– know your buds –

Documentation of Plant Buddy - Know your Buds

Jonathan Balcombe, Leon Endres, Veronika Langner

January 2023

Contents

1 Meta Data

Our team consists of Jonathan Balcombe (Developer, Designer), Leon Endres (Researcher) and Veronika Langner (Designer).

Adding to Jonathans UX background, his knowledge of working in a software engineering environment enriched the team, for example by taking over the Github usage. He was able to support the game with his logical way of thinking and managed development and design flows. Leon has a lot of research experience, that's why he was able to bring this knowledge to the table for our user tests. Furhtermore, he is good at bringing information on the point. This enabled us to do our presentations in a good way. This has complemented with Veronika's design skills. Veronika is also an inquisitive and ambitious person, that's why she always motivated the team to keep going. Since none of us had any good knowledge of Unity or Blender until now, we still had to teach ourselves everything. Our ambition and willingness to learn allowed us to do that. Each team member had a predefined role for which they were responsible, however we all had to learn a lot of new things and supported each other everywhere, which made us grow a lot as a team.

All branches except for the main branch have either been merged into it or deleted.

The Github repository can be found here:
https://github.com/Johnsens/var-ws-THI-Balcombe-Endres-Langner

Further information like the user personas can be found here:
https://www.figma.com/file/8KdDhKOG7xha9BgQCK6fJ8/Ideate?node-id=0%3A1t=xPDlqZ4ZZjVo6lEH-1

2 Introduction

The Topic of the UXD Master's project "Virtual and Augmented Realitiy" is Learning with or in Virtual Reality. Therefore it was our task to build a game which enhances teaching in Virtual Reality as a multiplayer game. Within one semester we created a game where the user can walk through a forest and learn new things about plants by picking them up. The multiplayer game mode is about finding certain plants faster than the other players. For this we created a concept, which we implemented in Unity. We bought a forest in the asset store and created the plants to be found in Blender. To test our concept, we conducted a user study. Based on the results we were able to improve our concept.

3 Conceptualization

3.1 Topic finding

At the beginning of the project, we had a lot of concept ideas. To settle on one of them, we visualized our ideas in a brainstorming session. Some of the ideas were

- Biology
  - Herbalism, walking in the forest or something
  - plants and mushrooms are there to you can pick
  - 3D view
  - What kind, poisonous etc.?
- Geography
  - like Geoguessr
  - You will be placed "somewhere" in the world
  - You get info about the country
  - You get more and more info and the more tips you take the more point you lose
- Physics
  - You can simulate physical events and have to guess before what will happen e.g. tornado
  - What happens when you do anything physical (kind of experiments, you can guess what happens)
- Chemics
  - Putting atoms together virtually
- Astronomy
  - Star images
  - Closer view of planets, stars etc.
- UX Design
  - Gestalt Principles
  - Tutorials, how to build a webside / app
- Art
  - a "walking" of art works
  - becoming 3D landscapes

- Music
  - VR Band
- History
  - Virtual Museum
  - Guided tour of historic architecture
- Health ED
  - Students can flow through the bloodstream, isolate, enlarge, and even walk inside the components of the human body
  - not only to understand anatomy but learn how to treat different medical conditions
  - Health Nutrition components, how does nutrition effect the human body
- Communication
  - Public Speaking
  - Language Learning

After we noted down all of our ideas, we thought about pros and cons of each idea and how well they can be implemented in the scope of this project. We evaluated this and came to the conclusion, that we want to go with the idea to virtually learn something about plants.

3.2 Concept idea

To further elaborate our concept, we first dealt with the problem definition and the use case. The problem was that people don't know which plants are eadible or not. Furthermore, many people don't know how plants look like in the real world. Our main use case is to learn something about plants while having fun playing a good game. Plant names can be better remembered by visualizing them and having a context, thus this game is a good way to learn efficiently.

