Allegheny College
Department of Computer Science

Senior Thesis

MathRunner

by

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Abstract

I decided to create a 2D math game for children called “MathRunner”. My motivation for creating this game was when working with kids I noticed that they wasn’t doing the best in math. But one thing every kid had in common was their attention is taken as soon as an electronic is turned on such as tv, laptop, game system, or some type of game they are immediately drawn in and they will pay full attention to that. With this information I came to the conclusion that with this 2D Procedurally Generated game based on color psychology I will be able to cause a huge impact on these kids life in a very positive way.

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Introduction

MathRunner is a children's game that will help them with their addition and subtraction skills. My main goal is to be able to be able to help kids from ages starting at 5-8 with their lower-level math skills (addition and subtraction) to ultimately make an impact on their concentration and attention span, as well as facilitating memory retention and learning all while playing my game MathRunner. I am creating my game using the Unity Gaming Engine and I am programming in C#.

I was intrigued by the article titled "Improving arithmetic skills through gameplay: Assessment of the effectiveness of an educational game in terms of cognitive and affective learning outcomes." As I delved deeper into the content, I realized that this article would make an excellent addition to my research paper. The article discusses the impact of educational games on children, compared to those who did not play games while growing up. The authors also explore the cognitive and affective learning outcomes associated with playing these games, particularly in the realm of arithmetic skills.

Through the article, I learned that educational games can be an effective tool for improving children's cognitive abilities. They can also have a positive impact on their attitude towards learning, making the learning process more enjoyable. The authors also provide evidence that using educational games in the classroom can increase students' engagement and motivation. This article has strengthened my understanding of the potential benefits of using educational games in a learning environment.

In the article it says "The idea of using games to help children learn math is not new. According to Van Eck and Dempsey [26], in 1985 a large study was conducted by the National Council of Teachers of Mathematics (NCTM, United States), who tested eleven math games for different grades with 1637 participants. The authors concluded that instructional games could be effective for higher grades when designed according to the curriculum and

implemented with instructional activities." cited [2]

Upon reading the article, I discovered that the study of improving math skills, particularly in children, has been an ongoing research topic since 1985. This finding highlights the importance of improving math skills in students and the significance of using educational games as a means to achieve this goal. The article supports the idea that math games can have a positive impact on students' math abilities and can contribute to their overall academic success.

Furthermore, I believe that math games can be an effective tool in improving children's addition and subtraction skills. These games can help students retain information more effectively and can even increase their IQ in the areas where they are playing the games. With this understanding, I will continue to explore the benefits of incorporating math games into the educational system, as it has the potential to provide students with a more engaging and interactive learning experience. Overall, this article has reinforced my belief that educational games can have a significant impact on students' academic performance and can play a vital role in shaping their future success.

Early education plays a vital role in shaping a child's academic and personal development. One key aspect of early education is math, and it's essential to ensure that children have a solid foundation in math concepts to excel in their future studies. In recent years, educational math games have emerged as an effective tool to make math learning more fun and engaging for young children. In this context, a recent article discusses the benefits of using math games for children aged 4-5 years to learn probability and statistics.

According to the article, incorporating educational math games into the learning process for young children can help improve their math skills. The study conducted by the researchers experimentally isolated the effects of gaming experience and estimated whether it improved arithmetic performance over and above the training effects expected from traditional teaching methods. The findings suggest that children who used math games had significant improvement compared to those who only received traditional teaching methods. Moreover, the study also indicated that math games could improve children's attitudes towards mathematics and lead to a more positive learning experience. These results highlight the potential of math games in enhancing early education and making learning more enjoyable for young children.

In the article it says “Recently, it has been shown that very young children can also benefit from the use of math games. In a recent study, an internet game was used in conjunction with other classroom activities to teach probability and statistics to 4- and 5-year-old children. The children who played the game showed improvement in their understanding of probability [18]. Likewise, a recent study conducted with second graders (7–8 years old) showed that the use of a handheld game (Skills Arena [13]) was beneficial to students learning mathematics, in particular for low-ability students, regardless of gender and ethnic background [21]. The results demonstrated that pupils who played the game outperformed pupils who did not on a mathematics test. Likewise, the scores that the students obtained in the game correlated significantly with achievement scores on the mathematics test.” cited [2]

The article highlights an interesting finding that playing math games can develop more positive attitudes toward mathematics after five weeks of playing. This can be particularly beneficial for young children as it can foster a desire to learn and develop their math skills. By having a positive attitude towards math, children may be more willing to engage in learning and may ultimately develop strong math skills. This underscores the importance of incorporating fun and interactive activities, such as educational math games, into the learning process to make it more enjoyable and engaging for children.

The article discusses the effectiveness of an educational math game in improving arithmetic skills and its benefits compared to traditional teaching methods. The study aims to determine the value added by the gaming environment in math education and assess the cognitive and affective learning outcomes of playing a commercial math game compared to paper math exercises and no assignment over three weeks. The article also reviews previous studies on the issue and their outcomes, such as the effectiveness of a math game versus traditional drill in teaching basic multiplication to 5th graders and the positive attitudes developed by 4th and 5th-grade students toward math after playing a computer math game. However, the study still raises questions about the effectiveness of math games for younger children and their actual learning gains compared to paper exercises and no assignment.

“According to McFarlane et al. [15] there are three areas in which the use of digital games can be effective in education: to train general cognitive abilities and skills, to evoke positive affective reactions and thus stimulate motivation, and for knowledge- and content-related learning.” cited [2]

The article discusses how the researchers used both objective and sub-

jective measures to evaluate the cognitive and affective outcomes of an educational math game. By combining these methods, they were able to isolate the effects of the gaming experience and determine if the game had a positive impact on arithmetic performance beyond that of traditional teaching methods. This type of experimentation is crucial to understanding the effectiveness of educational games and their potential to improve learning outcomes. By using a combination of methods, researchers can gain a comprehensive understanding of how these games impact students both cognitively and emotionally, providing valuable insights into how to design more effective educational tools.

In the text it says "Accordingly, in the present study we combine objective with subjective measures to assess the cognitive and affective outcomes of an educational math game. In order to reach this goal, second graders were randomly assigned to one of three groups: a 'gaming group', a group which was instructed to complete a paper exercises and a control group that did not receive any mathematical assignment. The experimental design including three groups instead of two (control vs. gaming), constitutes an important methodological aspect of the present study. By comparing paper drills to game playing relative to control conditions, we are able to experimentally isolate the effects of the "gaming experience" and thus estimate whether the gaming experience improves arithmetic performance over and above the training effects expected from the classical methods. To the best of our knowledge, there are no published studies in which the same methodology – using three groups for comparison – has been used to investigate the effectiveness of math games." cited [2]

In the article I read about the effectiveness of an educational math game compared to traditional paper drills and no assignment. Based on previous studies, the authors hypothesize that the educational game will be as effective as paper drills in improving arithmetic skills but will lead to greater anxiety reduction and higher levels of enjoyment and perceived competence. The study aims to assess both cognitive and affective learning outcomes of playing a commercial math game compared to paper math exercises and no assignment over three weeks. This information is useful when creating an educational math game, as it highlights the importance of considering both cognitive and affective outcomes, and the potential benefits of incorporating gaming elements such as enjoyment and perceived competence to improve the overall learning experience.

In the text it said "Based on the literature [9], [11] we hypothesize that

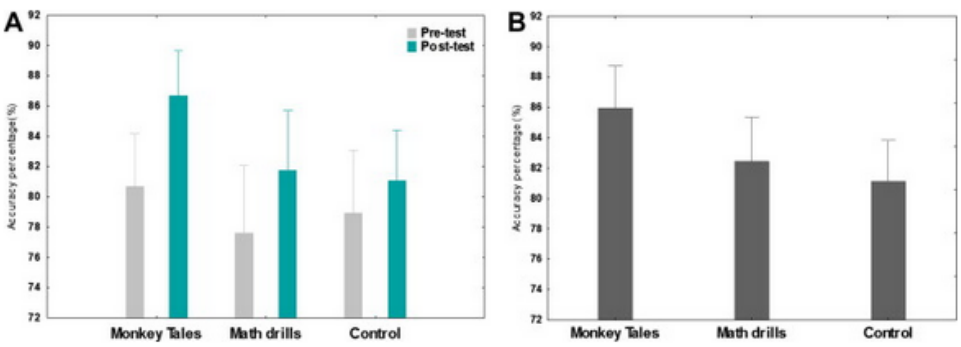
playing the educational game will lead to significant changes in affective learning as compared to the drill exercises but that they will not differ in terms of cognitive outcomes. More specifically, we expect that the educational game, in terms of accuracy and speed, will be as effective as paper drills in improving the arithmetic skills of children. However, we hypothesize that the educational game will lead to greater anxiety reduction, a first effective learning outcome, than the paper math drill exercises or the control condition. Furthermore, regarding enjoyment and perceived competence, two more affective learning outcomes, we expect that the self-reported scores for these two variables will be significantly higher in the gaming group than those in the paper exercises group." cited [2]

The article suggests that using educational math games can have a significant impact on children's learning outcomes compared to traditional methods. The study conducted in the article was able to isolate the effects of the gaming experience, proving that the benefits of using these games go beyond just the exposure to mathematical content. As such, incorporating educational math games into a child's learning routine could be a major advantage for their learning and skill development. This insight has motivated me to create an educational math game that can help children improve their addition and subtraction skills in a fun and engaging way. By doing so, I hope to contribute to the growing body of research supporting the use of educational games in improving children's learning outcomes.

In the world of education, finding effective ways to teach children is an ongoing endeavor. One method that has gained attention is the use of educational games. In a recent study, researchers sought to investigate the effectiveness of an educational math game on the cognitive and affective learning outcomes of young children. In the article, the results of these tests are presented and shed light on the benefits of using educational games in the classroom. In the text it says "A one-way between-groups analysis of covariance was conducted on the posttest accuracy scores using pretest scores as a covariate (see Fig. 2B). The results indicated that after the influence of the pretest was controlled, the posttest scores of the three groups were significantly different ($F(2.70) = 3.20$, $p < 0.05$). Post hoc comparison using the Tukey test showed that the posttest accuracy of the group that played the educational game was significantly better than the accuracy of the paper exercises group ($p < 0.05$) and of the control group ($p < 0.05$). This indicated that the educational game had a stronger learning effect on the students' accuracy in the computer math test when compared with the group of children

who did the paper math drills and the group that received no assignment. The post hoc test revealed that in terms of accuracy the adjusted average scores of the paper exercises group was not better than the scores of the control group ($p = .93$), indicating that only the group that played the educational game showed gain in the posttest scores when compared with the other groups."

Introducing educational math games to kids is a great way to engage them in learning and make it more fun. Games can also help children develop positive attitudes towards mathematics, as the study in the article has shown. As technology continues to advance, there is no doubt that educational games will become an even more important tool for educators to use in teaching math to young children. In fact, many companies and developers are already creating games that help children learn math in a fun and interactive way. By incorporating these games into the classroom or at home, children can build a strong foundation in math and develop a love for learning that will benefit them for years to come. cited [2]



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Fig. 2. (A) Mean accuracy rates in the pre and posttest measurements by group. (B) Mean accuracy rates in the posttest measurement, adjusted by pretest performance.

Figure 1: Mean Accuracy Pre and Post test

The article “MATH ANXIETY LINKED TO TIMED TESTS” by The Math Learning Center discusses how timed tests can cause anxiety in students and negatively impact their performance. The study showed that timed tests can trigger a fight-or-flight response in students, leading to memory recall blockages and poor performance. As a reader, I could relate to the feelings of the students in the study, as I also experience anxiety when taking timed tests. I agree with the article's assertion that timed tests can be detrimental to students' academic success, as they may struggle to demonstrate their true understanding and knowledge under pressure. Instead, educators should consider alternative assessment methods that allow students to demonstrate their knowledge and skills without being constrained by a limited time frame. In the article it said “ These are select responses from a study conducted in asking your students about their feelings regarding a timed math test. This article covers how researchers have found that timed math tests increase anxiety resulting in memory recall blockages and, thus, poor performance by students of all levels. It contains many excerpts (included in quotes) from an article written by Jo Boaler, a professor of Mathematics Education from Stanford University. Occurring in students from an early age, math anxiety and its effects are exacerbated over time, leading to low achievement, math avoidance, and negative experiences of math throughout life. cited [3]

Educators have witnessed the impact of math anxiety for decades, but only in recent years have timed math tests been shown to be one cause of the early onset of math anxiety. Indeed, researchers now know that students experience stress on timed tests that they do not experience even when working on the same math questions in untimed conditions. (Boaler)” cited [3]

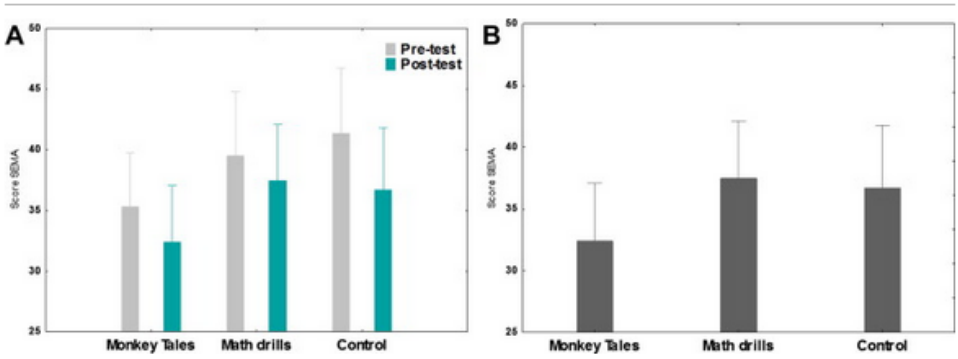
“In a recent study of 150 first and second graders, researchers measured students' levels of math anxiety, finding that children as young as first grade experienced it and that levels of math anxiety did not correlate with grade level, reading level, or parental income. Other researchers analyzed brain-imaging data from . . . seven- to nine-year old children while they worked on addition and subtraction problems and found that those students who ‘felt panicky’ about math had increased activity in brain regions associated with fear. When those areas were active, decreased activity took place in the brain regions that are involved in problem solving. (Boaler)”

The article “MATH ANXIETY LINKED TO TIMED TESTS” by The Math Learning Center discusses a study that used brain scans to understand how anxiety affects individuals during math computation. The study found that

children recall math facts stored in their working memory, and those with a larger working memory have a greater potential for academic success. However, stress caused by timed tests can block the working memory, causing familiar math facts to be forgotten. The study also found that math anxiety affects individuals with high working memory, who have the potential to excel in mathematics. Students who experience stress during timed conditions and cannot access their working memory tend to underachieve, causing them to question their math ability and develop further stress and anxiety. The article suggests that alternative assessment methods should be considered to reduce math anxiety and promote academic success. cited [3]

The article suggests that being in a comfortable learning environment can reduce stress, especially during timed tests. To make learning easier, educators should introduce different methods of teaching that are engaging and interactive, such as educational games. As children are increasingly attracted to electronic devices, incorporating educational games into their learning could be beneficial in the long run. According to research, the introduction of educational games has had a positive impact on children's learning. By integrating games and other interactive activities into the classroom, educators can help reduce math anxiety and promote a positive learning experience.

