DESIGNING AN EDUCATIONAL ONLINE 3D ESCAPE ROOM: MOTIVATING LEARNING THROUGH ENGAGING GAMEPLAY

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ABSTRACT

"Vamoose" is an inventive online 3D escape room game that merges entertainment with STEM education [4]. Motivated by the absence of in-person escape room experiences during the pandemic, the game offers players an engaging platform to learn science, technology, engineering, and mathematics (STEM) while solving captivating puzzles [5]. The game's puzzles, inspired by academic subjects, enable participants to test their knowledge and acquire new insights, fostering motivation and engagement among learners. Despite challenges in implementing a multiplayer feature, the game was refined through rigorous debugging. Extensive playtesting involving diverse age groups and educational backgrounds demonstrated Vamoose's effectiveness in transcending age-related differences, engaging learners, and promoting problem-solving skills. Ultimately, Vamoose exemplifies the potential of gamified learning to revolutionize education by seamlessly integrating entertainment and academic enrichment.

KEYWORDS

Escape Room, Multiplayer, Education, Puzzles

1. INTRODUCTION

We have always enjoyed playing escape rooms and would do them with our family occasionally on weekends. However, after the COVID-19 pandemic hit, we were unable to play them for a couple years [6]. This experience sparked the idea of an online 3D escape room that we could play with friends and family, recreating the experience of an in-person escape room [7]. In order to make this escape room idea unique, we decided to use this as an opportunity to test people on their academic skills. When creating puzzles, we kept in mind the idea of basing them off of academics, such as math and science. Thus, when playing, participants would be able to either test their knowledge or learn about these various topics in order to escape the room. This way, kids would be more encouraged to learn and hone these academic skills while also exposing them to various academic instruments such as microscopes. Therefore, kids who are unmotivated to learn in school or outside of school can find a new motivation by trying to complete a game.

The first article believed that games such as first person shooter would improve certain cognitive abilities. The shortcoming of this solution is that it does not take into account the other aspect of motivation and that they do not help educate children and therefore other education games may

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seem unappealing. Our game is fun and also educates kids on academic subjects, therefore can counteract this decline in motivation.

The second article believed that there are certain guidelines to creating an educational game. However, the guidelines listed looked over the fact that without an end goal, children could again become unmotivated. Our game has a very clear end goal, which is to escape the room. This goal would give children enough motivation to solve puzzles and learn [15].

The third article believed that regular video games could help with memorization, but again like the first article ignores the fact that there would be a decrease in motivation to play games that would help them learn academic knowledge.

Our solution to this method would be play testing. We would have people of different ages and educational backgrounds play this game, and record down how much time it would take for them to complete each room, and whether they needed external help whether it be searching something up on the internet or asking someone else for help. This data that we gather would be essential in helping us understand and gauge the difficulty of our game, as we can use this data to further improve our game by making puzzles easier or harder. In the end, by gathering enough data, we can ensure that the difficulty level of our game will be just right, motivating kids to learn to solve the puzzles by not making them too hard, but also being able to teach people how to solve these academic puzzles by not making them too easy [8].

Our experiment was trying to test to see if there was any correlation between age and the time it took for a person to complete the Dungeon Room. We set this experiment up by asking people of different ages to play Vamoose and time themselves. The most significant finding was that age didn't affect the time taken to complete the room that much, and the times were pretty consistent. This could most likely be because of each person's access to external resources such as a calculator.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Gauging our Test Result

One of the main challenges we wanted to tackle was the challenge of gauging whether our test of educational knowledge was successful. This problem was due to the fact that our main focus of the game was wanting to test people and have them learn to solve various problems. One way we could solve this problem is to have people of various ages and backgrounds play our game, and time them to see how fast they could solve each room and take note of whether they needed outside help. If they solved it too fast or didn't need any help, these results could help us improve the puzzles within the rooms.