For this we decided to define three different game modes. The first one is exploration. The player can go around in a world, pick up plants and then get some information about them. New plants are visually highlighted to recognize them more clearly. Already known plants should not be highlighted anymore to make the learning more efficient. If interested, players can take out the already picked up plants again and read up information about them. Those information should include an image of the plant, properties and the usages of the plant.

Secondly, we wanted to shave a Single or Multiplayer Game Mode where the player has to find specific plants for creating medicaments. The multiplayer game is about who gets the plants for remedies the fastest. We also had some ideas to let the slower player die because he was poisoned and has no remedy.

The third game mode is the Survival Mode. Here the player has to find plants for surviving. For example, if the player eats poisoness plants he has to find plants for medicamation to stay alive. This mode also includes a life bar.

In all of the game modes we wanted to include different aspects like the time of the day, the weather condictions and thus the different bloomings. For example, when the sun is shining after a rain more plants bloom than after a thunderstorm, where many plants got damaged, or after a dry period. We also thought about having bonus plants with special effects like being faster after eating a certain plant or getting dizzy after eating the wrong mushroom. As a further step we thought about having different bioms and different weather conditions to pick up plants.

3.3 Research

To better understand how learning works and how we can best support it with our game, we first conducted research. This research showed us that learning is defined as the intentional or incidental acquisition of mental, physical, social knowledge, skills, and abilities. This acquisition can take place both individually and collectively.

Learning therefore means predicting the future, thus adapting behavior and thereby achieving the greatest possible success. Learning together with others is essential. A virtual space for learning together is therefore an optimal environment for the learning process [Lep22].

Learning goals are achieved when learners can describe, define and remember facts, apply what they have learned and describe it in their own words, recognize the individual components of the whole and know how they interrelate, create something new from these components, and assess complex issues and develop solutions.

Important for effective learning are cooperations as well as collaborations, emotions and optimal feedback. Collaboration works best when users largely develop their learning objectives themselves, then engage with others to consider what they have learned from different perspectives. This creates a co-construction of knowledge [Lep22], [Dav22].

It is also important to anchor what has been learned emotionally by emotionalizing, interacting and addressing it personally. Because what we experience emotionally, we can remember better [Lep22], [Dav22]. In addition, the right feedback is important. This should be frequent, timely, continuous and explicit. But feedback that is too frequent can be perceived as restrictive. The feedback provider (in our case, the game) should adopt a value-free external perspective and focus on the specific behavior. If the user doesn't know what to do next, you could ask "What is your next step?" [Gre12].

Based on this research, we were able to design the learning in our game as efficient and effective as possible.