Creating a comfortable learning environment is crucial for the success of children's education. Anxiety and discomfort can often impede the learning process and cause significant challenges for kids. This is particularly true if children don't enjoy the teaching style or method of learning, leading to a decrease in motivation and interest. In the article, the importance of creating a comfortable and enjoyable environment is discussed in relation to improving children's math skills. In the article "Math anxiety ratings were also subject to a one-way between-groups analysis of covariance using the pretest times as a covariate (see Fig. 4). The results indicated that after the influence of the pretest was controlled, the posttest scores of the three groups were not significantly different ($F(2.70) = 3.20$, $p = .50$). This indicates that, in terms of math anxiety ratings, we failed to find evidence suggesting that after playing the educational game participants showed a math anxiety reduction." cited [3]



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Fig. 4. (A) Mean math anxiety scores in the pre and posttest measurements by group. (B) Mean math anxiety scores in the posttest measurement, adjusted by pretest performance.

Figure 2: Mean Math Anxiety Scores

The learning environment plays a significant role in how well children pay attention and engage with the material being taught. Research suggests that being in a comfortable and enjoyable environment can improve learning outcomes. Incorporating educational games into the classroom can make learning a more enjoyable experience for children, as compared to traditional paper drills or other controlled activities. When children are playing educational games, they are having fun while also learning, which can help them to retain information better. By creating a positive and engaging learning environment, educators can motivate children to learn and help them develop a love for learning that will stay with them throughout their lives. In the article it says "A chi-square test of independence was performed to examine the relation between enjoyment and the experience of gaming or doing the paper exercises. The results indicate a statistically significant association, 2 (1, N = 48) = 4.74, p < .05. Children were more likely to report high enjoyment when playing the game than when doing paper exercises."

A key factor that I am going to be using in my game will be color psychology. I plan on using color psychology in my game because every color has a

different effect on children's learning. Colors such as: red and blue colors are the best for enhancing cognitive skills and improving brain function. [10]

I believe that the implementation of color psychology will be a great addition to my game in order to help the kids retain more from the game and be able to learn more while playing. Color psychology is the study of how certain colors impact human behavior. Different colors have different meanings, connotations, and psychological effects that vary across different cultures. Along with cultural differences, color psychology is largely impacted by personal preference. Color psychology is something that I came across a few years back and it's been intriguing to me ever since. With this curiosity I decided to use this inside of my senior project. Many people may know about color psychology while others do not and color psychology is the study of colors and how they affect the brain.

Color psychology is the study of how colors affect human behavior and emotions. As a game developer, I decided to incorporate color psychology into my game in order to help kids retain more information and learn more effectively. By using specific colors that are known to promote focus and concentration, I hope to create an environment that is conducive to learning and retention.

For example, the color blue is often associated with calmness and tranquility, while yellow is known to promote energy and optimism. By using these colors in different parts of my game, I can create a visual experience that enhances the learning process. Additionally, by using color-coded systems for different levels or categories, players can more easily remember and recall information.

Studies have shown that colors can have a significant impact on learning and memory. By incorporating color psychology into my game, I aim to create an engaging and memorable experience for children that will help them retain information long after they have finished playing. Overall, I believe that using color psychology in my game will be a valuable tool in promoting effective learning and enhancing the overall experience for players.

With this implementation of color psychology I plan on educating those people that do not know about it while doing some good for the youth. I decided to use this because the study of colors and how it affects the brain can have a huge impact on somebody's learning process and their IQ level depending on when they start this process of using color psychology to boost their IQ or how well they'll be able to retain the knowledge. In order for my game to thrive and do its purpose I believe that color psychology is essential

in its programming. I say this because color psychology is a proven fact that certain colors help improve your memory, help you gain more knowledge, has an effect on your feelings, etc. knowing this information I had to do further research and it still doing more research to find out everything that goes on with color psychology in order to make my game is full proof as it can be.

- Red – Passion, anger, danger, vigor
- Green – Money, eco-friendly, peace, jealousy, envy, fertility, healing
- Blue – Peace, cool/cold, knowledge, trust
- Black – Mourning, death, evil, negativity, elegance
- Purple – Spirituality, wisdom, intelligence, royalty
- Yellow – Clarity, energy, freshness, optimism
- Pink – Girly, feminine, playful, romantic
- Orange – Warmth, joy, balance, freedom, expression, success

Also, in the animal and plant kingdom, bright colors serve certain survival functions such as reproduction and protection. Colors are unarguably a valuable marketing tool. However, the question is: are some colors better for specific purposes? Let's find out how you can leverage the effects of color on behavior."

"Painters have discovered the power of color and studied what it does to the viewer for centuries. During the period of post-impressionism, in which artists focused on evoking emotions, colors were used for their underlying emotional associations. Movie producers also trigger mood and emotions with colors. In Pixar's movie Inside Out color is a leading motif. Scenes in which the main character is happy are colorful. In gray and monotonous scenes, on the other hand, she is sad and without hope. In the movie, the five primary emotions have a distinctive color. Joy is of bright yellow, Anger of a warm red, Disgust of poisonous green, Fear of pale purple, and Sadness of deep blue. According to 9 the director, they chose the color partly based on color idioms in the English language. For example: to feel blue/ have the blues (sadness) or to see red (anger). Colors and their emotional associations are rooted in our cultural upbringing. They vary among cultures. In English, you are green with envy, in German yellow (gelb vor Neid sein). Purple is often associated with wealth, royalty and nobility. In Thailand and Brazil, purple is the color of mourning, however."

The quoted text from the article "The effects of colors on behavior" Written by Clara Vetter on 05/12/2019 is telling us how many people around the

world are affected by different colors used in our everyday lives and with this change in colorado w these colors will be affecting us. Above it said how painters were using specific colors to appeal to people's emotions. While movie producers also took advantage of this by adding in color psychology in movies. [12]

I find it interesting how movie writers use color psychology to affect humans emotions, behaviors, and perceptions. With this powerful tool many movie writers use it in order to enhance the audience's experience and communicate their message effectively. Movie writers use color psychology to their advantage by creating a mood by using colors to set the tone and create a mood in a scene. For example, the use of warm colors like red, orange, and yellow can create a sense of warmth, passion, and energy, while cool colors like blue and green can create a sense of calmness, tranquility, and relaxation. By choosing the right colors, movie writers can create an emotional connection with the audience and enhance the impact of the scene.

When the movie director is trying to show symbolism colors are often used as symbols to convey deeper meanings and themes in movies. For example, red is often associated with danger, passion, and blood, while black is associated with death, mystery, and power. By using colors in a symbolic way, movie writers can add layers of meaning to their story and make it more engaging and memorable to the audience. [4]

A big thing in many movies is something called Character development and many of the movies or tv shows expect a great story. The character development is a process by which a character in a story, novel, or other thing that brings in the audience through stimulation is shaped and evolves over time. It involves the creation of a well-rounded and believable character through a range of techniques such as backstory, dialogue, actions, thoughts, and interactions with other characters. As a character experiences events and challenges, they may undergo a transformation, whether it's a positive or negative change. Good character development not only helps readers connect with the character but also adds depth and complexity to the overall story. It's an important aspect of storytelling and can be a powerful tool in creating memorable and impactful narratives.

Character Development Colors can also be used to reveal character traits and personalities. For example, a character who always wears black may be perceived as mysterious, rebellious, or powerful, while a character who always wears bright colors may be seen as outgoing, cheerful, or flamboyant. By using colors to develop characters, movie writers can add depth and

complexity to their story and make it more relatable and engaging. [4]

One big thing that brings in the audience's attention is the Visual Appeal. Movie writers use color psychology to create visually appealing scenes that capture the audience's attention and keep them engaged. By using contrasting colors, complementary colors, and other color combinations, movie writers can create beautiful and captivating visuals that enhance the overall movie-watching experience. This is especially important in genres like fantasy and science fiction, where the visuals are a key part of the storytelling.

The quoted text from the article "The effects of colors on behavior" Written by Clara Vetter on 05/12/2019 is telling us how many people are affected by this change in color and how these colors will be affecting us. Above it said how painters were using specific colors to appeal to people's emotions. While movie producers also took advantage of this by adding in color psychology in movies. The movie "Inside Out'' was a great example of this because in the movie, the five primary emotions have a distinctive color. Joy is of bright yellow, Anger of a warm red, Disgust of poisonous green, Fear of pale purple, and Sadness of deep blue. These emotions are often associated with these colors making it cause an effect on us without even realizing it [12]

There are several different types of movies that use color psychology and in the quoted text from the article "The effects of colors on behavior" Written by Clara Vetter on 05/12/2019 is telling us how many people are affected by this change in color and how these colors will be affecting us. Above it said how painters were using specific colors to appeal to people's emotions. While movie producers also took advantage of this by adding in color psychology in movies. The movie that I'm going to be talking about is one that is obviously showing color psychology and that movie is "Inside Out'' by Ronnie del Carmen. Inside Out was a great example of this because in the movie, the five primary emotions have a distinctive color. Joy is of bright yellow, Anger of a warm red, Disgust of poisonous green, Fear of pale purple, and Sadness of deep blue. These emotions are often associated with these colors making it cause an effect on us without even realizing it.



Figure 3: InsideOut

"Also, within a culture, there can be differences, depending on the situation. Red can represent romance in a flower shop (red roses) or violence and unfairness during a football match (red card). When choosing a color for your brand, the culture and context have to be kept in mind. Especially during a cross-cultural marketing campaign. This can be challenging. The effects of colors on behavior and emotions might be very different. Some of the effects of colors appear across several cultures. Warm colors like red, yellow and orange evoke higher arousal emotions, such as love, passion, happiness, and anger. Cool colors, like blue, green and purple are linked to calmness, sadness and indifference. Colors can trigger these arousal states and emotions. Several studies show the impact of the paint color used in offices or living rooms on the mood of people in them. In many cultures, red means danger. Traffic signs that require immediate attention and reaction are usually red. That's a good choice, the effects of color on behavior are applied. From a neuroscientific perspective, making them red is a wise choice. In our brain, the majority of cells responsible for color vision are geared to respond to the color red. Therefore, red attracts our attention more. Hence, we can respond to a red cue faster."

Above is how the author is telling us about how the implementation of color psychology can have a different effect on people depending on their culture and the context of it. A prime example of this used in the text is "Red can represent romance in a flower shop (red roses) or violence and unfairness during a football match (red card)." So while implementing my game I will have to think of the differences that may occur from a context viewpoint as well as a cultural viewpoint of how this will affect those people.

In the text it said “Food color can have a significant impact on our appetite and taste preferences. Orange is known to increase appetite, while blue can trigger disgust and loss of appetite. These implicit color expectations can influence how we respond to food and drinks. Nestle’s launch of Matcha Green Tea flavored KitKat chocolate bars in Europe illustrates how color associations can impact customer behavior. While green is not typically associated with chocolate and sweetness, Europeans may be hesitant to try the product due to the color association with spoiled dairy products.

Colors can evoke emotions and influence decision-making, making it important for businesses to consider the impact of color on their branding and marketing strategies. Warm colors can create positive associations and promote trust in a brand, leading to increased loyalty and purchasing intentions. The color of a brand can also impact employee behavior, as studies have shown that red in a logo can lead to increased work effort. Understanding the emotional associations of colors can help businesses create more effective branding and marketing strategies.”

In regards to color psychology and food many different colors affect your appetite and sense of taste. Many fast food restaurants use color psychology in order to draw in customers. In the article it gave an example of how “Orange is known to increase appetite and is often used for food packages and in fast food restaurants. Blue triggers disgust and loss of appetite because there are no natural foods in (bright) blue.” A good example of how it’s used today is how Mcdonald’s has all these bright warm colors that will draw in children and they want to go and eat there. The use of color psychology was a great implementation because the colors not only appeal to kids but it also attracts the older people as well so this has helped them in a way to get in the position they are in.

In the text it says “The color of a product can have a significant impact on our body and behavior. For instance, red increases physiological alertness, heart rate, and adrenaline levels, while blue and green calm the body, reduce respiration, and lower blood pressure. The effects of colors on behavior can also influence the effectiveness of medical drugs and placebos. Warm-colored pills, such as red, yellow, and orange, are associated with stimulating effects, while cool-colored pills, such as blue, green, and purple, are associated with relaxing effects. In a study on the placebo effect, participants who received warm-colored pills reported a stronger placebo effect than those who received cool-colored pills.