2.2. Creating the Settings for Each Room

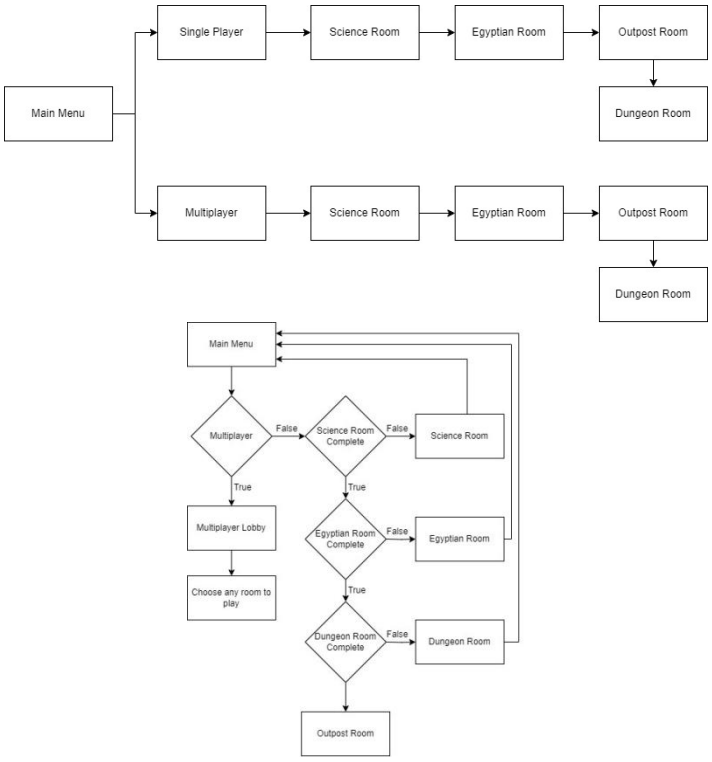
Our second main problem was creating the settings for each room. As neither of us have a lot of experience in 3d modeling, it was hard finding assets that we could use as we needed them to be specific as well as fit the theme of the room [9]. One way that we could solve this problem is the use of a new tool that features AI generation [10]. This way, we could create the specific assets that we would need in order to make our rooms come to life.

2.3. Present in the Multiplayer Aspect of our Project

Another problem is present in the multiplayer aspect of our project. The way we coded the multiplayer made it so that every change in the room was mimicked to the other computers in real time, instead of being stored. This means that if someone were to join the room after people have already started interacting with the objects, the different computers would not be synced up properly. One way to solve this issue would be to save all changes that have happened in the room and then communicate them to the computer that had just joined the room.

3. SOLUTION

Vamoose has 3 main components: a multiplayer, a grabber, and a puzzle class. These components are what makes the game. The multiplayer component allows multiple people to play at once, the grabber allows the player to interact with objects and puzzles, and the puzzle class which stores and classifies all of the puzzles within the game [14]. The grabber is essential for the puzzle class as without it, there would be no way to interact with various objects and puzzles and therefore no way to complete them and escape the room. The grabber is also essential for multiplayer as we would need to be able to use it to allow the players to interact with each other and see what each person is holding in order to have better communication. The puzzle class works with the multiplayer as in order to make the multiplayer work, each player needs to be able to know which puzzles are completed, as well as the location of every object in the room. Otherwise, one person may complete a puzzle or move an object, but it would not show on anyone else's device thus making this multiplayer aspect of the game entirely useless. Therefore, all three of these components create the base of our game, with puzzles in each room, a way to interact with each puzzle, and a way to have multiple people working together to solve and interact with these puzzles.