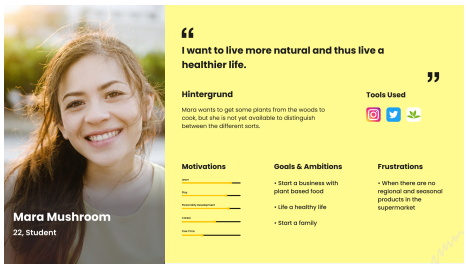

Figure 1: Persona Mara Mushroom

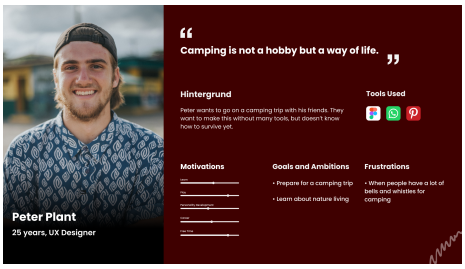

Figure 2: Persona Peter Plant

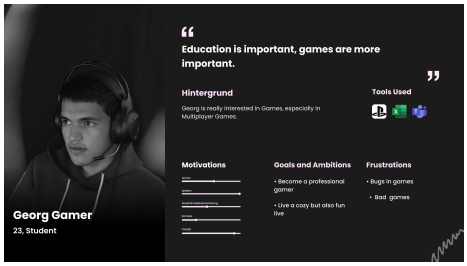

Figure 3: Persona Georg Gamer

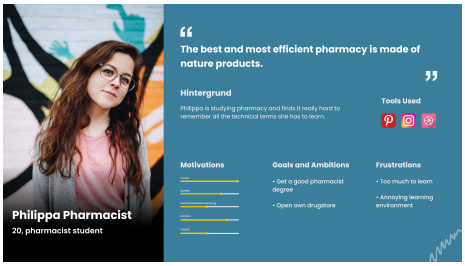

Figure 4: Persona Philippa Pharmacist

3.3.1 Personas and User Stories

Our personas include mainly students who are generally interested in plants or in games where you can learn something. Our primary personas are Mara Mushroom, a 22 years old student who wants to live more natural and learn more about plants, Peter Plant, a 25 years old UX Designer who wants to get some knowledge for his upcoming camping trip, Phillipa Pharmacist, a 20 years old pharmacy student, and Georg Gamer, a 23 years old student who really enjoys playing games.

Furthermore we have a secondary persona, Felix Forster. He is a 56 years old Forster who wants the people to protect the nature.

One user story is about a Peter Plant who wants to go on a camping trip with his friends. They want to really be close to nature so he wants to learn something about plants he can eat while the trip. Mara Mushroom is a person that is interested in cooking regional and saisonal. She wants to be able to distinguish on her own between eatable and poisoness plants so that she can get them and cook.

3.3.2 Brand Name Brainstorming

For becoming a recognizable brand, we made a brain storming for our name. We decided to go with "PlantBuddy - Know your Buds". Then we designed a logo.

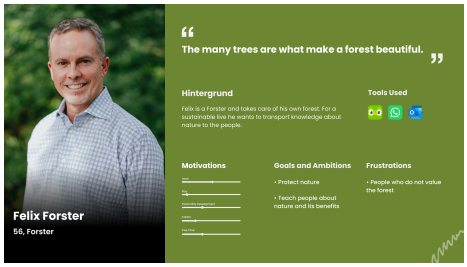

Figure 5: Persona Felix Forster

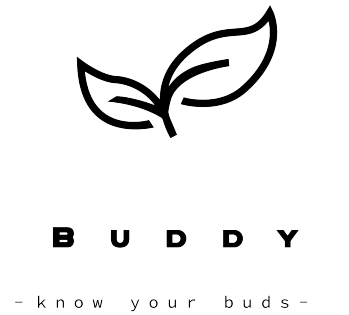

Figure 6: Logo of Plant Buddy

4 Unity Project

4.1 Code Management

All teammembers worked together in the Github setup at the beginning of the project, but only Jonathan had experience with it before. Over the course of the project, a lot of Test Branches were opened up and merged with the main branches again or deleted if not needed anymore. Unfortunately, the team didn't have experience yet with Unity and generally a asset heavy application development process in Github, which made commiting in the beginning a learning experience. As we used an asset pack to create a immersive experience, a lot would have needed to be pushed, conflicting with Githubs size limit. We added it to the gitignore file, but had to change our main branch twice in the process, as the commits sometimes were behaving differently from what we expected. Overall the team learned a lot about using Github in a development process.

4.2 Unity project structure

The overall structure of the project was built by having a understandable and organized structure in mind. We tried to follow best practices and make the overall organisation in the project easy to understand. Various scenes were added and deleted from the project. These Scenes were used for testing (for example for the usability test) and got deleted afterwards. In the final version, 2 scenes are still used. The ForestBiome Scene is the collaborative Scene, which represents the Biome the users will search the plants in. Looking at future work, there could be new Biomes added with new plants to discover in the same technical structure like the main Scene.
We decided to have a StartScene, where you return once you finish the Level and on Starting the game. Here the player also has the option to exit the game. For future purposes, the Biome/Level selection would also be in this start scene. In regards to assets, we stored all assets we downloaded for the Scene in one

place, to make sure it can be seen easily, which we created. In the Scene itself, we tried to order all related game objects by giving them empty parents. The modal parent consists of all pop-ups used in the Scene. The bounds parent holds all bounds placed in the level. This was sometimes also programmatically needed, as we actived and deactivated a lot of gameobjects, which needed an empty acrtivated parent to work with Photon.