Knowing the effects of color on our body and behavior can be beneficial

when creating products or marketing campaigns. Understanding which emotions and feelings are associated with particular colors can help to trigger the desired response in the target audience and increase loyalty and purchasing intentions. Additionally, color can impact employees' work performance, as seen in a study that found that a red logo increased employees' motivation to work harder."

When I was in my class last year deciding on comp ideas I thought it would be cool to use this knowledge to my advantage and implement it into my game in order to trick users into boosting their IQ/helping them gain more knowledge on basic/lower level math skills. While researching this topic I came across many different things like how along with different colors people may use different fonts to promote learning so in order to get the full effect of the color psychology I plan on making the font specific in order to help promote reading as well.

Motivation

I came up with the idea to make a game in unity after speaking with Professor OBC for my junior sem class last year. My idea was not what it is now in the past, but the evolution of the idea has gotten me to where I am now. As a game creator, it's not uncommon to run into roadblocks and obstacles along the way. For me, that happened when I realized that my first idea for a game just wasn't going to be enough to meet my expectations. Rather than giving up on the idea of making a game, I decided to keep searching the web for a new type of game to create. This experience taught me an important lesson about the creative process in game development. Sometimes you have to be willing to let go of your initial vision in order to make room for something even better. By exploring new ideas and experimenting with different gaming styles in unity. I'm confident that I'll be able to create a game that truly lives up to my expectations and delivers an unforgettable gaming experience to the kids that play.

My game is a procedurally generated map that will have the integration of color psychology in order to help children retain the information that they are learning in the game. I'm making this game through unity using C#. C# as a language that I was not familiar with before the start of this project. Not knowing how to program a C# was a challenge because it required me to have to learn this programming language in order to make my game in

unity. I believe that this was the best option for me because unity is one of the best gaming development engines. Unity is a cross-platform game engine developed by Unity Technologies, which is primarily used to develop video games and simulations for computers, consoles and mobile devices. With this, I am able to make my idea come to life.

I plan on making a game where children can come in not being the best at their lower level math skills such as: addition and subtraction. They will be thinking they're playing a fun game while the whole time they will be doing that and leaving off better than when they came in to play the game. MathRunner will appeal to the kids that are learning lower level math skills: addition and subtraction, so roughly around the ages from 4 to 8. I believe that I can do this by implementing color psychology into my game that will help the children to retain more information. I'll be able to learn in an efficient way, then previously. According to a study by CNN, "kids' average daily screen time has increased by 1.5 times during the pandemic."

With the technological advances in society today it caused humanity to evolve and improve in their use of electronics. Unlike in older times when everything was more so on paper with the new generation and new times, we have to adapt with them in order to appeal to keep them advancing at a steady rate. This led me to assume that the best approach for helping kids learn these skills would be through a game because of the increased screen time. My thought process to appear to the more technologically savvy kids was to make a game that would draw the children's attention just like the many electronics that they picked up during Covid. I believe that children are more drawn into playing games instead of doing classwork or homework. So eventually maybe adding an implementation of games into the classroom could take into effect in order to provide a more complex learning structure for the kids that will keep them engaged. With this game, I would like to improve on these children's knowledge with addition and subtraction. I will help them improve their skills by implementing color psychology, which is proven to help children retain the knowledge and be able to pick up on things more often than normally with these implementations.

After a bunch of trial and error I was able to come up with an idea for my game. For right now I plan on making my game and not putting a story in. There will be a skip of the story to the actual game play. But to start my game you will start off in a town that requires an idol to stay afloat. The idol will power the whole village. One day a boy is going for a walk when he sees a dragon with a wizard on its back flying around when they take the idol

and cause complete mayhem for the village and villagers. While the village goes into complete shock the boy follows the dragon into the dark forest and that's where the game gets started. Entering inside of the game MathRunner you will have to navigate through a maze in order to answer a certain amount of questions, correct to get to a final Boss fight that will allow you to finally win and be able to escape the maze freely or so you think. I want to have it where there is an infinite loop where you will never be able to get out of the maze, but the question is seemingly just getting tougher and tougher to encourage you to be able to learn and improve on what you know and want to know. As of right now, my game is not finished but with proper time I will be able to complete this game and have it where the implementation that I want to happen will happen.

MathRunner will challenge kids into having to use different problem solving and critical thinking skills when playing this game. I say this because after a certain amount of equations are solved wrong you will have one of your life's taken away compared to when you get it right and you get a point towards your total. In this game, there's only one way to win and that is solving math equations then defeating the enemies that come in your path. Once you have solved a specific amount of questions(depending on what level you're on) you'll be able to fight the main boss. Once you defeat the main boss, you then are transported to your next randomized maze that you navigate through in order to improve your lower level math skills such as addition or subtraction by playing the game MathRunner.

Goals Of The Project

My final goal for this project is to have a fully functional math game that will essienmsially help kids with their math skills (addition and subtraction) in order to create a safe and fun alternative to the traditional learning style. I want to provide a safe game for these children to b able to come to and play woth the intent of wanting to become better at these math skills while having fun at the same time. My game will allow kids to have an incease in their concentration and hav an impact on their cognative skills also providing a anxiety reliever.

Related work

My research for my comp is based on a few different things. While conducting research it was different at first because my idea wasn't all the way solid yet. I know that when conducting research it can be a daunting task, especially when the idea is still taking shape. It is not uncommon to feel uncertain and unsure about the direction of the research when the concept is not fully developed. In such situations, it can be challenging to figure out where to begin and what to do next. However, it is crucial to keep pushing forward and continue exploring different avenues in unity until the idea starts to take shape. It is essential to stay focused, patient, and persistent in the face of uncertainty and confusion. With time and effort, the idea will begin to solidify, and I will be able to begin the research on whatever idea I choose to go with. The key is to trust the process, stay motivated, and be open to new ideas and approaches along the way. I say this because my idea's main focus has changed and is now more redefined to fit the requirements of the comp to achieve a passing grade. My game was based on color psychology in order to help kids improve their math skill to ultimately help kids become better at lower level math(addition and subtraction). I chose to do my research on color psychology as well as on children who will be getting ready to begin learning or already freshly learned addition and subtraction.

I chose to do my research on children that are getting ready to start or already started lower level math skills such as: addition and subtraction because mathematics is an essential subject in children's education as it provides a foundation for logical thinking and problem-solving skills. As I began to conduct my research, I chose to focus on children who are about to start or have already started lower-level math skills, specifically addition and subtraction. This is an important area of study as these fundamental concepts are the building blocks for more complex mathematical concepts. Understanding how children learn and develop these skills at a young age

can be essential in helping educators and parents provide effective teaching strategies and support for young learners. Through my research, I hope to gain insights into how children learn and acquire basic mathematical concepts and use that knowledge to improve early childhood education. While researching I plan on getting information on how many different teaching styles and educational games can affect children in what was. I will also be conducting research on how color psychology will affect children.

I chose to do my game development in unity. Unity is a powerful gaming engine that allows developers to create high-quality 2D and 3D games for multiple platforms, including PC, mobile, and consoles. The engine provides a range of tools and features to help developers create the ideal game of their choice, including a robust physics engine, advanced scripting capabilities, and an intuitive user interface. Unity also includes a vast library of assets, such as models, animations, and effects, that can be easily imported and used to accelerate game development.

One of the key strengths of Unity is its flexibility, which allows developers to create games for a variety of genres and styles. Whether it's a first-person shooter, a platformer, or a maze game, Unity provides the tools needed to create a compelling and engaging gaming experience. Additionally, Unity has a strong community of developers who share resources, provide support, and offer valuable feedback

Unity is also known for its cross-platform capabilities, which means that developers can build a game once and deploy it to multiple platforms. The various different platforms including iOS, Android, Windows, macOS, and more. This allows developers to reach a wider audience and reduce the cost and time associated with porting games to different platforms.

Overall, Unity is an industry-standard game engine that has been used to create countless popular games, including Temple Run, Among Us, and Pokémon Go. It offers a range of tools, features, and resources to help developers bring their games to life, and its flexibility and cross-platform capabilities make it a popular choice for developers worldwide. Knowing all of this is the reason I went with unity gaming engine because it will allow me to bring my vision to life.

From an article by VeryWell Mind they told me how what I said previously is correct, how our decisions are influenced as well as our behaviors with the implementation of color psychology in our everyday lives. According to an article by VeryWell Mind, my previous assertion about the influence of color psychology on our decisions and behaviors is indeed accurate. The

article explains how certain colors can elicit specific emotional responses in individuals, and this can be used to influence their behavior or decision-making process. For example, warm colors like red and orange are often associated with feelings of excitement and enthusiasm, while cool colors like blue and green are associated with calmness and relaxation. By understanding these associations and using them strategically, marketers, game designers, and even individuals can leverage the power of color psychology to achieve desired outcomes in their everyday lives or in a game where they want the audience to feel certain emotions or react a certain way.

Color psychology is a fascinating subject that explores how different colors can impact our moods, emotions, and behavior. As noted in an article by VeryWell mind, the implementation of color psychology in our daily lives can significantly influence our decisions and actions. The article validates my previous assertion that color can affect our behavior and decision-making processes. By understanding the psychological effects of color, we can use it to our advantage in various settings, such as marketing, design, and education. For example, blue is known to be calming and soothing, making it an ideal color for bedrooms and relaxation spaces. On the other hand, red is associated with energy and excitement, making it a popular choice for restaurants and sports arenas. Overall, color psychology is a fascinating field that provides insights into how color can shape our perceptions, emotions, and behavior.

In the article it said " Color is a powerful communication tool and can be used to signal action, influence mood, and even influence physiological reactions. Certain colors have been associated with physiological changes, including increased blood pressure, increased metabolism, and eyestrain."

"Color psychology is the study of how different colors affect human mood and behavior. It explores how colors can influence emotional responses, as well as how responses to color are affected by factors such as age and cultural background. The meanings of colors How colors impact physiological responses Emotional reactions to color Factors that impact color preferences Cultural differences in the meanings and associations of different colors Whether colors can impact mental health How colors can influence behaviors Ways that colors can be utilized to promote well-being How colors can be used to improve safety and design more optimal home and work environments Why is color such a powerful force in our lives? What effects can it have on our bodies and minds? While perceptions of color are somewhat subjective, some color effects have universal meanings. Colors in the red area

of the color spectrum are known as warm colors and include red, orange, and yellow. These warm colors evoke emotions ranging from feelings of warmth and comfort to feelings of anger and hostility. Colors on the blue side of the spectrum are known as cool colors and include blue, purple, and green. These colors are often described as calm, but can also call to mind feelings of sadness or indifference.

Symbolic meanings that are often associated with different colors:

- Red: Passion, excitement, love
- Pink: Soft, reserved, earthy
- Purple: Mysterious, noble, glamorous
- Blue: Wisdom, hope, reason, peace
- Green: Nature, growth, freshness
- Yellow: Hope, joy, danger
- Orange: Warmth, kindness, joy
- White: Truth, indifference
- Black: Noble, mysterious, cold
- Black: 51% of respondents associated black with sadness
- White: 43% of people associated white with relief
- Red: 68% associated red with love
- Blue: 35% linked blue to feelings of relief
- Green: 39% linked green to contentment
- Yellow: 52% felt that yellow means joy
- Purple: 25% reported they associated purple with pleasure
- Brown: 36% linked brown to disgust
- Orange: 44% associated orange with joy
- Pink: 50% linked pink with love

The study's researchers suggested that such results indicated that color-emotion associations appear to have universal qualities. These shared meanings may play an essential role in aiding communication." Based on the information provided from "Color Psychology: Does It Affect How You Feel? How Colors Impact Moods, Feelings, and Behaviors" By: Kendra Cherry I was able to provide an evident claim on how color psychology can have different effects on humans moods, feelings, and behaviors. Also how colors can influence emotional responses, as well as how responses to color are affected by factors such as age and cultural background. With the implementation of color psychology in my game I plan on creating a game that will use all of

these things in order to draw my audience in and make them want to play my game more while making them learn and be able to retain more than the normal learning style.

"Color can play an important role in conveying information, creating certain moods, and even influencing the decisions people make. Color preferences also exert an influence on the objects people choose to purchase, the clothes they wear, and the way they adorn their environments. People often select objects in colors that evoke certain moods or feelings, such as selecting a car color that seems sporty, futuristic, sleek, or trustworthy. Room colors can also be used to evoke specific moods, such as painting a bedroom a soft green to create a peaceful mood." [5]

"Did you know food color can increase our appetite and impact our taste? Orange is known to increase appetite and is often used for food packages and in fast-food restaurants. Blue triggers disgust and loss of appetite because there are no natural foods in (bright) blue. These implicit color expectations may alter how we respond to food or beverages. For example, Nestle recently launched a Matcha Green Tea flavored version of the KitKat chocolate bar in Europe. Green is not usually a color associated with chocolate, dessert and sweetness. Instead, if a (dairy) product turns green it indicates that it turned bad. Therefore, this color association might keep some Europeans from trying and enjoying this version of the chocolate bar.

The color of your product can be the reason for a customer to buy it. Colors excite emotions in people. The effects of color often go through emotions.

Our brain relies highly on emotions and feelings when making a decision (see Kahneman's concept of System 1 and 2). Thus, it can come in handy to know which emotions your target audience associates with what color. As a result, you will be able to trigger precisely the feelings you want.

The use of warm colors in your campaigns or logo generally evokes trust and a positive attitude towards your brand. As a consequence, it leads to loyalty and increases purchasing intentions.

Your brand's color also impacts your employees. One study found that red in the logo causes employees to work harder."