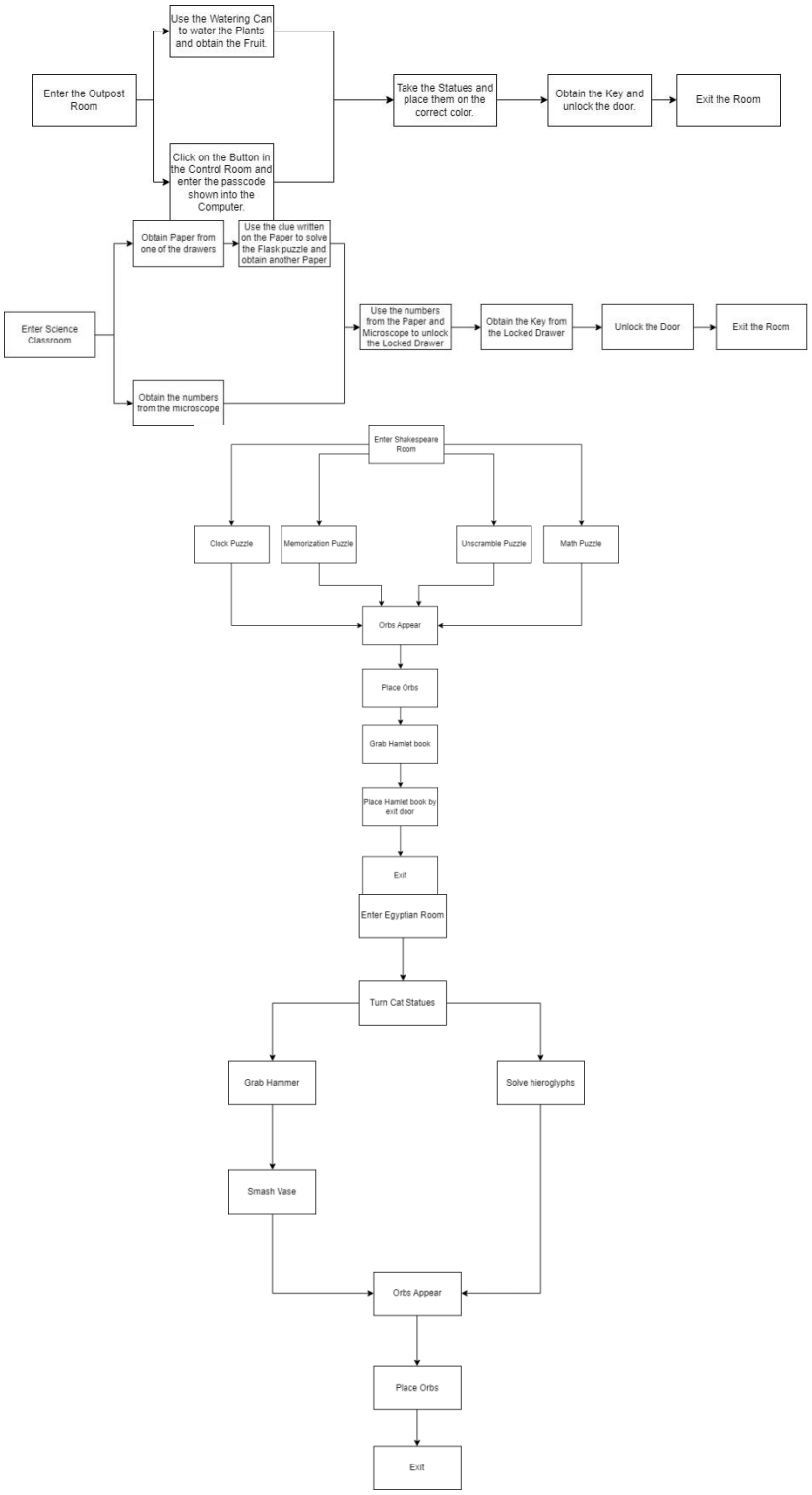


Figure 1. Overview of the solution

The purpose of the multiplayer component is to be able to have multiple people play the game at once. This component relies on something Unity provides called Netcode, which would send a signal between computers and sync the actions of all the players [13]. Otherwise, one person may complete a puzzle, but it would not show on anyone else's device.

