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# AUGMENTED REALITY AND AUDIO - SERIOUS BOARD GAME PROJECT

RESEARCH THESIS

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## ABSTRACT

By using the design thinking method research is done to find out how audio impacts the user experience and what ways there are for the implementation of audio. A prototype, featuring a Augmented Reality will be build and used as a way of testing.

The results indicate that for the implementation of audio in games, audio middleware such as FMOD is recommended. It also indicates that audio has an important role in applications to give the user an additional layer of information as well as help build the experience into a more complete state. The study shows there is a correlation between the way people see and hear things. There is an expectation that certain visuals will sound a certain way such as happy themes with chirpy and upbeat tones, and sad themes with deep and bass heavy sounds. This research supports the theory that sound has influence on users, and that it can make or break an experience. The test data suggest that sound is something that should be implemented and is almost always a positive even if the sounds are not optimal. Having sounds is still better then no sounds at all.

## PREFACE

This thesis about the implementation of audio within an augmented reality board game is written to conclude my study and bachelor graduation for the Creative Media & Game technologies program at Saxion University of Applied Sciences, Enschede. The basis of the thesis is the process of ways to implement audio as well as a survey to find how audio affects the user. I was engaged in researching and writing this bachelor thesis from September to January 2020/2021.

With a group of other graduate students, we aimed to find a company to allow us to work on an Augmented Reality boardgame project. Rene Stam from Stichting Gamelab Oost and Conceptlicious a company in Enschede the project was of interest if we made changes to make it into a serious game to which I and the others in the group had no objections. My original goal was to focus on visual art for the game. My original goal was to focus on visual art for the game, but during one of our meetings my interest got peaked by the idea of focusing on the audio instead. Audio is something I had not done before, so this was a good opportunity to learn more about it. I decided that was what I wanted to learn and centre my research around. With input from my graduation coach Mark Schipper, I formulated my research question. The research proved to be more difficult to get started on than anticipated because the amount of new information was overwhelming. My graduation also started as the world experienced a global pandemic, which at the time of writing was just coming up on the second wave which saw new and harsher restrictions in the Netherlands. While the first five weeks of the graduation we had an office to meet and work in the remainder of the 20 weeks have been from home. I quickly realized that this was something I struggled with. Luckily, it became manageable with the help of Gamelab Oost, the university and the other graduate student. We had video and voice calls on a day-to-day basis.

I would like to thank everyone that has helped me through this sometimes-difficult process, my company supervisor Rene Stam and University coach Mark Schipper and the team I worked on the prototype with. I would also like to thank everyone that helped with the tests and gave feedback throughout the process.

As you read this bachelor thesis, I hope you are in good health in these difficult and strange times and that it will provide you with something new.

Keimpe Snip,  
Enschede, 12th of January 2021

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## 1. INTRODUCTION

In this document, you will find research on the implementation of audio design for Augmented Reality (AR). The goal is to find the best solutions to keeping users immersed while interacting with AR software.

### 1.1 THE PROJECT

“Stichting Natuurpark Kronenkamp” from the small town of Neede in the Netherlands requested from “Stichting Gamelab Oost” a serious game to help in their campaign to promote the park and help generate interest for new visitors between the age range of 12 to 16.

The product will be a prototype of a serious game and will function as a template for future developers to build Augmented reality serious games on. The authors role is to implement the audio within a mobile AR game prototype.

### 1.2 THE CLIENT

“Organisatie Stichting Natuurpark Kronenkamp” henceforth called “the client” in Neede, a small Dutch town in the east of the Netherlands. The foundation was founded in early 2017 by two voluntary organizations, the “Instituut voor Natuureducatie en Duurzaamheid Oost Achterhoek (IVN)” and the “Stichting Vleermuizendorp Neede (St. VDN)”. With intended goal to preserve the surroundings and an eventual step up to host activities to increase the general liveability in Neede. (Nature park Kronenkamp, 2020)

### 1.3 THE CLIENTS GOALS

The client wants an educative serious game to help educate but also generate interest for people to visit “Natuurpark Kronenkamp” (Personal communication, 7 September 2020)

#### **Clients problem statement:**

The client invested a lot of budget into renovating and repurposing an old water purification plant into a centre for education-based events. However, because of low visitor numbers and no remaining budget to invest in marketing. They are now looking for a way to increase interest for people to come to visit.

#### **Requested product/service:**

The client has an interest in using new technologies to enhance the park experience or use interactive media to generate interest for people to come to visit the park. They want it to be educative to make it interesting for schools around the area. The main goal is to make a serious game with AR, which can be used as part of an advertisement campaign.

#### **What does the client want with the results:**

The client wants to be a positive influence for people of the township of Berkelland, of which Neede is a part. To go and visit the Kronenkamp park.

## 1.4 STAKEHOLDERS

### **The Company, Stichting Gamelab Oost, Enschede:**

A foundation set up by multiple companies to create a communal work environment will provide guidance and location for building the prototype.

### **The Client, “Organisatie Stichting Natuurpark Kronenkamp”, Neede:**

Will provide the information, target audience and requirements for the product.

### **The Student Keimpe Snip, Almelo:**

Will perform research related to their project goals.

### **The team, Augmented Quakers! Overijssel:**

Group of students working on the prototype for their graduation and internship.

### **The University, University of applied sciences Saxion, Enschede:**

Will oversee the graduation processes and judge its results.

## 1.5 PRODUCT DESCRIPTION

*A detailed description on the game can be read in “Appendix B – Game design document”.*

Summary: This Augmented Reality (AR) project is based around tabletop board games with a serious gaming twist.

The gameplay needs to be simple to play (low skill floor) and engaging to invoke a sense of curiosity among a young audience within a school setting.

It is a racing board game where four players go against each other to reach the final tile first. The first to reach the end wins the game. There are mechanics such as shortcuts and quiz questions about bats, water treatment, nature, and history of Neede along the way.

The Students role in the development of the product is implementing audio, concept and gameplay design.



## 1.6 SCOPE

There is a time frame of 20 weeks to perform research, build a prototype and test. The product and learning goals are centred around AR (Augmented Reality). (personal communication, 7 September 2020) Work from home has gone into effect midway through the project because of the Covid-19 pandemic. Resulting in a personal effect on the student's day to day productivity.

The client and the company have not provided the team with a monetary budget for the development of the product. The company, however, has provided funds for purchases made for the product. The student will work on the implementation of audio in the prototype while performing research into which methods can be used to achieve implementing audio and how different sounds affect the prototype's user. The student will not go in-depth on the psychology behind found research on why a sound affects a user the way it does. The student will also not rely on his own produced samples. He will make use of online audio libraries for most of the audio samples. The student will also not get involved with the marketing or campaign and underlaying goals for the prototype.

## 1.7 CRITERIA FOR SUCCESS, THE PROTOTYPE

The team is building a prototype for the client. The prototype is an Augmented Reality Serious game for use on android telephones and has been presented to the client as such. The prototype will not be ready to use for the client, rather, something the client can use as a foundation for further development.