4.3 Logging and Testing

The team had some problems in setting up a testing environment, which could not only be used in the lab, but also in other settings to test simple interactions and code. For this we wanted to used the HMD Mock-up VR mode in Unity. A HMD Manager was written, to make us understand, which glasses are connected in unity and how to move them. This proved to be the right decision, as we also connected different glasses outside of the lab and the created Manager gave us all the information needed. Logging was done for all basic interactions in the game, giving us insights on what was happening in the code.

4.4 Programming

In regards to programming, all teammembers haven't worked in CSharp or Unity yet, so all of the team learned a lot while programming.
We started with basic interactions and tried to pull as much from the sample scene as possible. We realized very quickly, that all interactions happen while the user is pressing and something disappears or appears. We are doing this by setting different GameObjects active and inactive in the scene. For this we are using the Draggable Script provided by HTC. Even though it is normally used for really dragging things and keeping things in the users hand, it fitted our purpose, as the GameObject taken would always disappear on picking the object up.
We defined global variables, to count the plants the user would pick up. The plants could be subdivided further by using tags in Unity. For example, if a plant has the poisonous tag, a second counter would go up once a player picked up that plant. With new tags, different plant types can be implemented in the future.
The picking up of the plants works with a simple but effective script, which lets the picked up plant disappear and the pop-up for that plant appear. This function also increments the counters saved in the GlobalVariables file.
In regards to the pop-ups, all pop-ups connected to a plant and the introduction pop-ups are placed in the world directly. This way, we can make sure the user sees the information after performing an action, without the pop-up being obscured by any objects in the biome itself. The only pop-up, which couldn't be location bound, was the Mission-Success-Pop-Up. Here a little script was created to make a pop-up appear in front of you. This script was edited slightly to fit our needs. It takes the pop-up, ties them to the camera vectors, normalizes the vectors and the flips the pop up around as the last step. This pop up would

show, once the last pop-up relating to a plant was found. In the beginning the trigger was put on the action of picking up a plant, but this led to two pop-ups showing up at once, so the trigger was moved to closing the last pop-up. With this change the user always had all information in sight. Bounding Boxes were added. These are just simple plains enclosing the area and making the sure the user can't dive into the lake, as we didn't account for that.
In regard to the movement, we are working with a locomotion system and continuos action-based movement provider based on XRI. Scripts for snap-turn and teleportation movement provider are still tied to the locomotion system.

4.5 Multiplayer

Starting the project we constructed a main scene in a single player approach, with only Photon Voice active, so everybody could play the game on their own, but still talk to each other, about where they found plants. The single player works with a counter, which increments everytime a plant is found. When the counter hits 5 the game ends for the player.
When we implemented the Multiplayer for the application, we ran into some decisions we had to make on how to construct it. First we had a problem with our counter method, which didn't account for the plants individually, but only incremented the counter. We tried fixing this by using an array and giving the plants ids from 0 to 4. Everytime someone picks up a plant, the slot in the array would switch to one. Once all positions in the array were changed to 1, the game would end for everybody.
At first we wanted to show the Mission-Accomplished-Pop-Up to everyone currently in the Level. When we tested it, this not only led to confusion, but ended the level for everybody, so the players not finished didn't have the chance to collect the plants they haven't seen yet. This had a potential impact on the learning effect, so we scraped this idea.
The solution in our mind was to have a sound played for all players, but have the Mission-Accomplished-Overlay only show for the one who actually collected the plants.
In Adobe Audition, we edited a voice that says "A player has completed the mission" and gave it some reverb. We added this voice to our Mission Accomplished sound. We realized the sound by using a Remote Procedure Call. By using the RPC, we could even use the simpler count again, which in turn made it easier for us. Once the Counter hit 5 we called a method for everybody in the room setting the RPC target to "all". The method SetSomeoneFinished method sets our finishedInformation Game Object active, which includes a sphere with zero scale, playing the global sound that someone finished the level for everyone. To not interrupt the game flow of the other players and thus increase the learning effect, we decided to not quit the game for the other players.

```
    public void Update()
    {
        //var tr = transform;

        if (!this.photonView.IsMine)
        {
            if(!someonefinished && Ifinished)
            {
                someonefinished = true;

            }
        }
    }

    public void IfoundAllPlants(){
        Debug.Log("foundallplants");
        Ifinished = true;
        someonefinished = true;
        photonView.RPC("SetSomeoneFinished", RpcTarget.All);
    }

    [PunRPC]
    public void SetSomeoneFinished(){
        Debug.Log("someone finished");
        finishedInformation.SetActive(true);
    }


}
}
```