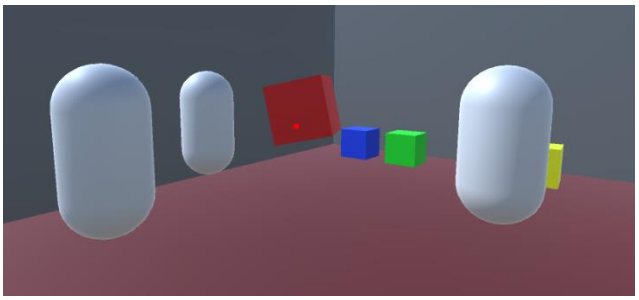


Figure 2. Screenshot of the game 1

```
void Update()
{
    if (IsOwner)
    {
        if (!playerBody) OnSceneStart();
        SubmitPositionServerRpc(playerBody.position, playerBody.localEulerAngles, playerHead.localPosition, playerHead.localEulerAngles);
    }
    else
    {
        playerBody.position = Position.Value;
        playerBody.localEulerAngles = Rotation.Value;
        playerHead.localPosition = HeadPosition.Value;
        playerHead.localEulerAngles = HeadRotation.Value;

        if(HoldingObjectID.Value != holdingOjectID)
        {

            if(holdingObject == null)
            {
                //Debug.Log("Object clicked");
                GameObject clicked = FindObjectOfType<EscapeNetworkObjects>().GetNetworkObject(HoldingObjectID.Value);
                //Debug.Log("Object clicked " + clicked.name);
                if (clicked)
                {
                    Grabber.ObjectClicked(clicked.transform, ref holdingObject, ref item, playerHead);

                }
            }
            else
            {
                Debug.Log("Object dropped");
                Grabber.AlreadyHoldingObject(ref holdingObject, ref item, playerHead);
            }
            holdingOjectID = HoldingObjectID.Value;
        }
    }
}
```

Figure 3. Screenshot of code 1

The code shown is called each frame and controls each player. If a player doesn't already have a player body, then one is created. The else statement changes each player's position and rotation, while also checking to see if they are holding an object. If they are, then that information is sent to the local player and "copied", so each player's game is synced up. The same is done when an object is dropped.

Another one of the important components in our project is the Grabber script. This component is mainly used to interact with the different objects in our room, such as the puzzles. The Grabber uses a raycast to detect the objects, and the objects are given different tags based on their different uses. For example, an object that can be picked up would have the tag "Grabable". The Grabber is very important for our game as it is what makes the game interactive.

Figure 4. Screenshot of game 2

```
2 references
public static void ObjectClicked(Transform clicked, ref Transform holdingObject, ref GameObject item, Transform pointer)
{
    if (clicked.CompareTag("Grabable"))
    {
        holdingObject = clicked;
        holdingObject.position = pointer.forward * FindObjectOfType<Grabber>().holdingDistance + pointer.position;
        holdingObject.parent = pointer;
        item = holdingObject.gameObject;
        if (holdingObject.name != "key" && holdingObject.name != "watering can")
        {
            Debug.Log(item);
            if (holdingObject.GetComponent<Rigidbody>())
                Destroy(holdingObject.GetComponent<Rigidbody>());
        }
        else
        {
            item = holdingObject.gameObject;
            holdingObject = null;
            Destroy(item.GetComponent<BoxCollider>());
            Debug.Log(item);
        }

    }
```

Figure 5. Screenshot of code 2

The code shown in the screenshot is run when an object is clicked, and the player is not currently holding an object. The first if-statement shows what happens when the object clicked by the player has the tag of “Grabable”. If that happens, the object is moved to in front of the player's face, the distance being based off of the variable “holdingDistance”. The second nested if-statement checks if the object is not the key or watering can, as both objects act differently than a normal object that can be picked up. This is because both objects are used to activate a different puzzle, the door for the key and the plant for the watering can, so the raycast needs to be able to ignore the currently held object and check for the plant or door.

The Puzzle class is also a very important component of Vamoose. The Puzzle class stores all of the puzzles used, and also checks to make sure each one is done, so the player can complete the room. The Puzzle class is a very integral part of our game, as without it, Vamoose wouldn’t be an escape room. The Puzzle class contains what makes Vamoose a fun and enjoyable game.