Indication of success for the team and student is when the prototype can be used as a tool for the practical testing of the research through survey of the target audience with the prototype.

For the client and the company, success is when the prototype meets the feature requirements. (see APPENDIX B – GAME DESIGN DOCUMENT) and can be used for further development or show that they need another approach. (personal communication, 7 September 2020)

## 2. PRELIMINARY RESEARCH

### 2.1 TARGET AUDIENCE

To make a prototype, research was done to establish who it was the final product would be for. An abstract conclusion will be written here, for the full research see Appendix C – Target Audience Research. And Appendix F – Resultaten Doelgroep onderzoek (translation: results target audience research)

While brainstorming the student conducted preliminary research into the target audience this would make it easier to make a prototype suited for the right audience and make the test.

The student made persona's and journey maps to establish what kind of users would interact with the app and the different experiences they have. (see figure 1 and 2)

A survey was sent to a high school on which 51 high schoolers participated. Results of the test show that about half of the children have android and the other half iOS devices. It was decided to only focus on the android version for the prototype as this is most accessible. Especially as the focus is not on building a full product. It is also harder to put apps on iOS because of its security and approval system.

The results show that the majority has heard about augmented reality before however, they do not know what it is. When describing Augmented Reality, they do show they have seen it before in apps they have used before such as Pokémon Go!<sup>1</sup>. Most of the children also seemed interested in Augmented Reality and having it be used within school lessons.

These tests have given insight about the intended target audience. The team learned that the real target audience might not be children but teachers. Teachers could use something like this game as a tool for teaching.

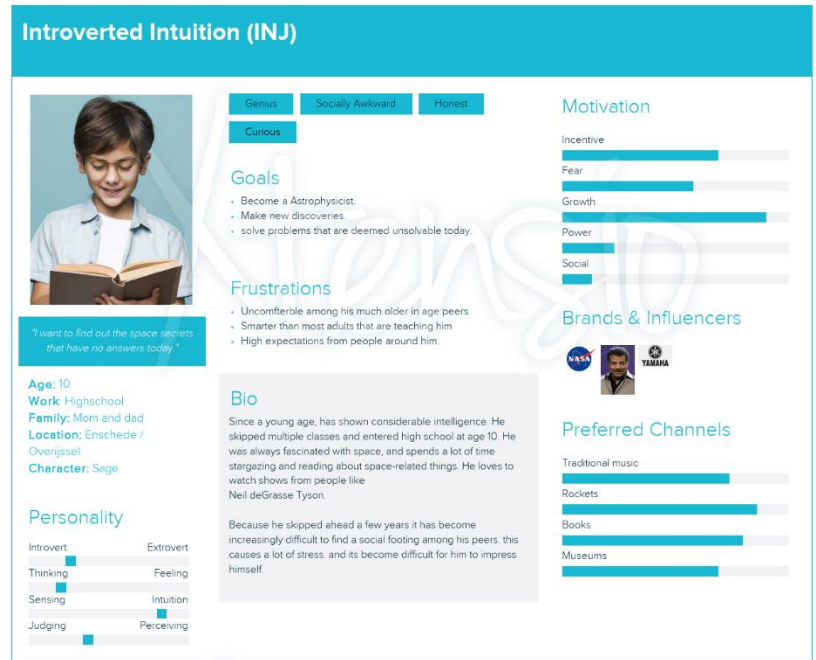


Figure 1 - Note. Persona

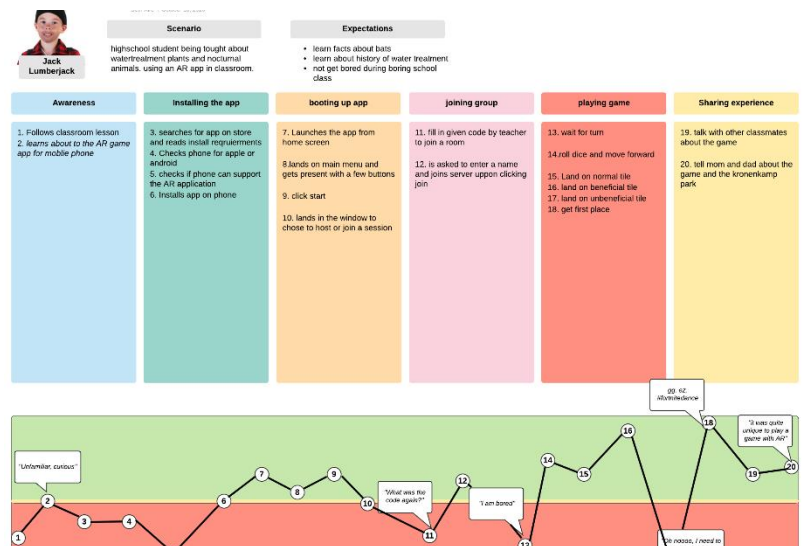


Figure 2 - Note. Journey map

<sup>1</sup> A popular phone app that features augmented reality features

## 2.2 PROTOTYPE COMPETITION RESEARCH

Detailed description can be read in “Appendix D – Competition Research”.

To help with developing the project research was done into other similar projects to the prototype. With research it became clear that of the few Augmented reality tabletop games most are using a head mounted display which holds the phone of the users. During the earlier brainstorm sessions of the project, it was discussed to use similar glasses, Aryzon (Aryzon, 2018), a small company in the business of making Augmented reality glasses. We had a meeting with one of their company representatives but ultimately decided against it as it would limit the development time available for the prototype. It is however something to keep in mind for an eventual full product version because it might create impact among the target audience when there is a fun gimmicky device involved and because of the other augmented reality board games that get crowdfunded are mostly played with Augmented reality glasses.

## 2.3 AUDIO

Detailed description can be read in “Appendix A – Audio encoding and bitrate”.

The research was done to find out what type of file formats and which bitrates would be best suited for implementation within the Unity game engine. The product is intended for mobile phones. It is necessary to know how to keep the disk size of the audio files as small as possible. The files that are mainly compared are .WAV, .AAC and MP3.

.WAV is a lossless file format; meaning it compresses the file without losing any data at the expense of a larger file size.

.MP3 is a popular audio extension it is a lossy file format; it compresses the data, losing some minor data in the process. Meaning that it will cut everything above and below a certain spectrum, reducing the file size drastically but also removing a lot of data. In the hard to hear regions of sound.

.AAC like MP3 is also a lossy file. It was developed as a successor to .MP3 however it never got as popular and as a result is not as widely compatible.

The bitrate has a big impact on both the perceived quality of a sound as well as on file size. (see figure 3) A higher bitrate means more data passes every seconds. The more data you have, the more detail you can put into your tracks. You can optimize the sounds by tweaking the bitrates. Achieving the balance point of quality and size depending on the type of sound it is, for example, the dialogue you would use a higher bitrate than a button sound in the UI as dialogue would require a lot more data. So, there is no cookie-cutter method setting for most audio files. Since our prototype is using the unity engine<sup>2</sup> (Unity Technologies, 2005) And unity offers the feature that upon building an application for a device it will compile and compress all the files for that device, this includes the audio settings. The student can tweak these settings within the engine as well to optimize it further. To utilize this feature, it is best to supply the engine with raw files, to which .WAV files seem most suited.