In regards to color psychology and food many different colors affect your appetite and sense of taste. Many fast food restaurants use color psychology in order to draw in customers. In the article it gave an example of how "Orange is known to increase appetite and is often used for food packages and in fast-food restaurants. Blue triggers disgust and loss of appetite because

there are no natural foods in (bright) blue." A good example of how it's used today is how Mcdonald's has all these bright warm colors that will draw in children and they want to go and eat there. The use of color psychology was a great implementation because the colors not only appeal to kids but it also attracts the older people as well so this has helped them in a way to get in the position they are in.



Figure 4: McDonalds

"Color does not only affect our psychological and emotional state but also our body. Consistent with psychologically preparing for danger, red is known to heighten physiological alertness. It activates our nervous system and thus increases the heart rate and the amount of adrenaline circulating in our bloodstream. This fight-or-flight response enables us to react faster.

Also, the previously mentioned relaxing effect of cool colors like blue and green leads to physiological changes. They calm the body, and for example, reduce respiration and lower the blood pressure. Therefore, surgeons often dress in green or blue.

The effects of colors on behavior go even further. The color of a medical drug seems to have an impact on its effectiveness. Red, yellow and orange pills are associated with stimulating effects; blue, green and purple with relaxing, or even numbing effects.

A study investigated the impact of color on the placebo effect. All participants believed that they were given stimulating drugs, even though they all got placebos. One group got warm-colored pills, and the other group got cool-colored ones. The findings showed that the placebo effect was stronger in people receiving pills of warm colors than for those who received cool-colored ones."

"According to the International Dyslexia Association, as much as 15 to 20 percent of the U.S. population may have symptoms of dyslexia. Those include slow or inaccurate reading, weak spelling, and poor writing. While not all reading problems are caused by dyslexia, some of the same accommodations can help many struggling students. Using the best fonts for dyslexia is one way you can help."

In the article "Best Fonts for Dyslexia and Why They Work" By: Jill Staake they told me that about 15 - 20 % of the United States have symptoms of dyslexia. With this new learned knowledge I came to the conclusion that a good amount of the population has this problem. With the implementation of what this article is telling me I believe that I will be able to help them not only boost their IQ with the regular implementations but with the added stuff for specific disabilities.

"This sans serif, non-italic font isn't monospaced, but Arial is still a good choice as long as you don't italicize it. If you're looking for a serif font, try Courier. It's monospaced, which makes it easier to read than its cousin Times New Roman. If you're looking for a serif font, try Courier. It's monospaced, which makes it easier to read than its cousin Times New Roman. Another font that's not monospaced but is sans serif, Verdana is overall rated as fairly easy to read."

According to the article the fonts above that are programmed in most computers are helping people with dyslexia be able to read and understand the text better. A common thing that Jill mentioned in the text in regards to the different fonts is that they shouldn't be monospaced.

"In Dyslexie, letters have heavier bottoms, slightly adjusted shapes, and longer sticks. This is a licensed font, and you'll need to pay to use it in all your programs. Learn more about Dyslexie here. OpenDyslexic is a free font and uses heavier bottoms and irregular shapes just like Dyslexie." [1] While there

are built in fonts there are specially made fonts too. As mentioned above things such as Dyslexie and OpenDyslexic are specially made fonts that are supposed to help with dyslexia but aren't proven yet but it doesn't hurt to try it. If these specific fonts were to get approved with further research then I plan on making this implementation to my game.

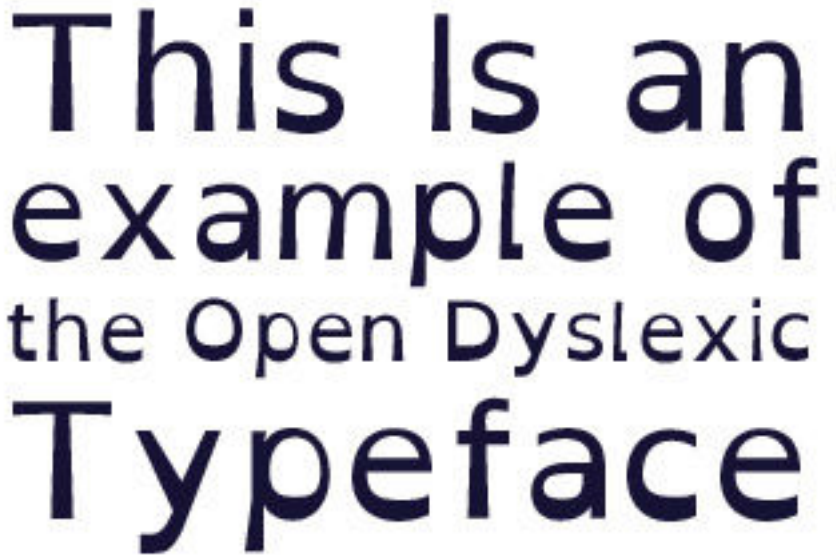


Figure 5: Best Font TO Use For Dyslexia

But now my comp is more so catering to the generation of my dungeon everytime without errors. Allowing the player to be able to move freely and play the math game without errors. Although I am still adding color psychology into my project in order to appeal to people's minds and cause a reaction based on the colors that I plan on using. I believe that my initial idea is still a great idea so I'm continuing with the implementation of color psychology but I will be testing the dungeon generation compared to the improvement of kids math skills after playing my game.

I chose to do my research on color psychology because it's a real thing that's implemented in our everyday life in order to control our behaviors. As I cited in my intro from one of the articles I read about color psychology Written by: "Clara Vetter" on 05/12/2019. While researching color psychology I came across another area of research and that is how different fonts

will affect learning and memory. I came across an article called "How Fonts Affect Learning and Memory" By Carla DelgadoOct 9, 2021 1:00 PM and this article opened my eyes and made me realize that I can affect kids in more than one way.

"According to some studies, hard-to-read fonts such as Bodoni, Comic Sans, Haettenschweiler, or Monotype Corsiva are better for retaining information compared to fonts like Arial or Times New Roman. Participants recalled more information from the material they read when it was presented in a font that was difficult to read, according to a 2010 study published in Proceedings of the Annual Meeting of the Cognitive Science Society."

While reading the article I came across this passage that talks about how different fonts help you retain more stuff than others. So based on this study fonts such as: Bodoni, Comic Sans, Haettenschweiler, or Monotype Corsiva are helping people retain the information. While on the other hand these fonts: Arial or Times New Roman are doing the opposite in retaining knowledge.

"For instance, distracting sounds like background chatter or environmental noise from aircraft and road traffic are shown to be detrimental to crucial parameters studied in students and office workers, like text memory, reading comprehension and attentional function. This finding prompted researchers to look into the effect of hard-to-read fonts — they learned that the increased engagement and task demand from the disfluency can significantly reduce one's processing of background noise." I think that this is an important part of the test because all kids have a short attention span. With this small attention span they are pron to getting distracted.

Children tend to get distracted by many things like noises for example. If kids were to hear or see something distracting then it will cause them to get away from the game and that will cause them to stop their learning. In the text it said "That's a quandary in our increasingly noisy lives because"young children learn language from hearing it," said Dr. Rochelle Newman of the University of Maryland. "They have a greater need for understanding speech around them but at the same time they're less equipped to deal with it.""

"It's not just a concern for toddlers and preschoolers. The ability to understand and process speech against competing background noise doesn't mature until adolescence, Leibold said.

Nor is the challenge just to tune out the background buzz. Brief sudden noises, someone coughing, a car horn blares can drown out part of a word or sentence. An adult's experienced brain automatically substitutes a logical

choice, often well enough that the person doesn't notice, Newman said.

"Young children don't do this. Their brain doesn't fill in the gaps," she said.

Children who were born prematurely may have an additional risk. When preemies spend a long time in an incubator, their brains get used to the constant "white noise" of the machine's fan different from a full-term baby who develops hearing mom's voice in the womb and thus is wired to pay more attention to voices, said Dr. Amir Lahav of Harvard Medical School." [9] So with this information I am going to look further into it because with harder to read fonts it will require more kids to focus on. Another area of research spawned up during one of my senior comp classes. We were telling our group our ideas and receiving feedback from our group members on what they think will help us be able to make our project better. One of my group mates brought up something the Professor OBC brought up to me before but I ended up forgetting. So when it was brought up again it sparked a fuse and made me look into it. In the article "Best Fonts for Dyslexia and Why They Work" By: Jill Staake a Contributing Editor with WeAreTeachers it said So with the implementation of this I believe that this will help me be able to ultimately create a more diverse game for kids to become better at lower level math skills. [9]

"According to the International Dyslexia Association, as much as 15 to 20 percent of the U.S. population may have symptoms of dyslexia. Those include slow or inaccurate reading, weak spelling, and poor writing. While not all reading problems are caused by dyslexia, some of the same accommodations can help many struggling students. Using the best fonts for dyslexia is one way you can help." In the article "Best Fonts for Dyslexia and Why They Work" By: Jill Staake they told me that about 15 - 20 % of the United States have symptoms of dyslexia. With this new learned knowledge I came to the conclusion that a good amount of the population has this problem. With the implementation of what this article is telling me I believe that I will be able to help them not only boost their IQ with the regular implementations but with the added stuff for specific disabilities. "This sans serif, non-italic font isn't monospaced, but Arial is still a good choice as long as you don't italicize it. If you're looking for a serif font, try 21 Courier. It's monospaced, which makes it easier to read than its cousin Times New Roman. If you're looking for a serif font, try Courier. It's monospaced, which makes it easier to read than its cousin Times New Roman. Another font that's not monospaced but is sans serif, Verdana is overall rated as fairly easy to read."

According to the article the fonts above that are programmed in most computers are helping people with dyslexia be able to read and understand the text better. A common thing that Jill mentioned in the text in regards to the different fonts is that they shouldn't be monospaced. "In Dyslexie, letters have heavier bottoms, slightly adjusted shapes, and longer sticks. This is a licensed font, and you'll need to pay to use it in all your programs. Learn more about Dyslexie here. OpenDyslexic is a free font and uses heavier bottoms and irregular shapes just like Dyslexie." While there are built in fonts there are specially made fonts too. As mentioned above things such as Dyslexie and OpenDyslexic are specially made fonts that are supposed to help with dyslexia but aren't proven yet but it doesn't hurt to try it. If these specific fonts were to get approved with further research then I plan on making this implementation to my game.

While searching through games that children played or are playing I did a little research along with my prior knowledge to come up with some ideas on how my game will be. Some games that I am going to be talking about are Number Muncher, Mancala (the first math game invented), and red remover. Number Muncher - is a 1986 video game and a spin-off to the title Word Munchers. It was made by MECC for Apple II, then ported to DOS and Macintosh in 1990. The concept of the game was designed by R. Philip Bouchard, who also designed The Oregon Trail. Two versions of the game were released, the Consumer Version (for home use) and the School Version (for classrooms). After The Learning Company acquired MECC, the game was rebranded as "Math Munchers".

Mancala - is a family of two-player turn-based strategy board games played with small stones, beans, or seeds and rows of holes or pits in the earth, a board or other playing surface. The objective is usually to capture all or some set of the opponent's pieces. Red Remover - is a game where players must make all the red blocks 28 disappear off screen without losing any green blocks. Players click objects to make them disappear, and must do so in a way that gets the red blocks to fall off the screen. The game features strict physics, with objects reacting realistically to forces of gravity within the game. I plan on implementing these things into my game to create the best game for kids to play in order to retain and learn more than what they are and make it fun for them. With the implementation of all of my related research it will help me ultimately create the best game that I can create. With the implementation of different fonts for people with disabilities, adding color psychology, adding lower level math skills and tying it together

will allow the kids to boost their IQ.

In conclusion, based on the research conducted, it is evident that a game like MathRunner can have a positive impact on children's learning environment. The game has the potential to not only enhance their math skills but also reduce stress and anxiety levels. MathRunner provides a fun and engaging way for children to learn subtraction and addition, and the game's safe environment will make them more comfortable with numbers. With the help of games like MathRunner, we can make learning math a more enjoyable experience for children, ultimately leading to improved academic performance and a positive attitude towards learning.

Method of approach

MathRunner is an innovative game that aims to offer students a new way to learn math in a fun and creative way. With its engaging gameplay and interactive challenges, MathRunner provides students with the opportunity to develop their math skills while having a blast. The game is designed to cater to students in kindergarten - fourth grade ages 4 - 10 (also for any kid that wants to play in order to improve those skills) and with a range of levels and challenges that gradually increase in difficulty(later development). MathRunner allows children to explore different math concepts such as addition and subtraction through problem-solving, critical thinking, and logical reasoning. By offering a unique and exciting approach to learning, MathRunner has the potential to transform the way students perceive math and instill a love for the subject that will last a lifetime.

Last year during my junior semester class I was in the process of coming up with ideas for my comp and I had to take it before my senior comp class. Taking this class has helped me get a surface level understanding of how unity works along with how I can use the programming language C# to make the game work. While working on my project I had to struggle before I was able to get it working. The name of my game is "MathRunner"; A educational math game based on color psychology. I remember a while back I saw an informative video on how color psychology is used in our everyday life in order to influence our behaviors. I was interested in it because many people don't understand it but it's being used in everyone's life. In an article I found online "The effects of colors on behavior" Written by Clara Vetter on 05/12/2019 it said: "Our brain is wired to pay attention to objects that are of a contrasting color compared to its surroundings. It helped our ancestors to find food, or to notice potential dangers and hazards.

Some of the different game ideas that I started to develop before the finalization of my game MathRunner was essential to the creation of Math-

Runner. The previous version of MathRunner was a platformer. A platform game, commonly referred to as a "platformer," is a style of video game where the player makes a character move through an environment with a series of action-based moves, like running, jumping, or swinging from ropes. Another main detail about the platformer that I created was that it was a single screen like mario and that isn't what I wanted to create. While developing this game it was a good experience for me to learn how this type of game works. Although it was hard to complete this style of game it helped me somewhat familiarize myself with the programming language C#. The platformer game I made was fairly simple. There were assets that I downloaded so I was able to download that into my unity and that allowed me to not have to use blender to create my world or characters at all. What made me get stuck with the platformer was creating movement for my player. I created a script that had code in it that will allow me to move my character left and right with the arrow keys. But when I pressed the spacebar the player had an unlimited jump which was no good. If the user held the space bar you'll be able to super jump in a sense where you can jump off the screen. This error caused a lot of unexpected errors. So once I fixed this error and only allowed a certain amount of distance to be covered after jumping it allowed my game to run smoothly.

