provide students with a definition of what a food chain is. An example food chain is shown as the graphic on the slide, based on the pre-training principle, to activate prior knowledge. Based on the feedback from the SME each food chain was modified. The extra choice was removed, and all food chains were altered so they began with a primary producer. Some of the animals used were also changed to better demonstrate the natural flow of the Everglades food chain. The food chain game in level two is designed for the learner to investigate native food chains in the Florida Everglades and how Burmese pythons are invading this natural ecosystem. This understanding is to help students determine patterns and predict change in the Burmese python and mammal populations. The chart below shows the SME’s review laid out, with the pro’s and areas of concern listed.

SME Review

The SME Review really assisted in pin-pointing exact areas to target and revise. The SME went through each level and assisted by providing explicit feedback that aided in revising the final product.

Pros:	Areas of Concern:
• Interactivity	• Video cut-off
• Gradual increase in knowledge	• Clarify Definitions
• Appropriate levels	• A couple spelling/grammar errors
• Consistent with objectives and lesson	• Revising the food chain game
• Graphics	• Adding explicit feedback
• Enjoyable	• Puzzle interactivity level 3

DISCUSSION

Multimedia, coherence, spatial contiguity, pre-training, personalization and voice principles from Mayer's Principles of Multimedia Learning were used throughout the project (2017). These principles were the guiding force in design. When implementing the Snake Invaders during the various iterations these principles helped to direct the revision process. When reviewing the game, it was apparent that there were some issues with the food chain interaction, though it was unexpected that the issue was so wide spread. The factors that lead to this unexpected result were the lack of preview, feedback, disordered food chains, and extra choices. To modify the food chain game the pre-training, multimedia, and coherence principles were more thoroughly implemented. Coherence was established by eliminating the extraneous choice, thus reducing some of the confusion, however the food chains had to be altered to have a proper order from primary producer to predator. This led to adding in different animals and plants to properly form food chains. Two slides with interactions to build background knowledge added the pre-training. Additional feedback supplemented the multimedia principle. By adding words in conjunction with the images, learners can better understand and complete the food chains.

The results coincided with the theoretical framework in that design-based research was utilized to analyze, develop, test, reflect, and refine. Throughout the iterations the quantitative and qualitative feedback was used to provide the evidence to drive revision and make changes that align to the objectives while maintaining the interactions. Additionally, knowledge was constructed by the group members through this experience of creating Snake Invaders, just as students will construct their knowledge as they play the game and experience the interactions. This correlates with Piaget's theory of cognitive development, constructing knowledge through experiences (Powell & Kalina, 2009, p. 242).

For future iterations of Snake Invaders, it is recommended that some of the narration in level three be sped up and the unnecessary wording be removed for more coherence. Furthermore, due to the revision of the food chain game in the last iteration, modification may be necessary to better meet the needs of the learner. To more fully develop the game more interactions can be

developed with open-ended feedback, reflection, and current information about Burmese pythons and mammal populations. To expand the game to meet more science standards a more in-depth analysis of ecosystems and a comparison between the Florida Everglades and South Asia, where the Burmese python originates could be conducted to explore climate zones, weather, and habitats. As a community outreach component, research can be conducted about invasive species within the students' communities. The research can then be applied cross-curricular by creating a blog, webpage, flyer or information pamphlet to share, educating the community of the dangers of the invasive species and how to avoid introducing invasive species to the ecosystem and ways to preserve native species.

REFLECTION

The most challenging aspect of the game development was overcoming the hurdle of learning the new software, Articulate Storyline as game development was underway. Storyline was new to all group members therefore, there was the added level of difficulty of having to learn how to use the software while, designing, developing, and aligning the game to the lesson objectives. It was also vital to verify Snake Invaders contained all necessary content and answered the research question established. Creating a simulation in a virtual environment to meet lesson standards was a daunting task, as was learning Storyline, yet our group was up to the challenge. Snake Invaders went through major changes throughout the iterations, it began with an idea and a research question and developed into a game with interactions, characters, narration, and music, that meets the learning objectives of the lesson. There are ways that the game can be improved and expanded. It was and still is a work in progress and I would love to have the opportunity to further develop it at a later date.

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