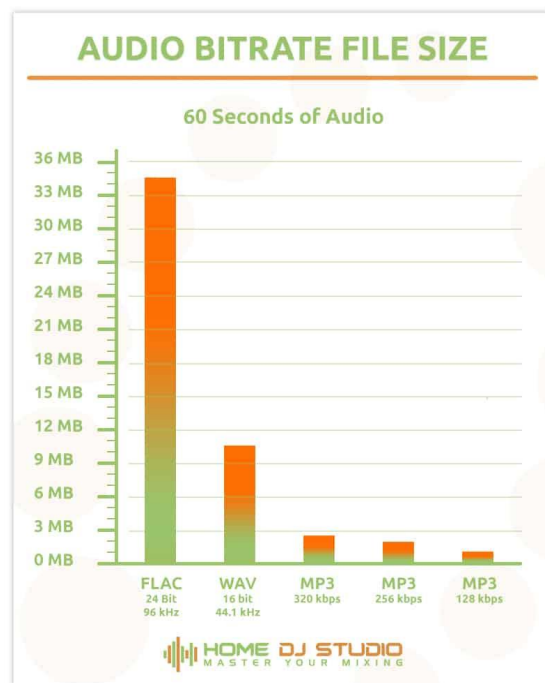


Figure 3 - note. Audio file sizes based on file and bitrates, (Calabrese, 2020)

<sup>2</sup> An editing tool for making applications.

### 3. PRIMARY AND SUB-QUESTIONS

The research will be focused around implementing audio for a mobile augmented reality game. The main research question has been formed. To give the solution to the main research question it has been divided into five sub-questions.

#### 3.1 PROBLEM STATEMENT

**Research question:** How to implement audio feedback within Augmented Reality (AR) to enhance the player experience of a mobile AR game prototype.

#### 3.2 SUB-QUESTIONS

1. *What types of audio feedback are there in video games?*
2. *How does audio differentiate from normal applications within AR?*
3. *How does audio feedback influence the player experience?*
4. *What tools are available to implement audio feedback?*

### 3.3 METHODE

The method of approach will be Design thinking, this method will be used to define what types of research methods need to be used to answer the sub-questions. Design thinking is an iterative method to develop a product in a way that aims to best understand what the client's real needs are. With design thinking, you can deconstruct problems that are unclear or badly framed. (Dam & Siang, 2020).

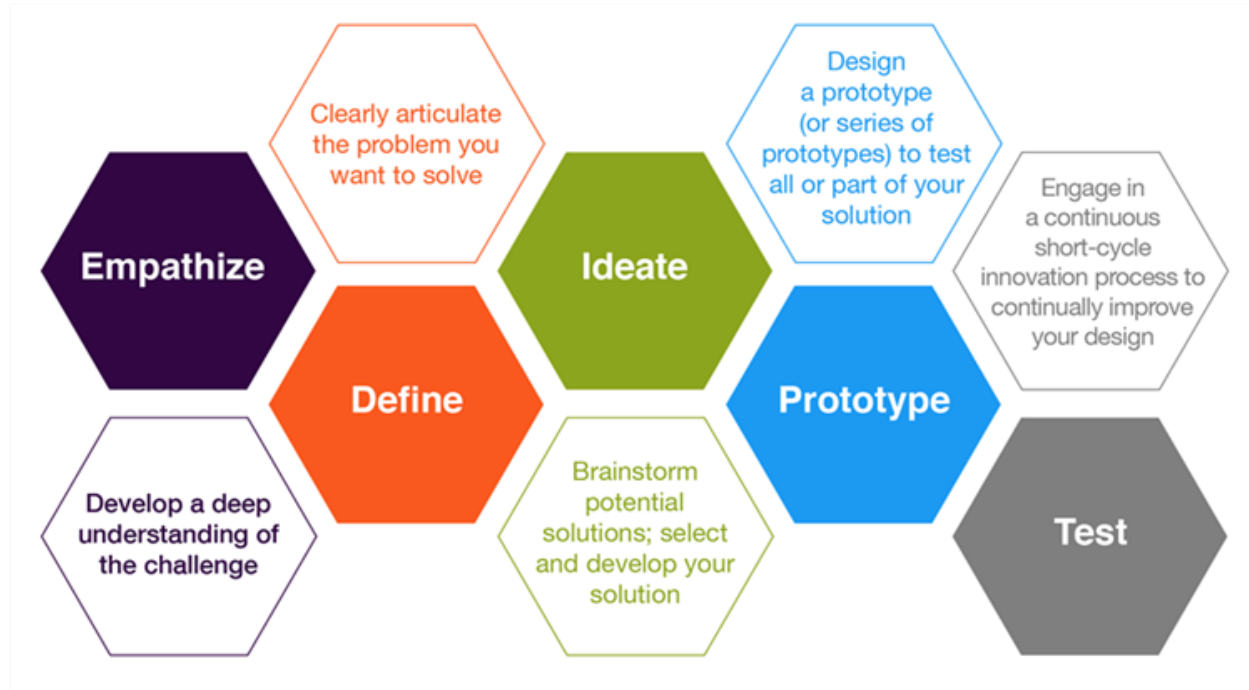


Figure 4 - Design thinking

Research methods have been used from the CMD methods pack. (Turnhout, 2015)

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### 3.3.1 WHAT TYPES OF AUDIO FEEDBACK ARE THERE IN VIDEO GAMES?

- *Desk Research*
  - Find written papers on how sounds give different types of feedback, such as why a sound comes across as happy and others as sad etc.
  - Sources are websites and videos / audio.
  - Data reduction: use keywords to filter down search results and use abstracts to determine if the source contains relevant information.
    - Keywords: Positive, Negative, Audio, emotion/emotional, Human behaviour, affect, effects of audio on human behaviour, cues.

---

### 3.3.2 HOW DOES AUDIO DIFFERENTIATE FROM NORMAL APPLICATIONS WITHIN AR?

- *Desk research*
  - To find out if there are written research papers on the topic.
  - Sources will mainly come from websites and scriptures.
  - Search terms.
  - Data reduction: use keywords to filter down search results and use abstracts to determine if the source contains relevant information.
    - Keywords: audio in AR, AR vs flatscreen, benefits of Augmented Reality audio

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### 3.3.3 HOW DOES AUDIO FEEDBACK INFLUENCE THE PLAYER EXPERIENCE?

- *Desk Research*
  - Find existing written articles and scriptures.
  - Sources are websites.
  - Data reduction: use keywords to filter down search results and use abstracts to determine if the source contains relevant information.
    - Keywords: positive, negative, audio, emotion/emotional, human behaviour, affect, effects of audio on human behaviour, cues.
- *Survey*
  - Ask a short number of questions from users of the prototype what they experience during different playback of sounds.
  - Source will be Prototype users.

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#### 3.3.4 WHAT TOOLS ARE AVAILABLE TO IMPLEMENT AUDIO FEEDBACK?