But as I continued to work on it I believed that it wasn't what I wanted to do. It is too one dimensional and I didnt believe that it would draw the user in and make them want to play my game. This led me to my creation of my procedurally generated 2d math game. I was searching for a new idea on the internet. When I came across several different people and games that they've created which allowed me to come to the conclusion that I wanted to make a procedurally generated 2D dungeon game. The game will have lower level math skills such as addition and subtraction that will allow kids to have impacts on them such as on their concentration and productivity increases in certain aspects of their intelligence based on color psychology.

Here is the fax from The Psychology of Color: How Do Colors Influence Learning? By: Sh!ft, Best Color For Concentration And Productivity Is Orange By: Shana Ecker, and Color Psychology: How to Best Use 6 Colors in Learning By: Melissa Taylor all show that color psychology can improve concentration and productivity.

The field of color psychology has gained significant attention in recent years due to its potential to enhance learning, concentration, and productivity. The facts from "The Psychology of Color: How Do Colors Influ-

ence Learning?" By: Sh!ft, Color Psychology: How to Best Use 6 Colors in Learning By: Melissa Taylor, and Shana Ecker's article "Best Color For Concentration And Productivity Is Orange" provide valuable insights into the impact of color on our cognitive processes. According to Ecker, the color orange is particularly effective in improving concentration and productivity. By understanding the psychology of color and its influence on our minds, we can leverage this knowledge to create more effective learning environments and improve our work productivity. [**Sh?!**ft] [10] [7]

"You probably know this already, just by taking a look at a forest or a field. Low wavelength colors promote restfulness and calm, and they improve efficiency and focus. So that's why green is an excellent color for improving concentration. Apart from being one of the easiest colors on the eyes, it reminds us of nature. That's why TV stars stay in the 'green room'. It's a relaxing space.

Green is a good color for keeping long-term concentration and clarity, making it a good choice for an office – as opposed to red, which is seen as stimulating and exciting. Maybe it helps in the short term, but stimulation has to tail off sometimes.

Think about the orange sun setting over the horizon. Nice, right? It's true, orange can be a welcoming and mood-lifting color for learners, which in turn promotes comfort and improves neural functioning. Some theorists argue that an environment rich in the color orange increases the oxygen supply to the brain, stimulating mental activity while simultaneously loosening peoples' inhibitions. An increased oxygen supply also leads to feeling invigorated and getting ready to 'get things done.' Some have even suggested that test centers be painted orange to stimulate exam-takers. Some research suggests that people with highly intellectual work, which requires a high cognitive load, for instance, programmers or academics, are more productive in a blue environment. That said, though; we can't keep life too monochromatic – it should be balanced with warmer colors. These can be found by using the opposite side of the color wheel.

Blue is best used for learning situations which are challenging. Blue paper, blue ink, or blue highlighting can be used to help improve reading comprehension too. Blue in general seems to be a relaxing and calming color, but lighter shades will seem more 'friendly' while darker ones seem a little more somber."

Additionally in the article Best Color For Concentration And Productivity Is Orange By: Shana Ecker shows that "Red screams pay attention to

me!! The color Red helps learners remember information, facts, and figures. Red on white is the easiest to read. But a little goes a long way with this color choice so use red sparingly. The color green is not only a relaxing color, but it's associated with all things healthy, and it helps concentration. According to color psychology, the color blue promotes creativity and peaceful feelings. Educators can use blue for learning situations that are challenging. The color yellow is a stimulating color that asks the learner to pay attention. That's why so many highlighters are yellow. And school buses! If that isn't a clear use of color psychology in everyday life, I don't know what is. Welcoming and mood-lifting, the color orange can help learners feel comfortable, which improves brain function. Some research says that orange tinted glasses improve a person's mood. Interestingly enough, orange glasses effectively block the blue light from electronics that can interfere with melatonin and sleep."

Providing children with a strong foundation in basic math skills, such as addition and subtraction, is essential for their academic success. However, it can be challenging for some children to grasp these concepts, leading to frustration, poor retention, and decreased productivity. To help children gain a better understanding of these lower level math skills, I will be utilizing a variety of strategies in regard to color psychology. These might include incorporating multiple different colors, font styles, and if I find other stuff with further research into my game MathRunner to make my game more engaging and interactive. By using a variety of teaching methods I found through research, children are more likely to retain the information and stay focused, leading to increased productivity and academic success after playing my game.

As an aspiring game developer, the process of creating a game can often involve trials and errors. This was certainly the case for me as I started to think about if my platformer game would be enough to meet my ideal thought for my game. My initial idea was to create a platformer game where players would have to collect a certain number of keys to progress to the next level. However, after working on this concept for a while, I began to realize that this idea was not the best fit for me. While the platformer game was engaging and fun, it didn't quite capture the level of complexity and variation that I was looking for. Eventually, I decided to shift my focus to a procedurally generated 2D dungeon game, which would allow for endless variations and keep players engaged and challenged over time. Making this decision allowed me to explore new possibilities and ultimately create a game that I was proud of and look forward to making into an app for kids to utilize

it and improve on their skills.

I was able to create a procedurally generated map that will generate a random dungeon with rooms connected by corridors in order to create my fully functioning game MathRunner. While creating this game I came across many errors and different challenges that caused me to get down and began to think that this project wasn't going to be able to be completed. But with the persistence I have and dedication to my topic I was able to make significant progress to completing the fully functioning prototype for my game MathRunner.

Developing a game is a complex process that requires a lot of effort, patience, and dedication. As a game developer, you will face numerous challenges that can impede your progress and put your project at risk. One of the most frustrating problems that can occur during game development is software crashes. In my experience, I encountered a severe issue where my Unity crashed while still working on my procedurally generated 2D game. Unfortunately, I had no idea why my Unity editor deleted my initial version of my project called MathRunner. It could have been due to the storage problem on my PC, but I couldn't confirm it. Losing my MathRunner project set me back significantly, and I had to start all over again. As a game developer, I realized that setbacks like these are inevitable, and it's crucial to have a backup plan and regularly save your progress to prevent losing your work. This led me to regularly uploading working and non working versions of my game in order to make sure that I never lose anymore of my work because of a system error.

Game development is a constant learning experience, and it requires a lot of patience and resilience. Losing my MathRunner project was a significant setback for me, but it also taught me an essential lesson. From that experience, I learned to be more cautious with my work and always save my progress to prevent losing everything. Additionally, I made sure to have a backup plan in place in case of any unexpected crashes or errors. As a game developer, it's crucial to remain positive and keep pushing forward, even when faced with setbacks or challenges. Every mistake is an opportunity to learn and improve your skills, and it's essential to embrace that mindset to succeed in this industry. In the end, I was able to overcome my setback, and my game MathRunner is back up and running and I am continuously adding new improvements to my game through research and making it happen when making my game better.

Another area of research spawned up during one of my senior comp

classes. We were telling our group our ideas and receiving feedback from our group members on what they think will help us be able to make our project better. One of my group mates brought up something the Professor OBC brought up to me before but I ended up forgetting. So when it was brought up again it sparked a fuse and made me look into it. In the article "Best Fonts for Dyslexia and Why They Work" By: Jill Staake a Contributing Editor with WeAreTeachers it said "Specially designed fonts like Dyslexie and OpenDyslexic add one more feature. They strive to make the differences in mirrored letters like "d" and "b" more obvious, with subtle changes to their appearance. Some researchers feel that special fonts like Dyslexie don't offer any true benefits at all. But they also say there's no harm in trying them out." "With those criteria in mind, these four standard picks are typically recommended as the best fonts for dyslexia. They're available on pretty much every computer, so consider setting one of them as your default. These are as following Arial, Courier, Verdana." Basically anything that is sans serif font, not monospaced, but is sans serif could be beneficial in what I am trying to do. [9]

So with the implementation of this I believe that this will help me be able to ultimately create a more diverse game for kids to become better at lower level math skills.

While searching through games that children played or are playing I did a little research along with my prior knowledge to come up with some ideas on how my game will be. Some games that I am going to be talking about are Number Muncher, Mancala (the first math game invented), and red remover.

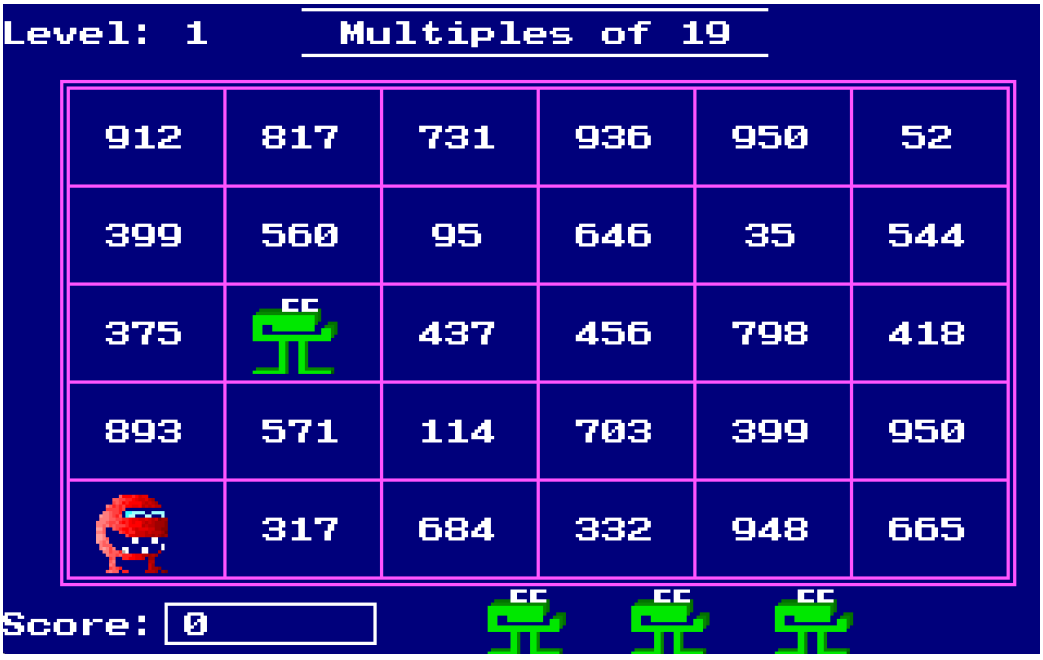


Figure 6: NumberMuncher

Number Muncher - is a 1986 video game and a spin-off to the title Word Munchers. It was made by MECC for Apple II, then ported to DOS and Macintosh in 1990. The concept of the game was designed by R. Philip Bouchard, who also designed The Oregon Trail. Two versions of the game were released, the Consumer Version (for home use) and the School Version (for classrooms). After The Learning Company acquired MECC, the game was rebranded as "Math Munchers".



Figure 7: Mancala

Mancala - is a family of two-player turn-based strategy board games played with small stones, beans, or seeds and rows of holes or pits in the earth, a board or other playing surface. The objective is usually to capture all or some set of the opponent's pieces.

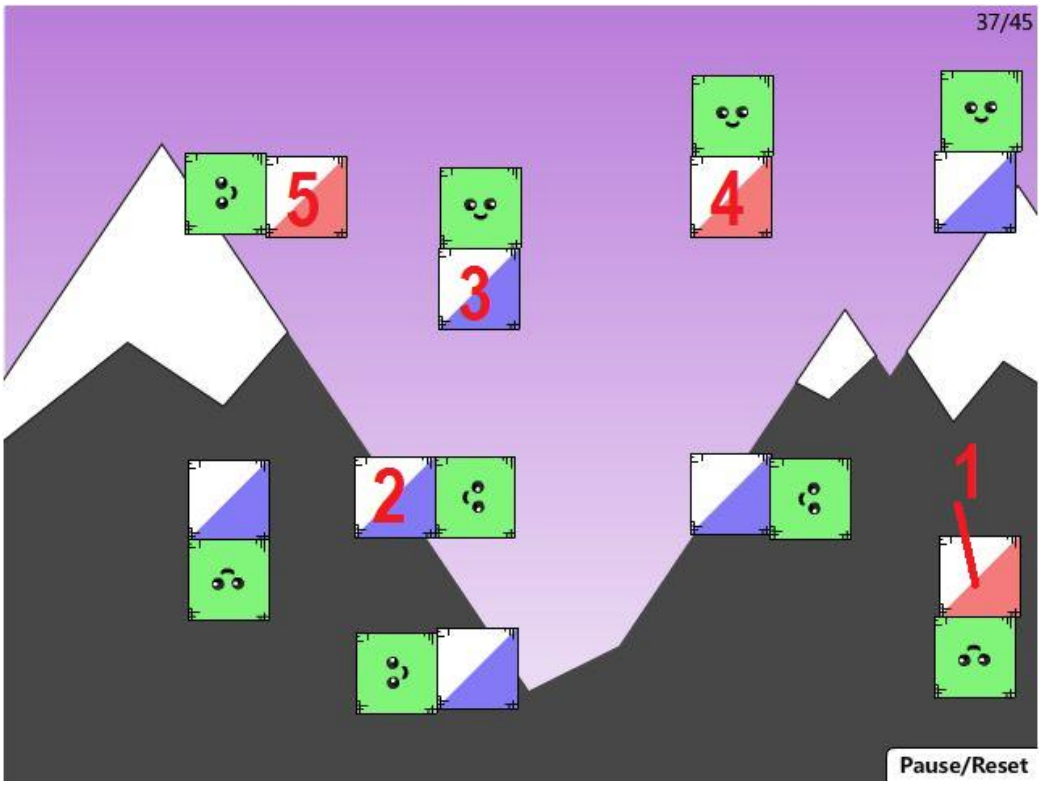


Figure 8: RedRemover

Red Remover - is a game where players must make all the red blocks disappear off screen without losing any green blocks. Players click objects to make them disappear, and must do so in a way that gets the red blocks to fall off the screen. The game features strict physics, with objects reacting realistically to forces of gravity within the game.