Figure 7: Remote Procedure Call for finishing the game

```
    void updateStartMissionOverlay()
    {
        startMissionOverlay.transform.position = XRRigPosition.position + new Vector3(XRRigPosition.forward.x, 0, XRRigPosition.forward.z).normalized * spawnDistance;
        startMissionOverlay.transform.LookAt(new Vector3(XRRigPosition.position.x, startMissionOverlay.transform.position.y, XRRigPosition.position.z));
        //flipping the menu around, as it was backwards
        startMissionOverlay.transform.forward *= -1;
    }

    public void showEndoverlay()
    {
        if (endPopUp.activeSelf == true)
        {
            endPopUp.SetActive(!endPopUp.activeSelf);
            endPopUp.transform.position = XRRigPosition.position + new Vector3(XRRigPosition.forward.x, 0, XRRigPosition.forward.z).normalized * spawnDistance;
        }
    }
}
```

Figure 8: Tracking of the Mission Accomplished Popup to the Players View

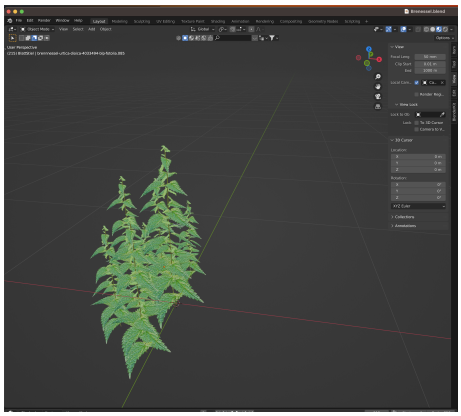

Figure 9: Nettle modelled in Blender

5 Building Plants

To make the game more immersive, we decided to buy a forest asset from the Unity Asset Store. We chose "Forest Environment - Dynamic Nature" from NatureManufacture. The plants that need to be collected in the game we modeled ourselves in Blender. This required us to learn the program first.

We tried to model the plants in different ways. First, we created vertices, faces, and edges to build a basic framework. Then we added modifiers, and blurred the edges. We refined that in Sculpting mode. For the first plants, we used the brushes to color the plants. Here, however, we found that the plants didn't look real enough for our immersive world. So we took a different approach and used Image Textures for detailed plant elements like leaves. This way we could make sure that the plants were closer to our world and fit in nicely.

In this way, we then modeled Nettle, Blueberry, Rosehip, Cyclamen and an Arum. The Rosehip also We exported the finished models as an fbx file and imported them into Unity. Here we had some troubles, because we needed to import the textures in an additional step. Furthermore, some plant files were so big that Unity didn't run after the import. Since we all had big problems with this despite a larger RAM, this took a lot time to fix and some models had to be build new again. After we finally placed our plants in te world, all further properties like the Photon View were given to our plants in Unity, or in the code.