- *Desk Research*
  - Find different tools.
  - Sources are websites.
  - Data reduction: use keywords to filter down search results and use abstracts to determine if the source contains relevant information.
    - Keywords: FMOD, Unity, audio, Wwise
- *Risk Analysis*
  - Determine the best tool to use based on competencies and amount of new learning required.
  - Costs.
  - Sources are websites.
  - Data reduction: List of requirements.

## 4. RESEARCH

### 4.1 WHAT TYPES OF AUDIO FEEDBACK ARE THERE IN VIDEO GAMES?

#### 4.1.1 THEORETICAL

##### 4.1.1.1 CONDITIONING

The search terms resulted in a variation of papers written about audio affecting human behaviour and how audio cues can be used to give the player feedback about something they visually see and whether what they see is something good or bad or even piquing curiosity.

There is a lot of research on the topic where visual cues and audio cues are used to affect behaviour an example of this is an operant conditioning chamber, also known as a skinner-box (figure 5).

A skinner box is a tool used for activities such as studying operant conditioning. an associated learning process where positive and negative reinforcement is used to voluntarily modify behaviour by having the response be in control of the subject. Classical conditioning which is involuntary as they are affecting stimuli and biological events to affect a test subjects reflexes and thus are not reinforced by consequences and are not the result of a choice made by a subject it is out of its control. (Staddon & Niv, 2008), (Schmajuk, 2008), (Rubin, 2018)

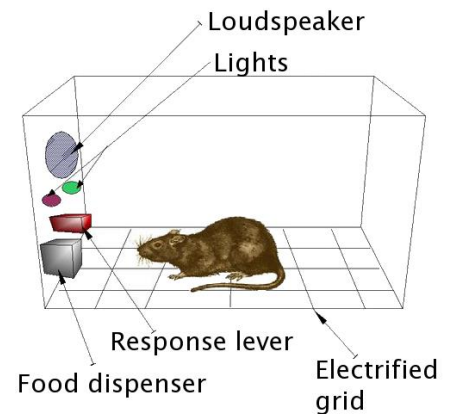


Figure 5 - Skinner box (Andreas1, 2007)

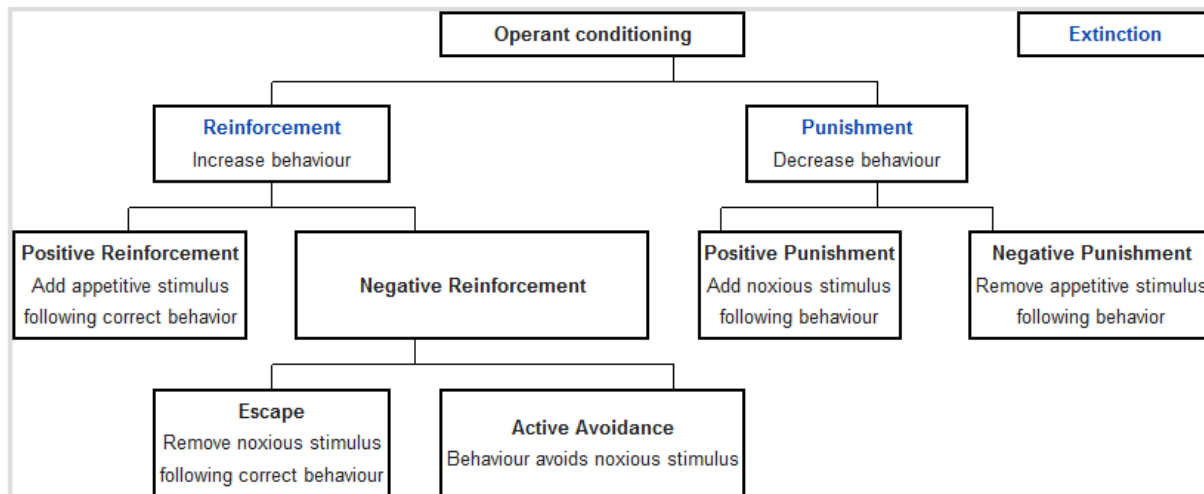


Figure 6 - Types of operant conditioning (Wikipedia, 2020)



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#### 4.1.1.1 CLASSICAL CONDITIONING AND AUDIO

Sound is being used to condition people daily if not at almost all times. It is effectively used alongside visual cues in for example commercials to make you react in a positive way towards something they are trying to advertise. A good example can be found on a segment on classical conditioning from the program 'The Sound of Science' where they played the sound of a buzzing phone every 30 seconds to make people check their phones. (Watt, 2018).

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#### 4.1.2 TYPES

*Diegetic and Non-diegetic sound:* the terminology is mainly used in films; however, it also applies to video games. Diegetic sound is any sound that comes from stories world or in a video games case, the game world. A non-diegetic sound means that the sound does not originate from the game world and its story but rather is an additive to enhance the player experience. Characters "living" inside the game world would not be able to hear these sounds. (Masterclass, 2020)

Karen Collins, author of the book, *Game Sound* (Collins, 2008) and a blog post from Andrew Quinn, *Types and Roles of Sound in Games* (Quinn, 2008) puts video game audio into four categories.

*Dynamic Audio:* this category deals with gameplay, input and game space sounds and is separated into two parts, Interactive Audio; Audio that plays because of player input and Adaptive Audio; Sound that plays as a result to changes in the game and gameplay itself.

*Diegetic Sounds:* the sounds in this category are sounds that are played within the range of the player or user. There are *non-dynamic sounds* which the user does not have control over. *adaptive diegetic sounds* which react to changes that do not affect the player. Lastly there are *interactive diegetic sounds* which are resulting of player interaction. Such as firing a weapon or walking and running. Sound effects and dialogue make up this category.

*Non-diegetic sounds:* this is the category that contains the music and other sound effects.

*Adaptive Non-Diegetic sounds* are reacting to the gameplay that the in-game characters cannot hear. *Interactive Non-Diegetic Sounds* these are sound effects played as a direct reaction to the player interacting with the game such as interactive music and gameplay effects. *Non-Dynamic Linear sounds* are sounds that are played during the moment the player cannot interact, such as cutscenes.

*Kinetic Gestural interaction:* these are the Diegetic and or Non-Diegetic sounds the player physically does. Like playing an instrument with a controller or using a joystick throttle the trust of a spaceship and produce sounds at different increments.

Another, less complicated to categorize game music is the method used in an article written by Sander Huiberts and Richard Van Tol. (Huiberts & Tol, 2008) They use four categories. Zone, Effect, Affect and Interface.

*Zone* contains environmental sounds and helps set the tone and ambience of the game. These sounds are Diegetic, *Effects* are Diegetic gameplay sounds that can happen on and off screen and contain everything from things like footsteps to gunshots and explosions happening in the distance.

*Affects* are the non-diegetic sounds that help set the mood. Then there is *Interface* which are non-diegetic sounds that play when navigating the interface, such as game menus and HUD (heads-up display, usually a two-dimensional screen overlay to display information to the player). These sounds are to enhance feedback and give information.