Figure 6. Screenshot of game 3

```
1 reference
private bool AllObjectsTriggered()
{
    if (objectTriggers.Length == 0) return false;
    foreach (bool triggered in triggeredObjects)
    {
        if (triggered == false) return false;
    }
    return true;
}
```

Figure 7. Screenshot of code 3

The method depicted is called when all of the requirements for a puzzle are complete, and each puzzle has something different done when the puzzle is solved, such as having a key appear.

4. EXPERIMENT

One blind spot in our program is due to the fact that although we want our game to educate and test people's knowledge, we have no way of knowing whether the puzzles are too hard or too easy [12].

In order to test this problem, we would have many people play our game with varying ages. Once they start playing, we would take various notes such as how long it took to complete each puzzle, whether they needed to ask someone for help or look something else, their academic background, etc. We would not have a controlled variable due to the fact that it would be hard to determine what a control would be, as our data would come from people of various degrees of knowledge.

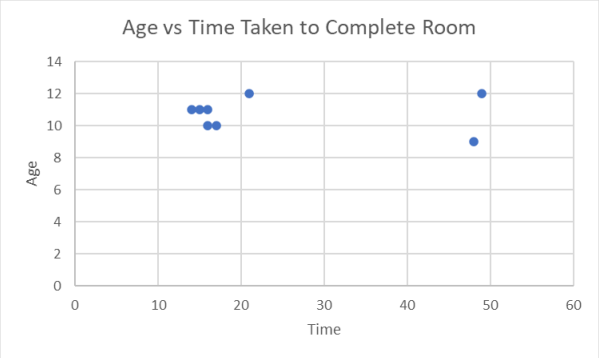


Figure 8. Figure of experiment 1

The average time was 10.75 minutes, and the median was 11 minutes. The lowest value was 9 minutes while the highest was 12, so there was not a lot of variation. This surprised us the most because we thought the time taken for each person to complete the room would vary a lot. I think it turned out this way because the puzzles did not require anything too difficult, only some math that was not too difficult. I think what had the biggest effect on our results was the fact that there were not any limitations on what resources a person could use, since they were on their own computer. This means that many people used calculators and the internet, which would drastically lower their time.

5. RELATED WORK

The first article determined that playing different video games can train people and various abilities [1]. An example of this would be how first-person shooter games would improve someone's ability to lock on a target in a chaotic environment. However, this solution does not take into account the factor of motivation and how although it may improve cognitive abilities, it may hinder their motivation to learn as these games do not train them to improve their knowledge in academic subjects such as math. Our project hopes to be able to teach kids academic topics such as math and science but in a much more exciting way, allowing them to be motivated to learn.

The second article states that in order to create a good educational game, it would need to be different from the others [2]. For example, instead of heavy instruction, it should have the children explore and figure things out by themselves. This solution is effective in that it makes educational games more enjoyable, which gives them more motivation to play and to learn. However, one

limitation is that it ignores the fact that if these games do not have an end goal, the kids may lose interest and prefer to play some other games that do not teach them anything. Our game takes this factor into account as it has an end goal, which is to escape the rooms. This goal would motivate children to learn about the different educational topics within the room in order to complete their goal of solving the puzzles and escaping.

The last article mentions how according to their studies, people who played video games were better at memorizing information and controlling impulsive behaviors [3]. However, this article, like the first one, looks over the fact that children especially would have less self control over playing video games rather than studying. Vamoose solves this problem by creating an end goal for the children in order for them to be able to have motivation to complete the game by learning about various academic subjects. However, this game does not help improve skills such as memorizing information as it is mostly educational and therefore doesn't require any skills that would normally be used, in for example, a first person shooter game.

6. CONCLUSIONS

Some limitations to our project could be how the number of playable rooms is a bit small and they are rather short. Because of this, it's only suitable to be played once, which is similar to most escape rooms. To fix this, we might add more puzzles and randomize them each time a room is played. If we had more time, we would also like to spend time creating longer and more difficult rooms.

In conclusion, Vamoose is a multiplayer escape room game, which tests a player's abilities to solve problems and think outside the box [11]. Although it has some limitations, Vamoose is a game that will help increase critical thinking skills among younger players.

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