After researching how games use color psychology in order to draw in more people's attention and improve their concentration and productivity. I was able to gain more knowledge on how they do that along with a few games that implement color psychology in them. The games that I was experimenting with are Red Remover, Mancala, and Number Muncher. After researching and experimenting I believe that I now know how I want to implement color psychology into my game in order to help these children with their lower level math skills:addition and subtraction. Color psychology has been extensively used in the gaming industry to enhance user experience and improve their

concentration and productivity.

According to Color Theory in Games – An Overview By: DVNC Interactive "When we see certain colors we instantly have thoughts associated with those colors come to mind. When you see red you may start thinking about fire, stop signs, or passion. When you see blue you may have thoughts associated with relaxation or sadness. The psychology of a color can "hint" to players an object's faction (good versus evil). When most gamers see a red crosshair on their screen they instantly think to fire. However, if the player sees a green crosshair they know that it is a teammate and they shouldn't fire. Combining the crosshair of a sight with a color that means danger instinctively makes a player want to shoot at the target. While using a color that's more natural and softer signals a friendly relation to the player."

"Game developers can also use color psychology to communicate to players what the purpose of an object is. This can range from red or green for objects that have to deal with health to using blue for objects that deal with shield or mana.

Effective color systems for games use both players' biases towards certain colors in relation to games and the designer's intent with an object to communicate with players." [6]

Color is an essential component of game design, and games designers often use it to evoke specific emotions and trigger particular behaviors in players. By using warm colors like red, orange, and yellow, game designers can create a feeling of excitement and energy in players. These colors can be used to draw attention to specific game elements, such as buttons or power-ups, and to create a sense of urgency in players.

On the other hand, cool colors like blue, green, and purple tend to have a more calming effect on players. They can be used to create a relaxing and focused atmosphere in the game, and to encourage players to slow down and think more carefully about their actions. By strategically using color combinations and patterns, game designers can create a more immersive and engaging experience for players, ultimately leading to a more enjoyable and successful game.

Games designers often use colors to evoke specific emotions and trigger certain behaviors in players. For instance, warm colors such as red, orange, and yellow tend to be associated with energy, excitement, and stimulation. Cool colors such as blue, green, and purple, on the other hand, tend to be more calming, relaxing, and focused. By strategically using color combinations and patterns, game designers can enhance player engagement and

improve their overall experience.

During my research, I experimented with several games that incorporated color psychology into their design, including Red Remover, Mancala, and Number Muncher. By observing how these games used colors to enhance player engagement and productivity, I gained insights into how to use color psychology to develop my own educational game. Specifically, I plan to use warm colors such as yellow and orange to stimulate the children's minds and increase their energy levels while incorporating cool colors such as blue and green to enhance their focus and concentration. By carefully balancing these color combinations, I hope to create an effective educational game that will help children improve their basic math skills.

The use of colors and fonts in game design can have a significant impact on the learning and engagement of players, particularly children. As a game designer, you plan to incorporate these elements into your game to help children improve their math skills while having fun. By conducting related research, you hope to create your best game yet by implementing different fonts for people with disabilities and leveraging color psychology to enhance the game's effectiveness.

You believe that by tying all of these elements together, children will be able to boost their focus and concentration while playing your game. This is particularly important when designing a game aimed at improving math skills, as concentration and focus are essential for success. The use of different colors, such as red and blue, has been shown to enhance cognitive skills and improve brain function. The color green is associated with all things healthy and helps with concentration, while the color yellow is a stimulating color that encourages learners to pay attention. Finally, the color orange can help learners feel comfortable, which can improve their brain function.

In addition to the use of colors, you have also selected three child-friendly fonts based on an article titled "The 10 Best Child-Friendly Fonts for Kids" by Claudia Wild. The fonts you've chosen include Comic Sans MS, Sassoon Primary, and Gill Sans Infant Std. These fonts are easy to read and can help children focus on the content of the game. With the implementation of these fonts and the use of appropriate colors, you believe that your game will be a success in achieving your goals of improving children's math skills while providing an enjoyable experience.

In conclusion, the use of colors and fonts in game design can have a significant impact on the learning and engagement of players, particularly children. By implementing different fonts for people with disabilities, leveraging color

psychology, and adding lower-level math skills, you hope to create a game that will help children boost their focus and concentration while having fun. With careful planning and research, you believe that your game will be a success in achieving your goals of improving children's math skills and providing an enjoyable experience.

In my game, MathRunner, I plan on incorporating various elements that can have a positive impact on children. One such element is using different color text to enhance retention and learning. Research has shown that colors play a significant role in affecting human behavior and emotions, and by using warm colors, I hope to create a friendly and safe learning environment. By making the game visually stimulating, it will make it more engaging and attractive for children, increasing their willingness to participate and learn. I believe that with the implementation of these different elements, MathRunner can become a useful tool for parents and schools looking for an educational math game that can help children deal with stress and anxiety while providing an effective way to learn math skills like addition and subtraction.

Experiments

In this chapter, I will be discussing my project, MathRunner, which is an educational game based on color psychology designed to help young children with basic math skills(addition and subtraction). I created this game using Unity's gaming engine, and it serves as a prototype for the fully functioning game that I aim to develop in the future. In the following paragraphs, I will explain how I implemented color psychology into my game, and how it works to enhance the learning experience of young children. Additionally, I will provide a defense of my claim that my implementation of color psychology will work as intended along with how my map will generate flawlessly every time through the procedurally generated dungeon.

MathRunner is a procedurally generated dungeon game that uses color psychology to enhance the learning experience of young children. I believe that color psychology is a powerful tool that can be used to influence the mood and behavior of players in a game. In my game, I used color psychology to create an environment that promotes learning and engages the player in a way that is both fun and educational. For example, I used warm colors like red and orange to signify danger and caution in the game, while cool colors like blue and green were used to represent safety and calmness. By doing so, I aimed to create a sense of urgency and importance around mathematical problems while also creating a calm and welcoming environment for young children to learn and explore.

My implementation of color psychology in MathRunner is intended to create an immersive and educational experience for young children. Along with this I am aiming for a fully functional game that can act as a tutor in a sense that will help these kids with their math skills just as well as a tutor would. Using Unity's gaming engine, I was able to create a functional prototype of my game that lays the foundation for the fully functional educational game that I intend to develop further. Through this project, I hope to help

young children improve their basic math skills in a fun and engaging way.

Although the results of my project will ultimately depend on future work, I encountered several obstacles during the development process that hindered the completion of my game in Unity. Despite spending countless hours trying to troubleshoot and fix the issues, some of them proved to be quite significant. One of the most significant challenges I faced was the deletion of my project due to a technical glitch that occurred on my laptop. Unfortunately, this setback resulted in the loss of a significant portion of my progress towards completing MathRunner. I was devastated and frustrated because I feared that I would not be able to meet the deadlines for the senior comp.

In addition to the technical issues, I also faced other challenges such as time constraints and the steep learning curve associated with game development. Although I had prior experience in programming, I found that game development was a completely different ball game. It required a level of creativity and problem-solving that I was not accustomed to. However, I was determined to overcome these obstacles and complete my project to the best of my abilities. Despite the challenges I faced, I believe that this project has taught me valuable skills such as patience, perseverance, and the importance of effective project management.

While working on a gaming development project, I faced a significant challenge in trying to comprehend the programming language C#. My limited knowledge of the language became a significant hindrance in completing the project on time. It resulted in a learning barrier that caused little errors in my code, like incorrect declarations and incorrect implementation. These minor issues continuously occurred because of my limited understanding of C#. As a developer, I realized the importance of having a strong foundation in the programming language, which is crucial in ensuring that the codes run smoothly and efficiently. Despite the challenges, I learned to persevere and took steps to improve my understanding of C#, allowing me to overcome the obstacles and complete the project successfully.

Some of the errors that I ran into were:

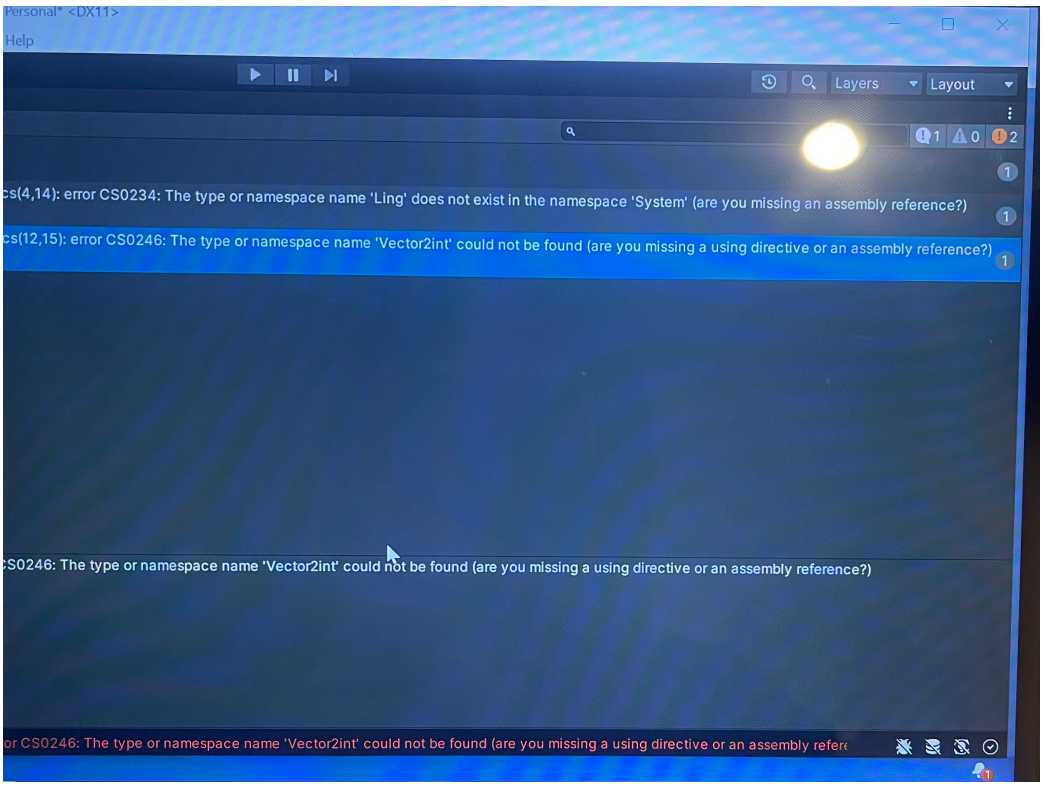


Figure 9: Unity Error Message

- During the game development phase of my senior project MathRunner, I faced a recurring error that I had encountered multiple times before. The solution was seemingly straightforward, as it involved changing a lowercase "i" into an uppercase "I". Although this seemed like a minor issue, I learned that such small mistakes could lead to significant project failures. Thus, I was relieved to have identified and resolved this error, allowing me to move forward with my project without any further obstacles. This experience taught me the importance of paying close attention to even the smallest details when developing a project, as it can have a considerable impact on the overall outcome.

As a game developer, encountering errors is a common occurrence, but it's important to learn from these mistakes in order to improve your skills and create better games. Through the consistent minor errors that I encountered

while working in Unity, I was able to gain a better understanding of what the platform likes and doesn't like.

One of the most common errors that I ran into was the "Type Namespace Error." This error was typically caused by me not setting a variable's name correctly, often due to simple spelling errors. In order to fix this error, I had to double-check my code to ensure that all variable names were spelled correctly and properly set.

While these errors may seem minor, they can have a significant impact on the functionality of the game. Addressing them promptly and thoroughly is essential to creating a smooth and enjoyable gameplay experience for players. Through these experiences, I was able to develop a better understanding of Unity's requirements and refine my skills as a game developer. With each error that I encountered and corrected, I gained a better understanding of the platform and the best practices for creating successful games.

With these consistent minor errors that I continuously received I was able to start to understand what unity likes and doesn't like. One of the errors that I ran into a few times was an "Type Namespace Error". An "Type Namespace Error" was basically me not setting a variable's name correctly. Most of the time it was spelling errors and I had to change the spelling of a word or correctly set the variables in order for my script to run correctly.