Both methods cover the sounds that are present in games, however, the method used by Sander Huiberts and Richard Van Tol is easier to follow and understand as there are fewer subdivisions in the categories and the terminology is easier to follow as opposed to what is used by Karen Collins in the book, *Game Sound*.

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### 4.1.3 PRACTICAL APPLICATION

Because of the scope of the prototype and the research question that the student aims to answer the prototype will use non-diegetic sounds. For the full game it would be good to have sound effects on the terrain. Water sounds when a pawn passes water or the sound of buzzing bee's when the player is near a beehive, for example. It would potentially give a bigger influence over the player experience. For a prototype, the scope is lower and simple sounds that play when a player interacts with the user interface or feedback when the chosen pawn makes a sound when moved is sufficient to test the effects of player experience in a game. The game in the prototype state does not necessarily need to feature an adaptive audio system, although it would be highly recommended for the full product.

By playing the same sounds when something good happens the player will start to connect the sound that played to a positive event, and the same can be done with negative events. Potentially you can use the sounds to influence the player to feel something when hearing the sound even if nothing positive or negative happened to them in the prototype.

## 4.2 HOW DOES AUDIO DIFFERENCIATE FROM NORMAL APPLICATIONS WITHIN AR?

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### 4.2.1 THEORETICAL

When it comes to audio, there are multiple options.

*stereo sound*: being able to play sounds from left to right in a horizontal axis by using two audio channels.

*Spatial sound*: which acts more like real life where it can also play sounds from above, below and behind and is captured with a binaural microphone.

*3D audio*: sounds placed within a virtual three-dimensional environment playing sounds from placed sources. (Mattana, 2017)

*Mono*: the most accessible and simplest. *Mono* uses only a single audio track. It does not allow audio to be perceived in a specific location on its own.

When in a virtual environment it does not matter as the sound will naturally be coming from the location it has been placed in. In augmented reality when it comes to the immersion and the engagement of the player the use of 3D audio or Spatial sound is the way to go according to Loïs van Ruijven. (Ruijven, 2018) Spatial sound combined with AR combines the ability for sound to be played from anywhere with object-based sounds. This allows the effect distances to remain intact and create a real interaction. In other words, spatial sound can help the AR experience in numerous ways such as allowing sounds to guide the user's attention or help with narrative and keep them engaged.

There have been experiments with spatial sounds and AR, one of which they looked at the usefulness of navigating and searching through an AR environment with the help of spatial sounds.

An experimental study of spatial sound usefulness in searching and navigating through AR environments.

Dariusz Rumiński (2015) concluded that spatial sound is a great tool for directing users to find objects in a virtual three-dimensional space and noted that it may increase the user’s perception, helping to limit the search boundaries of the objects they were seeking. The control group, which tested with no sound also noted they could see the benefit to spatial sound.

Users that are using spatialized sound where both scoring higher and finishing tasks faster. see figure 7 and 8.

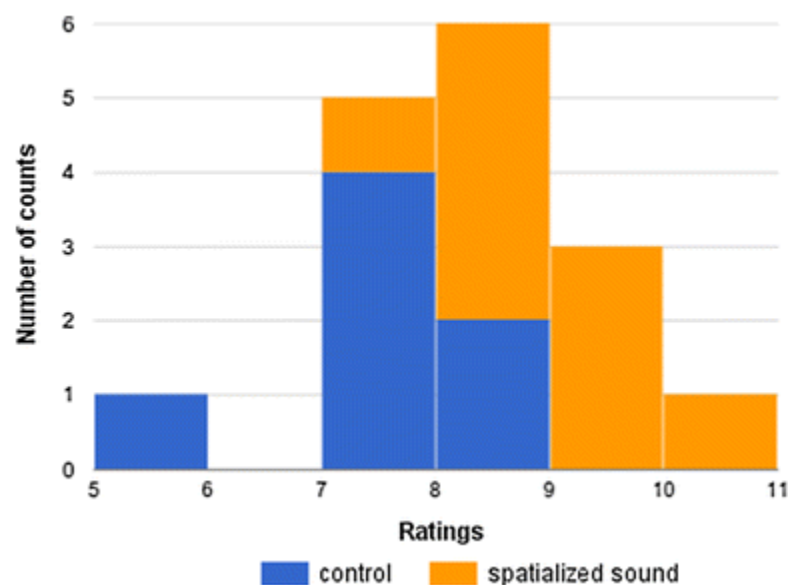


Figure 7 - Test results scores (Rumiński, 2015)

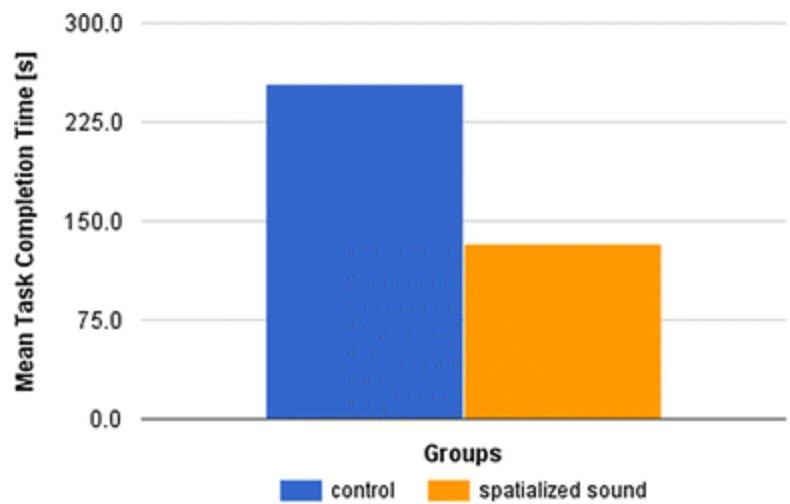


Figure 8 - Test results scores (Rumiński, 2015)

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## 4.2.2 PRACTICAL APPLICATION

As stated previously in sub-question 4.1 What types of audio feedback are there in video games? For the prototype using spatial sound would be a great addition to how the user experiences the sound and game events. A great example can be seen on a YouTube video uploaded by UploadVR. (UploadVR, 2017) which shows an augmented reality game being placed on a table. Featuring spatial sounds, however for the prototype and the nature of the main research question, testing it with mono will be sufficient and does not require the feature at this time. It would be a recommendation for the full game.