Figure 10: User Study

Figure 11: Player wants to grab a plant

6 User Study

6.1 Study Setting

For our User Study we tested PlantBuddy with 2 female and 3 male participants between 23 and 25 years. The test setting was in our VR lab in G006. First, we gave the participants an introduction and asked for their demographic data as well as their previous experience with virtual reality. In order to compare the learning effect of PlantBuddy, we wanted to know the participants' knowledge about nettles. After that we let them put on the VR headset and gave them the hand controllers. We also wanted to compare continuous movement and turning with teleportation and snap turning, thus starting with a scene, where the participants were using continuous movement. While fulfilling the task the participants should think aloud so we could collect qualitative data. Their first and only task was to find the nettle. Right next to their spawn location, they had to read the introduction, which was a popup consisting of four different pages, where the participants could click through. Directly after reading the introduction, we asked to rate the introduction and what they would improve. Afterwards they should try finding the plant and read the popup, which showed up, when finding it. Here we have again asked for the opinion about the popup. Following this, we asked questions about the movement and the feelings about PlantBuddy. Next we gave the participants the same scene with one difference. We replaced the continuous movement with a snap turn and teleportation. Again we asked for the participants' opinion about that. Last but not least, we asked for the general liking of the game. To evaluate the learning effect of PlantBuddy, we again asked about the knowledge of nettles. The questionnaire we used for the user test can be found at https://forms.gle/UirbjiYdrF7zadaf9.

6.2 Evaluation

To better understand the outcome of the study, we will split the evaluation into the learning effect, the movement, the popups and the general opinion.

6.2.1 Learning effect

For the learning effects, we asked the participants about the latin name, a description of the plant and positive or negative effects, which the nettle has on the human body. The latin name could not be given by any of the participants and unfortunately this saw no improvement after playing the game. Howevery, the description and the effects on the human body saw very large improvements, which might be due to a higher interest in these categories. Regarding the description, two out of the four participants could describe the look of a nettle perfectly. After playing the game this number rose to a total of four, which is an improvement by 100%. The reason for a good description from two of the participants might have been to the fact that the nettle is a very common plant for German people, but not for people from outside Europe, which was the case for the other three participants, who could not describe it. When talking about the effects on the human body, no participant possessed a good knowledge before playing the game. Some answers just said it causes itching or you can make tea out of it. Nevertheless, this changed drastically after playing the game. Every participant could at least name two effects on the human body up to a maximum of four, which we considered a very good result.

6.2.2 Movement

For the movement, we have compared continuous turn and movement with snap turn and teleportation movement. The participants unanimously reported that they prefer continous movement and turn. The snap turn felt very weird and unintuitive to the participants, therefore not being considered as a good alternative. The teleportation movementhas also been considered less immersive and ruining the experience. Nonetheless, three of the participants reported that the movements feels too fast and that it makes them dizzy.

6.2.3 Popups

We have had various occasions, where we presented popups to our participants: The introduction, when a plant has been found and to end the game. While the end popup and the plant popup did very well, because of the nice design and the dense, but accurate description, the introductions popup was perceived as tedious to read. The lack of pictures, the high amount of text and the small font size were all pointed out as things to improve.

6.2.4 General feedback

Apart from the feedback above, there were some smaller issues, which the participants pointed out.

1. The time to find the plant was perfect. The participants did not consider it as too long or too short, even though one participant had problems of finding the plant at first

2. Our particle effect, which indicated the location of the nettle, was perceived as smoke by two participants.

3. If we only place one plant of a kind, it might look very unnatural. It would be better to group more plants of one kind to increase the level of immersion.

6.3 Improvements

After the user study, the three of us sat together and talked about all the things, which we wanted to improve in the game. Over the course of the last weeks, we worked on several things:

- Sounds: To achieve a higher level of immersion and also because some people have mentioned it in the study, we tried to include sounds in the game. First we implemented a sound for the environment itself and also for the environment near the river, so the river seems more realistic. Additionally, we wanted to give the users a more rewarding feeling, when finding a plant, which is why we also implemented a success sound for finding a plant and also for the ending popup, when the "mission" is accomplished.

- Bounding Box: In our study version of the game, we had no boundaries in our world, which means that the users could simply walk over the edge and fall off the world. We decided that this is a big flaw and we have to create a bounding box, which hinders the users from doing that. Furthermore, we also did the same for the small sea in our environment, because it would seem a bit unrealistic for the user to dive underwater.