Another error I ran into was:

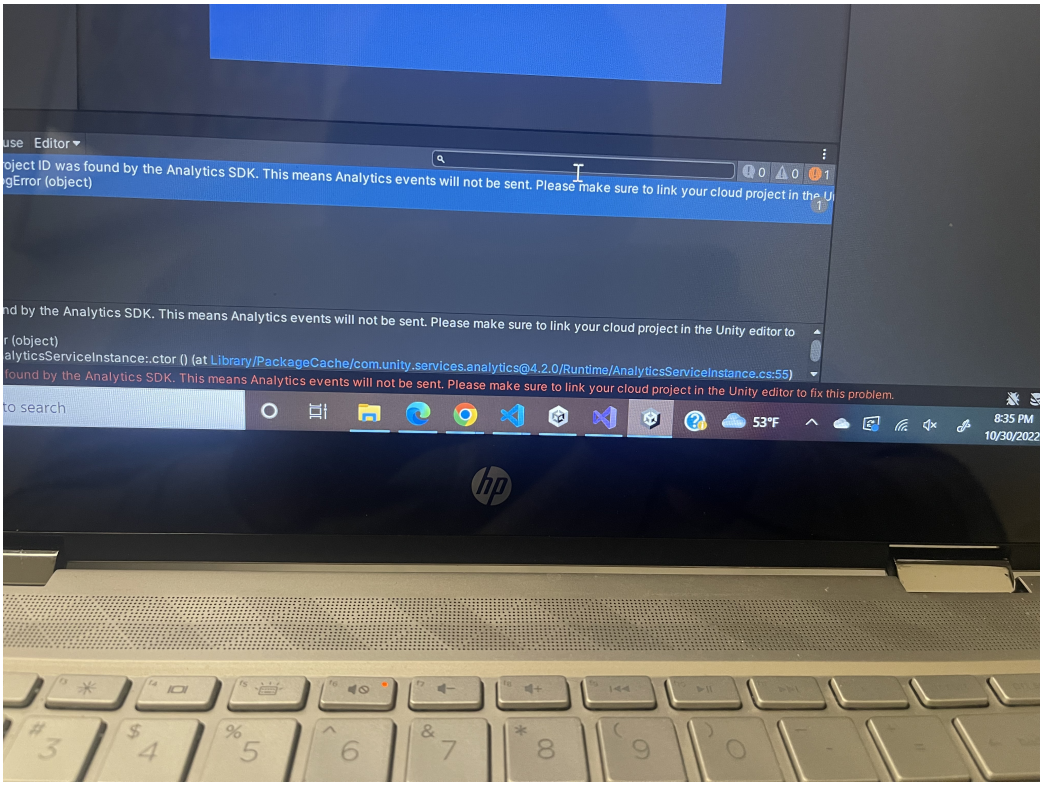


Figure 10: Unity Error Message

- During the course of my senior project MathRunner, I encountered an error that left me perplexed about how to resolve it. Despite my initial confusion, I took a systematic approach to address the issue. First, I turned to Google to look for potential solutions to the problem. Additionally, I contacted my first reader and sought their assistance with resolving the issue. The error occurred due to a mistake in one of my scripts, causing it to fail. Ultimately, I had to remove the script entirely and start anew. After recoding the script correctly and placing it in the correct location within the editor, I was finally able to move past the error and continue with my senior project. Despite the setback, this experience taught me the importance of meticulousness and attention to detail when coding, as even a small mistake can lead to significant consequences.

Another error I ran into was:

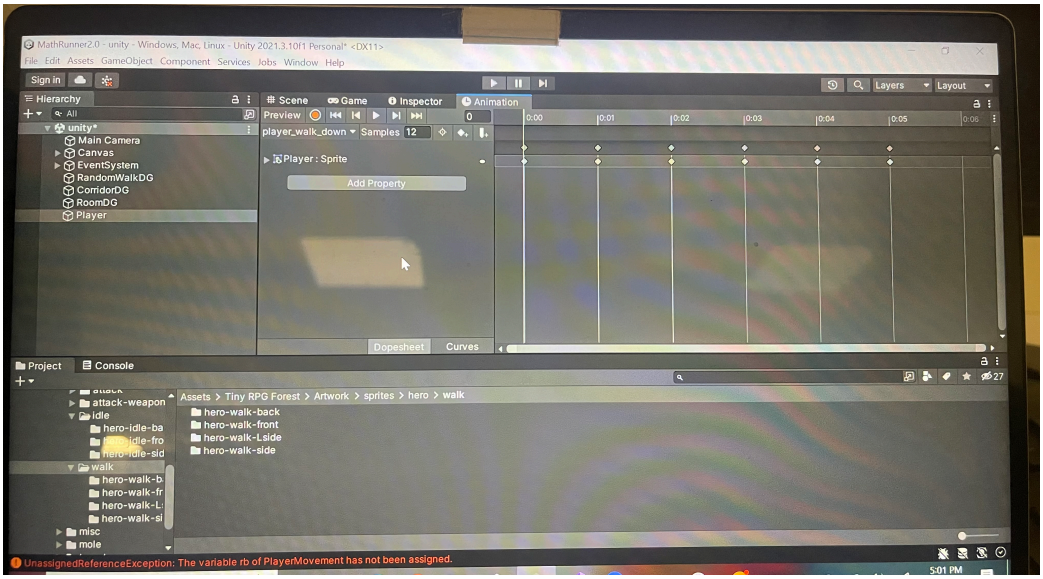


Figure 11: Unity Error Message

- While working on my senior project MathRunner, I encountered a familiar issue that involved setting something in the editor. Although I was able to write the script properly, I realized that I had placed it in the incorrect location within my player's hierarchy. This caused my player to be unable to move left, right, up, or down, and prevented proper animations from displaying. However, after recognizing this mistake and relocating the script to its correct position, I was thrilled to witness my player moving smoothly and showing seamless animations as I moved it around in various directions. This was a significant breakthrough for my project, and it taught me the importance of double-checking and ensuring that scripts are placed in their proper locations to avoid similar issues in the future.

The process of generating a map for my game can be quite complex, and sometimes errors can arise that make it difficult to progress in the game. In my case, I encountered an error with the map generation that prevented the spawning of corridors needed to access different rooms in the game. The

problem was that the corridors weren't being generated correctly, creating an "island" that prevented players from being able to move from room to room in the dungeon. After some investigation, I discovered that I needed to make some adjustments in the hierarchy in response to the corridors script. By setting the tileMapVis equal to itself and adjusting the corridor length and count, I was finally able to see a complete map being randomly generated.

Fixing errors in game development can be a time-consuming and challenging process, but it's essential to ensure that players have the best possible experience. In this case, I had to spend a significant amount of time figuring out the root of the issue and determining the appropriate steps to take to fix it. However, the end result was well worth the effort, as players can now navigate through the map without these little bugs occurring. It's always satisfying to see your hard work pay off and to know that players are going to enjoy the game I created.

As a game developer, encountering issues with the display of game elements can be frustrating and potentially game-breaking for players. In my case, I ran into an issue with the walls not being fully displayed correctly. This created a potential hazard for players, as it could lead to them falling through the wall and being stuck in an infinite void. This error needed to be addressed promptly to ensure a smooth and enjoyable gameplay experience. To fix the issue, I needed to go into the settings and set the walls equal to the preset image that I had downloaded. This required a bit of trial and error to ensure that the walls were displaying correctly on all sides and in all areas of the game. Once I had made the necessary adjustments, I was able to see a marked improvement in the appearance and functionality of the walls.

It's important to remember that even seemingly minor errors can have a significant impact on the player experience. Addressing these issues promptly and thoroughly is key to creating a successful game that players will enjoy. With the walls now displaying correctly, I can move forward with confidence in the knowledge that players will be able to navigate the game without encountering any game-breaking issues.

Another Issue that I ran into was my walls not being fully displayed correctly. As shown above in the image it doesn't show a full wall all the way around in the corners and other parts where this would essentially cause a big error in my game. Imagine walking through the game and you suddenly fall through the wall to an infinite dark hole that wouldn't be any fun. So in order to fix the error I had to go into the setting the walls equal to the preset image that I downloaded.

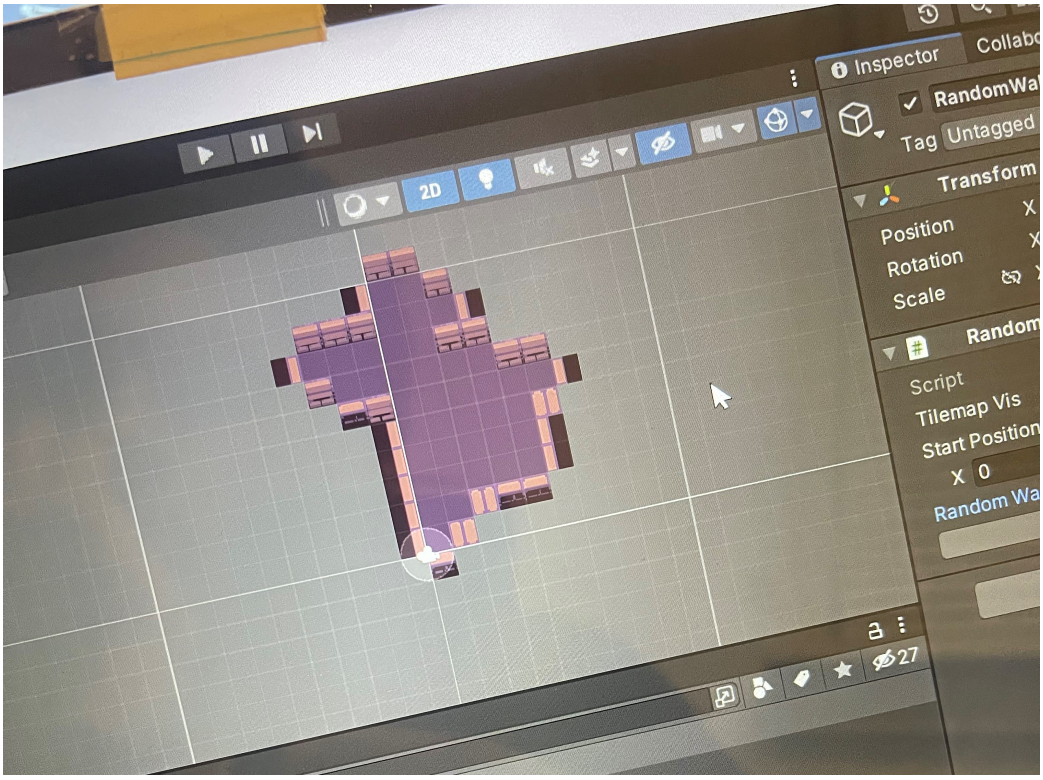


Figure 12: Error With Walls

In game development, attention to detail is essential to create a polished and immersive experience for players. However, errors can sometimes arise, causing issues that can detract from the overall quality of the game. In my case, I encountered an error that prevented the walls from covering the entire surrounding area of my game, creating a jarring visual effect. After some investigation, I discovered that I needed to select tile bases in order to fix this issue. With this correction made, I was able to see a marked improvement in the appearance of my game. The walls now wrapped completely around the map, creating a much more cohesive and immersive environment for players to explore. It was satisfying to see the game start to take on a more polished and professional look.

As a game developer, it's important to stay focused on the details, even when it comes to seemingly minor issues like wall coverage. By taking the time to address these small errors, we can create a much more polished

final product that players will enjoy. It's all about creating an immersive experience that draws players in and keeps them engaged, and attention to detail is key to achieving that goal. Overall, I'm pleased with the progress I've made so far and excited to continue refining my game.

Here is where I was able to select tile bases in order to have the walls completely cover the whole surrounding areas of my game. With the correction of this error I was able to see my walls completely wrapped around the map and it actually started to look like an actual game.

One of my problems was with the IRB. I was unaware of the IRB and the process that It takes and how long it will take to get one. From an article "IRB Review Process' ' By: Research Ethics and Compliance from the University of Michigan. I found out the time period it will take for me to get an irb and in the article it said ""Turnaround" is the estimated time it takes to complete the IRB review and determination process. Full-board: 4 - 8 weeks Expedited: 2 - 4 weeks Exempt: $<$ 1 week" Given this specific time period I wouldn't be able to receive an Irb so this caused me to have to alter my project into what it is now. [8] [11]

I was unable to test on children so now I am testing that my generation of my map is correct and flawless without error. So now my results depend on if my game will successfully work or not everytime. With the errors that I ran into this wasn't an easy task to accomplish but I know that in order to accomplish what I set out to do I will need to continuously work until the deadline. As of right now I am able to create a procedurally generated map and with this map I am able to create a fully functional version of my gaming dungeon that will allow a user to boost their focus and concentration when playing the game.

Results

I wasnt able to create UnityTest so I did my testing over paper and pencil for the amout of the game that I have completed. For my testing I will be looking for certain features of my game to work. In the tables below I will be showing my testing.

MathRunner Testing: 1's = Yes & 0's = No

Table 1: MathRunner Testing

Test 1	Pass or Fail
Dungeon generates correctly	1
Player generates correctly	1
Player aren't able to run through walls	0
Object spawn in correctly	0
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	0
Players animations show clearly when moving(L,R,U,D)	0
Accuracy	43%

Test 2	Pass or Fail
Dungeon generates correctly	1
Player generates correctly	0
Player aren't able to run through walls	0
Object spawn in correctly	0
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	0
Players animations clearly show when moving(L,R,U,D)	0
Accuracy	29%%

Test 3	Pass or Fail
Dungeon generates correctly	1
Player generates correctly	1
Player aren't able to run through walls	0
Object spawn in correctly	1
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	0
Players animations clearly show when moving(L,R,U,D)	0
Accuracy	57%%

Test 4	Pass or Fail
Dungeon generates correctly	1
Player generates correctly	1
Player aren't able to run through walls	0
Object spawn in correctly	0
Corridors are connected to rooms no hidden holes in the floor	0
Player movement is clear when (L,R,U,D) keys are pressed	1
Players animations clearly show when moving(L,R,U,D)	0
Accuracy	43%

Test 5	Pass or Fail
Dungeon generates correctly	1
Player generates correctly	1
Player aren't able to run through walls	1
Object spawn in correctly	1
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	0
Players animations clearly show when moving(L,R,U,D)	0
Accuracy	71%

Test 6	Pass or Fail
Dungeon generates correctly	1
Player generates correctly	1
Player aren't able to run through walls	1
Object spawn in correctly	1
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	1
Players animations clearly show when moving(L,R,U,D)	1
Accuracy	100%

Test 7	Pass or Fail
Dungeon generates correctly	1
Player generates correctly	1
Player aren't able to run through walls	1
Object spawn in correctly	1
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	1
Players animations clearly show when moving(L,R,U,D)	0
Accuracy	86%

Test 8	Pass or Fail
Dungeon generates correctly?	1
Player generates correctly	1
Player aren't able to run through walls	1
Object spawn in correctly	1
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	1
Players animations clearly show when moving(L,R,U,D)	0
Accuracy	86%

Test 9	Pass or Fail
Dungeon generates correctly?	1
Player generates correctly	1
Player aren't able to run through walls	1
Object spawn in correctly	1
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	1
Players animations clearly show when moving(L,R,U,D)	1
Accuracy	100%

Test 10	Pass or Fail
Dungeon generates correctly?	1
Player generates correctly	1
Player aren't able to run through walls	1
Object spawn in correctly	1
Corridors are connected to rooms no hidden holes in the floor	1
Player movement is clear when (L,R,U,D) keys are pressed	1
Players animations clearly show when moving(L,R,U,D)	1
Accuracy	100%
Mean Accuracy	71.5%

The data gathered from testing my game 10 times has provided valuable insights into its current state. With a pass rate of roughly 71.5%, I am pleased with the progress made thus far. This result indicates that my efforts in refining the game have paid off, and that it is now passing more often than not. Moving forward, I recognize that further updates and features will require ongoing testing and dedication to achieve a fully functional game with a pass rate of 95% to 100%. However, I am confident that with consistent diligence, I can continue to improve and refine the game until it reaches its full potential.