## 4.3 HOW DOES AUDIO FEEDBACK INFLUENCE THE PLAYER EXPERIENCE?

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### 4.3.1 THEORETICAL

Sounds can serve different purposes from adding mood and ambience with zone sounds to informing players about things that happen in the game. They can confirm actions, or warn the player influencing them to react. A good example of this is how in the game Minecraft<sup>3</sup> when a player hears the hissing sound of a creeper, an enemy that usually spawns behind the player in the game it then silently creeps up to the human player and explodes itself dealing a lot of damage after playing a short hissing sound. (Matt \_\_, 2012). The creeper directly influences the player to react. Sound effects need to make sounds that represent how things sound in the game's reality, sounds help create the suspension of disbelief (Coleridge, 1817). (Parker & Heerema, 2007)

Using sound to give players feedback on their choices is often done, such as the sound of losing karma in the game series Fallout (PeterSkeeter, 2012) when you perform an action seen as bad or evil. In the same way, you can also play an upbeat or happy sound to indicate a good choice. It is good to remember that these sounds should match the overall theme and thematically match the other sounds used in the game. Another effective use of sound to influence the player is to associate a chime with gaining a reward or when getting an achievement, think of getting a trophy or achievement popup on Xbox or play stations. Combining the sound with the visual popup can give the player a sense of accomplishment and boost their ego to keep engaged with the game. (Impey, 2019)

According to Singh (2020) music should complement the game and its interactions; however, should not be intrusive. It should try to match the theme and the style of the game. As the player's brain is connecting sound effects to events in the gameplay it creates a more complete experience, together with music playing in the background the addition of sounds can allow the user to escape into this new world. (Singh, 2020)

A Bachelor thesis written by Sebastian Wöhrman and Nael Ningalei (Wöhrman & Ningalei, 2018) performed tests about the effects of sound in horror games, using a select number of games and a heart rate monitor.

They concluded that sound has a big impact on the player experience, see figure 9. They also concluded that it also impacts how the players play and interact with the game. With the sound version of the test players more often skipped parts of the levels to get through it faster. Avoiding exploring everything.

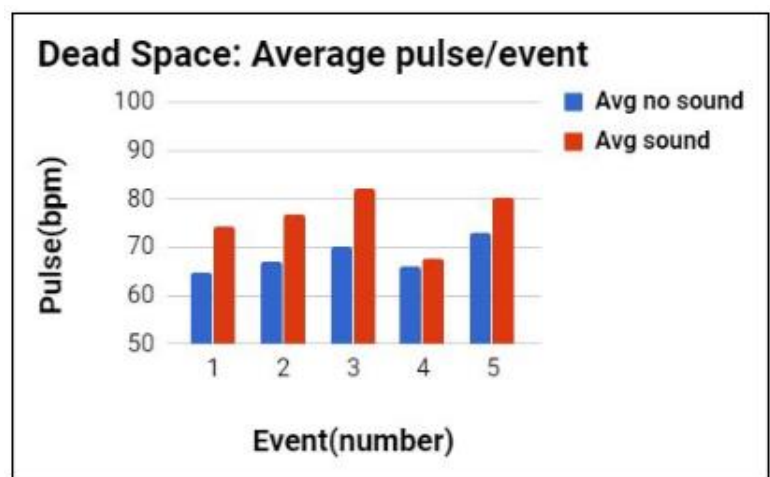


Figure 9 – Graphic showing pulse during events with and without sound (Wöhrman & Ningalei, 2018)

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<sup>3</sup> A popular sandbox survival game



### 4.3.1 PRACTICAL APPLICATION – SURVEY QUESTIONS

To perform a test, simple sounds have been implemented into the prototype and the participants were asked to fill in a survey where four questions about the audio:

The questions:

*Question one: Did you experience the audio differently in augmented reality when compared to normal phone apps?*

This question is asked to find out if the sounds used sufficiently utilized the sounds to enhance the AR experience as well as to find out if players think there is a difference in the way you experience audio between the two platforms.

*Question two: Did the audio influence how you felt about things that happened in the game?*

To find out if people felt differently based on sounds playing during events and

*Question Three: Did you feel the sounds made you react differently to an event?*

Similar question too question two, however it aims to see if people react different.

*Question four: Did the audio enhance your experience, or did it subtract from the game?*

Whether the player found that audio was necessary.

The results will be shown and explained in chapter 5.

## 4.4 WHAT TOOLS ARE AVAILABLE TO IMPLEMENT AUDIO FEEDBACK? AND PRACTICAL SOLUTION

### 4.4.1 THEORETICAL

Middleware for implementing audio into video games is present in pretty much every triple-A (High budgeted development) video game production and in fast amounts of indie games (Small teams with limited budgets). The reason they use middleware is that they offer a base set of features that do not come with the game engine toolkit default (Engines like Unity, unreal) while they do offer good and simple enough tools for audio it does not meet the requirements of many bigger projects.

While it is also possible to program your system, this would mean spending a lot of time and effort of both your designer and your programmer to make such a system as well as then having to learn how to use it so many opt-in to use the toolsets offered by programs such as *FMOD* and *Wwise*. Budgets often are not as big a concern for most middleware are also not present as the point where you start having to pay only happens once your product is making a certain amount of money. See figure 10.

or this sub-question, the focus will mainly be on FMOD and WWISE and the unity default audio tools. As these are the most

suggested, CRIWARE is used mostly by Asian companies such as capcom and fabric is not

often brought up in the conversations and blogs. And to keep on the topic I will exclude ELIAS, as it falls outside the scope of how much I can research and in initial searches it was not often suggested or brought up. One of the biggest strengths of any of the middleware is the feature to allow adaptive audio, which was explained in 4.1. Having a tool to

MIDDLEWARE COMPARISON CHART	fmod	Wwise	elias ADAPTIVE MUSIC	CRIWARE	Fabric
Free Licensing	YES, up to \$500k	YES, up to \$150k	On Quote only	YES, up to \$25k	YES, up to \$400k
Distribution Rights	Lifetime	Lifetime	Lifetime	Subscription	Lifetime
Free Plan on # Games	1 Game a year	Unlimited	Not Stated	Not Stated	1 Game a year
Support / Free Plan	Forum (No Email)	Forum & QA only	Forum, QA and Email	Forum, QA and Email	Forum, QA and Email
Product Logo on Games	All Plans Required	All Plans Required	All Plans Required	All Plans Required	All Plans Required
Logo Waiver Fee	Only Paid Accounts	No Logo Waiver	Only Paid Accounts	Not Stated	Not Stated
Media Assets Limit/ Free	Unlimited	500	✗	Not Stated	Unlimited
Source Code Access/ Free	✗	✗	✗	Not Stated	\$750
Works on Unity	✓	✓	✓	✓	✓
Works on Unreal	✓	✓	✓	✓	✗
Other Game Engines	✓	✓	✓	✓	✗
Platforms	All Major Platforms	All Major Platforms	All Major Platforms	All Major Platforms	Not Stated
Sound Design Implementat.	✓	✓	✗	✓	✓
Adaptive Music Implement.	✓	✓	✓	✓	✓

by Theo Nogueira (www.theonogueira.com) - Updated on Jul 20th, 2019

Figure 10 – Graphic comparing features on multiple audio middleware (Nogueira, 2019)

change sounds, volumes, values on the fly is powerful, and allows you to have a much faster workflow. Adaptive features such as changing the footstep sounds based on the surface your character walks on, and randomizing sounds are useful. (Nogueira, 2019)

Other benefits to using audio middleware are that it can reduce the disk size of the audio down a lot, especially for mobile devices this is a great feature as on phones its more important to make your games disk usage as small as possible. Both FOMD and Wwise can compress-export to fit budgets. It can change bit rates sample rate and sound formats, and since the middleware handles options to randomize things like the pitch you can alter the original sound files non-destructively without having to upload multiple versions of the same sound.