- More Plants: Something more obvious than the other points, because we have planned it even before the study, was to include more plants. Next to the nettle, we have decided for the following plants: Blueberries, Cyclamen, Arum italicum and the rose hip. All of these plants feature their own model, created by us, their own plant popup and their own location on the map.

- Particle effect: The particle effect was a bit confusing for some people in our study. It reminded them of smoke. We have thought a lot in how to improve the effect, but could not think about many alternatives. We changed the the color from white to yellow and increased the spawn rate of the particles a little, however we realized that the main problem was

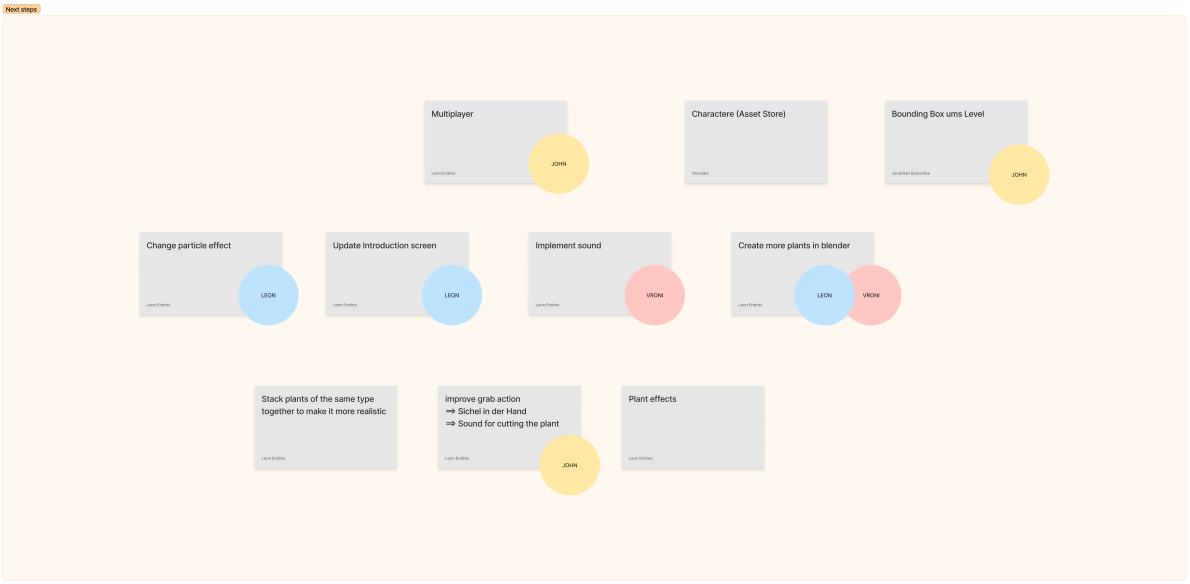

Figure 12: Prioritization of improvements after User Tests

not caused by the effect itself. The reason for the confusion was caused by the fact that the participants did not know that the plants have a particle effect to indicate the location. To improve this, we added a slide on our introduction popup with a picture so the users in the future would be informed about the effect.

- Introduction popup: The change described in the last paragraph was no the only change our introduction popup has received after the study. We decided to shorten the text on slides 2 and three and a picture on every slide to, so they do not appear bland and boring anymore.

With all of these changes done, most of the mentioned flaws have been solved. For further confirmation we asked a few people for feedback and tried to solve it. However, a second user study would be required, which could be part of future work on the game.

7 Limitations

We had many ideas to make the game exciting and thus make the learning efficient and fun. However, we quickly realized that due to the short time available, we first had to define an MVP and then, if there was still time left, we could add more features. The requirement was to develop a multiplayer game where you can learn something, making reaching that target our main goal.