Evaluation

I wasn't going to be able to receive an IRB to test on humans so this caused me to have to switch up my idea to what it is now. At first I wanted to test on children to see if my game would prove to be effective in helping kids with these math skillls. But I wasnt able to get an IRB becasue of timing constraints.

An IRB, or Institutional Review Board, is a committee of individuals responsible for reviewing research studies that involve human participants to ensure that they are conducted ethically and in accordance with regulatory standards.

IRBs are needed when testing on humans because research involving human participants can pose potential risks to their well-being, rights, and privacy. Therefore, it is important to have an objective and independent

review process to protect the rights and welfare of participants, as well as to ensure that the research is scientifically valid and valuable. IRBs typically review the study protocol, informed consent process, recruitment procedures, and other aspects of the study to ensure that it meets ethical and regulatory requirements. Only after IRB approval can research with human participants proceed.

In order to get an irb The IRB process typically involves several steps: Submission: The researcher submits their study protocol and other required materials, such as informed consent forms, to the IRB for review.

Initial review: The IRB evaluates the submission to determine if it meets ethical and regulatory requirements. The IRB may request revisions or additional information from the researcher. Full review: If the study is determined to be more than minimal risk, it may require full review by the IRB, which involves a more detailed evaluation of the protocol and additional input from experts, community members, or other stakeholders.

Approval or disapproval: After review, the IRB will either approve the study, request modifications before approval, or disapprove the study. Ongoing monitoring: The IRB will continue to monitor the study to ensure that it remains ethical and in compliance with regulations.

The length of the IRB process can vary depending on factors such as the complexity of the study, the quality of the submission, and the workload of the IRB committee. It is important to plan ahead and allow sufficient time for the IRB review process, as it can take several weeks to several months to obtain IRB approval.

In the article "Institutional Review Boards Frequently Asked Questions" By: Office of the Commissioner, Office of Clinical Policy and Programs, Office of Clinical Policy, Office of Good Clinical Practice it says "Under FDA regulations, an IRB is an appropriately constituted group that has been formally designated to review and monitor biomedical research involving human subjects. In accordance with FDA regulations, an IRB has the authority to approve, require modifications in (to secure approval), or disapprove research. This group review serves an important role in the protection of the rights and welfare of human research subjects.

The purpose of IRB review is to assure, both in advance and by periodic review, that appropriate steps are taken to protect the rights and welfare of humans participating as subjects in the research. To accomplish this purpose, IRBs use a group process to review research protocols and related materials (e.g., informed consent documents and investigator brochures) to

ensure protection of the rights and welfare of human subjects of research." [8] [11]

Future Work

In the future I plan on making my 2D procedually Generated game based on unity to be turned into an app with a few different things added to it and implemented to make it better. In order to get this project to do what i want in the future I want to have level difficulties. With these different levels of diffficulty I will be able to have higher level math skills required so my game can appeal to other groups of people as well as children. I feel like with these implememtations in the game it will allow me to be able to reach out and help more people that may struggle in different ways compared to only childrens struggles.

Future Ethical Implications and Recommendations

As stated earlier I want to make the reconmendation that I can make it a better game by adding a harder difficulty that will allow differnt people to play this game such as teenagers and adults with the addition of higher level math skills being a requirement. With this higher level requirements I would implement different types of math compared to just simple addition, subtraction, multiplication, and division. I will add things like negative numbers, combo questions like (1 * 5 + 10 - 4/2 *2 + (-4) =), and also fractions etc…

Conclusions

As a game developer, the journey has been quite challenging and enlightening. The experience has taught me to appreciate the sheer amount of dedication and hard work that goes into creating games and animations. At the beginning of my journey, I had no idea how much time, effort, and resources it takes to bring a game to life. But as I continued, I quickly realized that game development is a complex process that requires a lot of patience and perseverance.

Throughout the development of MathRunner, I encountered numerous setbacks and errors that forced me to rethink and redesign my project multiple times. However, each challenge taught me something new about game development and how to tackle problems creatively. For example, I learned the importance of testing early and often, iterating on designs, and making sure that my game is properly working the way it should.

Despite the challenges, I remained committed to my goal of creating a game that was both fun and educational. MathRunner is a game that helps children learn basic mathematical concepts such as: addition and subtraction while having fun. I am proud of what I have achieved, and I hope that it will inspire the children of whichever generation I publish my game to be a hard worker and you'll excel at anything you put your mind to.

My experience in game development has been both rewarding and challenging. It has taught me valuable lessons about perseverance, things not going your way, and problem-solving. If you are considering game development as a career or hobby, I encourage you to embrace the challenges and never give up on your dreams. With hard work, dedication, and a little bit of creativity, you too can create a game that you are truly proud of.

As a game developer, one of the most satisfying moments is seeing your hard work pay off and your game come together. After encountering several errors in the corridor generation process, I was finally able to fix the issue

and see the procedurally generated map come to life.

The correct map was now generating smoothly, with the corridors spawning correctly and allowing players to enter different rooms and complete the game. It was a significant improvement from the previous error-ridden version, which created an island-like effect and made gameplay challenging.

With the corridors generating correctly, I could now move on to other aspects of the game and continue to refine the player experience. It's essential to remember that each error encountered presents an opportunity to learn and improve your skills as a game developer.

Seeing the corrected map generated with the corridors spawning correctly was an encouraging sign that I was on the right track. It was satisfying to see the game take shape and become more polished with each error that I encountered and addressed. With this hurdle overcome, I could now focus on bringing even more exciting features to my game and creating an immersive experience for players.

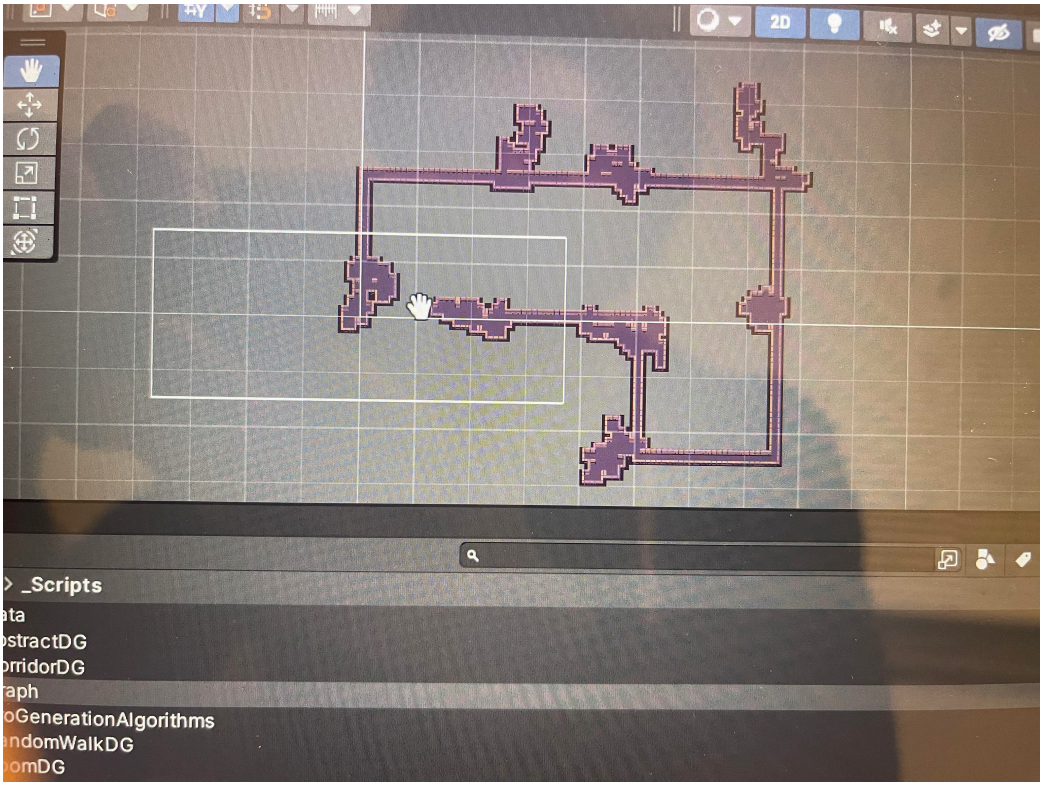


Figure 13: Correct Corridor-Generation

As a game developer, creating a procedurally generated map is an exciting and challenging task that requires a lot of time and effort. After encountering and addressing various errors in my game, MathRunners, I was finally able to see the map generated correctly based on the scripts and elements I implemented in Unity.

In the image, the map is being generated seamlessly, with the walls being placed accurately along the edges, creating a visually pleasing and immersive gameplay experience. It generates multiple rooms, allowing players to explore and navigate through the game, adding an element of randomness and unpredictability to the game.

Creating a procedurally generated map requires a lot of attention to detail, patience, and technical know-how. But seeing the final product come together makes all the effort worth it. As a game developer, there's no better feeling than seeing players immerse themselves in my game and enjoy the

experience that I've created.

With the map generating correctly, I could now focus on further enhancing the gameplay and adding new features to keep players engaged and entertained. Creating a game that is both fun and challenging requires a delicate balance, but with each error encountered and corrected, I gained valuable experience and insight into the game development process.

After completing the procedural generation of the map in my game MathRunner, I felt a sense of accomplishment. However, I couldn't help but feel that something was missing. Which leads me to my future work that I plan on completing later in life. I realized that adding a player into the game would take it to a whole new level. The player would allow users to move around and explore the maze, creating a more immersive experience. This will be a great addition to my game because what game does not have a player so this is an essential item I will add.

Furthermore, I recognized the need to add a player camera to the game. This camera would enable users to get the best possible gaming experience by allowing them to navigate the dungeon with ease. Adding a player and camera to MathRunner would also provide an opportunity to showcase the game's aesthetic qualities. This will allow you to view the game in a dungeon sense that will allow you to feel the great experience of playing the game MathRunner.

Although unforeseen circumstances and time constraints prevented me from completing the game in its entirety, I am excited about the future work that awaits. With the addition of a player and camera, MathRunner will become an even greater game that I can be proud of. I am eager to continue working on this project and see where it takes me.

In order to make my game MathRunner more educational, I am considering adding math equations based on addition and subtraction everytime you begin to try to enter into a new room of the dungeon. By incorporating this feature, I believe that it will engage users more and improve their math skills. Additionally, I plan to use color psychology to further enhance their experience. WIth all of the research that i've completed on the topic i believe that i can confidently say that the addition of the different fonts and color psychology in the math equations it will help the children essentially become better at addition and subtraction.

The math equations will not only help users practice their addition and subtraction skills, but also improve their focus and concentration. With the addition of a correct or wrong system, I will be able to monitor user's answers

to the questions and determine if they are eligible to pass or lose a life based on their responses.

I believe that by adding these elements, the game will become more interactive and enjoyable for the user. Furthermore, the educational aspect will help to create a well-rounded experience that can benefit users of all ages. I am excited to see how this addition will impact the game and its users, and look forward to implementing it in future iterations.

To add more excitement and depth to my game MathRunner, I am considering incorporating a boss fight. This addition is significant because it provides players with a tangible goal to work towards, and creates a sense of accomplishment upon defeating the boss.

In order to trigger the boss fight, I plan on implementing a system where players must correctly answer a certain amount of questions before being transported to the boss room. The boss fight will be different from regular enemies in the game, as it will be turn-based and require players to answer math questions correctly in order to progress. The turn-based aspect of the boss fight will allow players to strategize and plan their attacks based on their answers to the math questions. If they answer correctly, they will have the choice of the next attack they want to do. However, if they answer incorrectly the boss will attack and lets just say you don't want that to happen because after three hits from the boss, they will lose the fight and have to start all over.

Adding a boss fight to MathRunner will provide users with a new level of challenge and engagement, while also promoting their learning of math skills. I am excited to see how this feature will impact the game and enhance the overall user experience.

Adding a few extra features to a game can enhance the overall gameplay experience and bring the game to the next level. For instance, I believe that implementing a few key features will help with the lower level math skills of younger generations. These features can make a significant difference in the quality of education and gameplay.

However, I realized that to complete the implementations, I will need to improve on my current knowledge of the programming language C# and the Unity Gaming Engine. Improving my knowledge will help me better understand the concepts I need to implement, and give me the skills needed to create the next big educational game.

Once I can better familiarize myself with the concepts listed above, I will be able to start the planning on how I will start the next step of my

development of the game, MathRunner. This game will challenge children to use their critical thinking and problem-solving skills to complete the game.

By incorporating these additional features, I have high hopes to make a positive impact on the younger generation's education and create an enjoyable gaming experience. It is vital to remember that educational games can be just as fun and exciting as traditional games while still providing valuable knowledge and skills to players.

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