---

#### 4.4.1 PRACTICAL SOLUTION

As the student has some prior knowledge in using the *FMOD* program, the original intent was to utilize this tool, and after making a comparison with Wwise, it seemed the wisest course of action was to use *FMOD*. While working towards integrating *FMOD* into the project, a realization was made that for the prototype all that was needed where simple mono sounds that played based on user input. To use *FMOD* for that would be like using a sledgehammer to crack a nut. Instead, it was opted to use Unity's built-in sound tools and call upon the sound's trough C# (Scripting language) scripts.

In a YouTube video by Brackeys (Brackeys, 2017), who made a lot of free unity tutorials, the student learned to make a few simple scripts and customize them to the needs for the prototype.

The audio runs by way of three scripts. The audio manager (see figure 11), the Sound script and the Pawn Audio script. The Audio manager handles spawning in the sounds to be called upon by the sounds script when the game is running and allows the user to define the sound pitch and volume of each sound that is loaded in. the audio manager also manages the background music and all variables.

the sound script defines the audio clips and gives purpose to the values defined in the audio manager.

Pawn Script is what defines the tag's and what sound should play on collision with each tag.

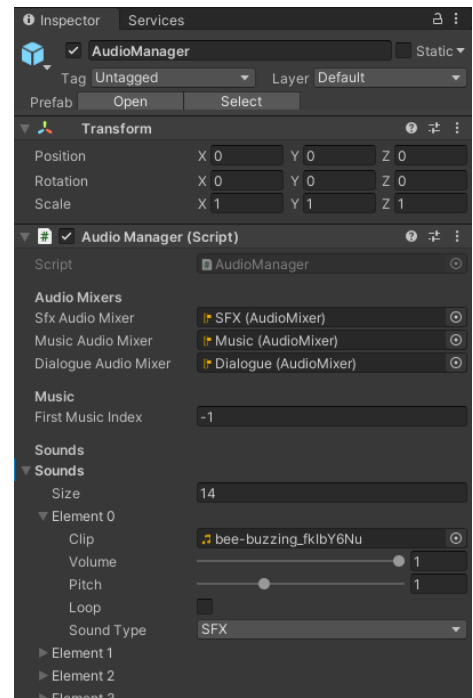


Figure 11 - note Inspector window from prototype in



## 5. TEST AND PRACTICAL RESULTS

### 5.0 ENHANCING THE EXPERIENCE SURVAY

The full survey results can be found in appendix E. The results shown below will be expanded upon further in the discussion, chapter 7. As stated in chapter 4.3, a test was done. The participants of the test were family members as well as people from the Gamelab oost community. nine people participated in the survey.

Question one (Figure 12) shows that most testers did not feel there was a difference between the audio on augmented reality and normal applications on the phone. Suggesting that there is no difference, however, this might be because of the small sample size as well as inadequate audio implementation.

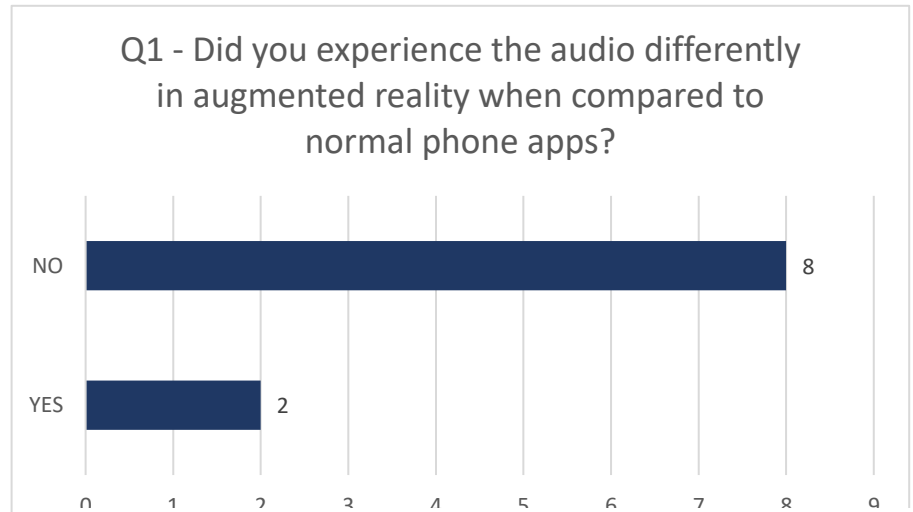


Figure 12 - Note. Survey questions, Appendix E

Question two and three (Figure 13 and Figure 14) shows that the opinion of audio having an influence on events is divided. Meaning that more tests must be done to get a more complete picture. Some of the participants also noted that the choice of audio for the pawns brought them out of the experience. They claimed the sounds did not match with what they expected from the visual appearance of the pawns. This could be a good indicator of how important it is to match the sound effects with the theme and setting of the prototype.

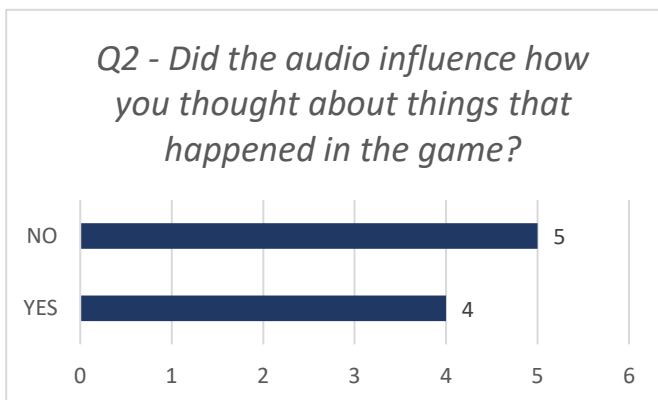


Figure 13 - Note. Survey questions, Appendix E

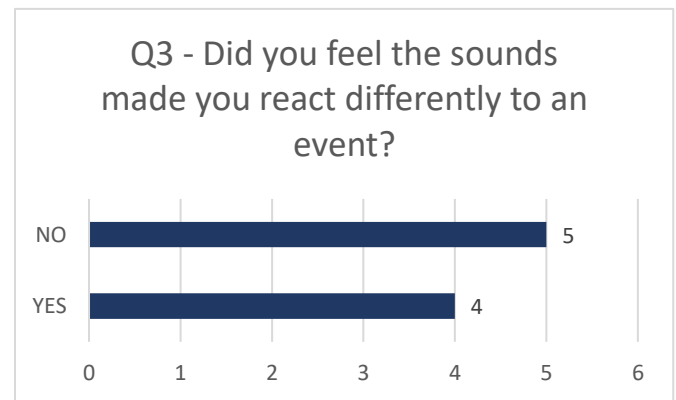


Figure 14 - Note. Survey questions, Appendix E



Question four (figure 15) shows that there is a clear majority that feels audio has a positive effect on the experience.