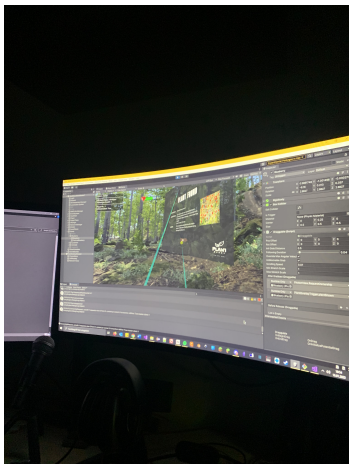

Figure 13: Player has fount a plant

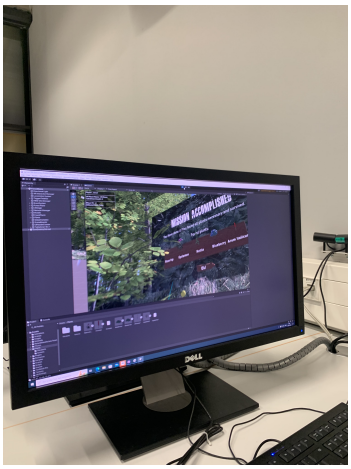

Figure 14: Player has accomplished the mission

At first we wanted to develop three different game modes. The exploration mode was for discovering and learning about plants. A single or multiplayer survival mode, where you have lives that you can lose by picking up poisonous plants, or regain by healing plants. The third mode we wanted was about who could find certain plants for a medicine first.

We decided to start with a simple game to test simple procedures. This involved opening the game, starting it, and exploring the biome. As soon as the player touches a plant, the success screen appears. As soon as this worked, our first goal was met. However, since this first stage was more complex than we initially thought, we had to spend more time on basic functionality. This lead to the current mode, where all users on the server are searching for plants, and get notified if someone finds them. But every user still searches for plants themselves. Built upon this, like described in the Programming section, there could be a mode, where the Unity tags are used to differentiate for example between poisonous plants. This would inflict damage to the user. For this we modelled a healthbar at one point, but instead focused on the main mode first. The mode of medical teaching, where you have to find the ingredients for a certain medicine, we unfortunately could not implement due to time constraints. But this would also tie nicely into the current system, with more plants added to the game, ingredients shown at the beginning and right or wrong choices of plants in the biome.

In the future we would elaborate the previous modes. In the single player discovery mode, the information of the plants will be more detailed. The general description of the plant and ingredients needs to be built upon. We also want to include more plants throughout each Biome, if new Biopmes are added. The immersion could also be built upon, for example by including a psychedelic camera effect when poisonous plants are ingested. Another idea was to enhance

the learning and tighten the game flow by showing a quiz at the end of the level, forcing the users to learn the information shown before.

8 Summary

In this documentary, we could see how the development process of the virtual reality game PlantBuddy. We started with an introduction to our topic finding process and concept idea, followed by a first implementation tested with a user study and eventually having a game, which satisfied both our expectations and the needs of our user group. Everyone in our group has played video games before and because of that, we could identify many problems as early as in the conceptualization phase. We always asked ourselves the question "Would I have fun playing this game?" and if the answer was no, we knew that the suggestion was bad. What we could not foresee though, were the different problems, which are unique for VR games. Motion sickness, as reported in our user study, was a problem, which we did not have in mind. We wanted to give the users a rather fast movement through the world, because we thought that it might get to boring otherwise. Eventually we have learnt that it is not as simple as that: Users of VR games face different conditions than users of other video games. In addition to that, when we were phantasizing what our game will look like, we did not know that many of these ideas are not realizable in our final product. The three game modes presented in the beginning were a very big stretch and something which should be focused on, when continuing to work on this game. Also, many other features, like differing biomes with different plants, noticable effects, when eating the wrong plants and weather conditions are all things, which just were too much for a project of this size. But still, all of these things are worth considering in the future, because they would add more immersion and realism to this game. Furthermore, they would obviously enhance the learning effect due to the broader spectrum of plants. Likewise, we were also able to learn a different set of new skills. All of our collectable plants have been made in blender. This project gave us the opportunity to learn this new tool and maybe utilize it in the future for other projects. We were also able to use Adobe Audition, which we just learned in another lecture. In addition, a lot of experience in project management and structured work with Github could be learned. In summary, we have accomplished a lot this semester and have created a good foundation for continued work.

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