Participants also stated that without a sound the experience would be dull. Except for the pawn sounds. The background music was also said to be fitting. Some especially appreciated sounds on things such as when it was their turn to play

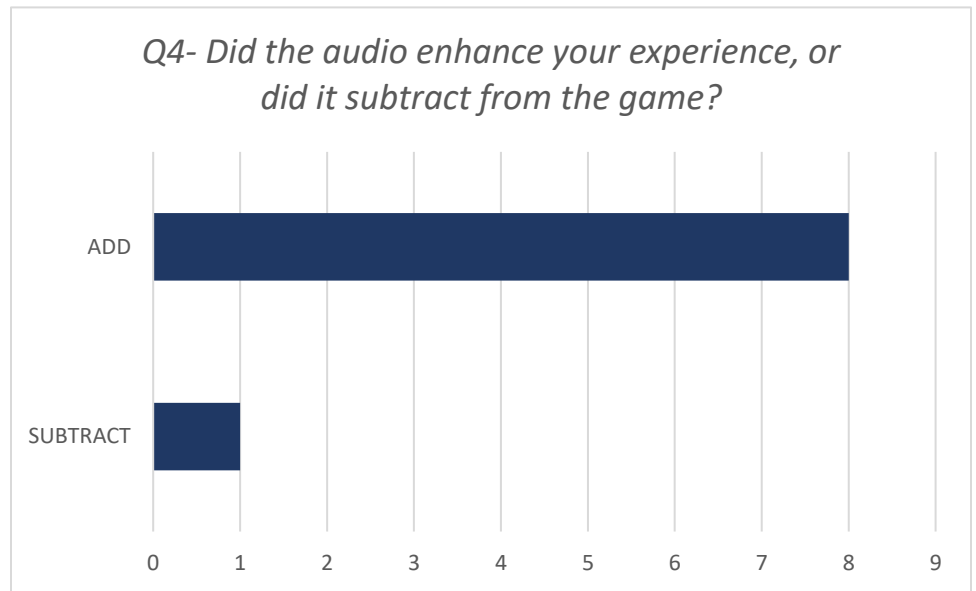


Figure 15 - Note. Survey questions, Appendix E

## 5.1 AUDIO IMPLEMENTATION

As exclaimed in 4.3.1, ultimately the choice was made to go with unity's sound engine for implementing audio. This was an iterative process, in which the students originally started working on FMOD and went as far as implementing the plugin and have it communicated between FMOD and Unity, however, that is where some issues started to arise with playback of sounds, while the student was sure with time it was a solvable issue from past experiences with an audio-related course focussing around FMOD he experienced similar problems which caused a lot of delays without a simple solution. By talking with one of the programmers from the project group the idea was brought forth to try to get it to work without audio middleware. Making the scripts was an iterative quest, the student first laid out when the sounds should play when. (Figure 16)

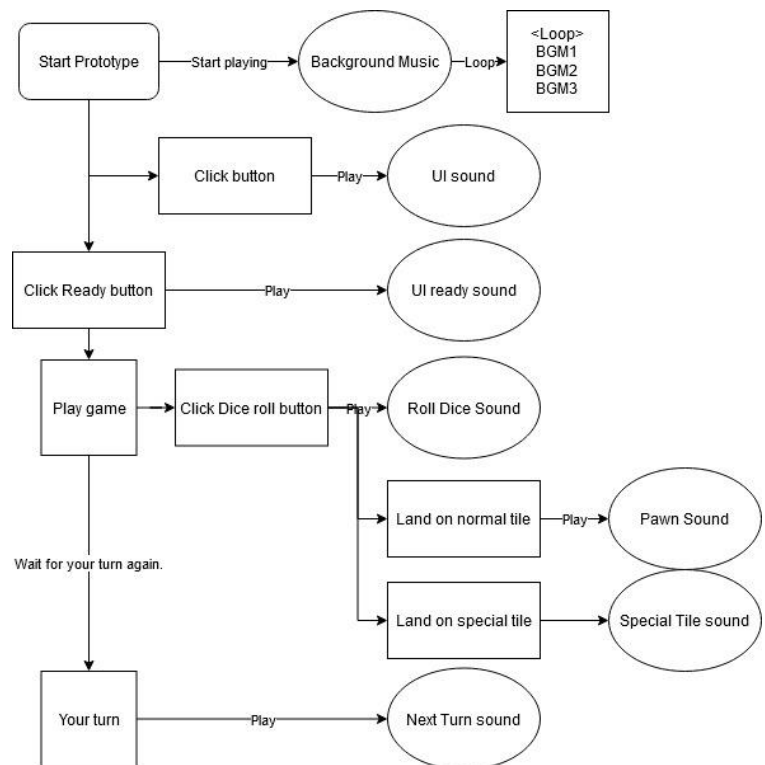


Figure 16 - Note Flowchart of prototype sounds

The first iteration was a bareboned audio manager (Figure 18) and a sound script to define the sounds. Based on tests the student added features to allow an audio mixer to be added to it (figure 17), and categorize sounds into dialogue, music and SFX corresponding with the sliders the player has access to in the menu. The background music also has been added to the audio manager.

```
using UnityEditor.Audio;
using System;
using UnityEngine;

@ Unity Script | 1 reference
public class AudioManager : MonoBehaviour
{
    public Sound[] sounds;

    @ Unity Message | 0 references
    void Awake() {
        foreach (Sound s in sounds)
        {
            s.source = gameObject.AddComponent<AudioSource>();
            s.source.clip = s.clip;

            s.source.volume = s.volume;
            s.source.pitch = s.pitch;
            s.source.loop = s.loop;
        }
    }

    1 reference
    public void Play(string name)
    {
        Sound s = Array.Find(sounds, Sound => Sound.name == name);
        if (s == null)
            return;
        s.source.Play();
    }
}
```

Figure 18 - Note. First version of audio manager

In the end because of iterative testing the features the student intended to be in where all present and sounds can easily be added, the volume and pitch can be changed as well as put sounds in categories which connect to the in-game settings UI allowing players to change the volume of different types of audio. Since we change audio in steps of 1 between 0 to 10 and audio calculates with decibels making it different then calculating normally a calculator was later used to calculate how much. (figure 19)

```
1 using System;
2 using System.Collections;
3 using System.Collections.Generic;
4 using UnityEngine;
5 using UnityEngine.Audio;
6
7 @ Unity Script | 7 references
8 public class AudioManager : MonoBehaviour
9 {
10     [Header("Audio Mixers")]
11     [SerializeField] private AudioMixerGroup _sfxAudioMixer;
12     [SerializeField] private AudioMixerGroup _musicAudioMixer;
13     [SerializeField] private AudioMixerGroup _dialogueAudioMixer;
14     [Header("Music")]
15     [SerializeField] [Tooltip("If set to below 0, first music played will be random")] private int _firstMusicIndex = 0;
16     private readonly List<Sound> _bgMusicList = new List<Sound>();
17     private int _currentMusicIndex = 0;
18     [Header("Sounds")]
19     public Sound[] sounds;
20
21 @ Unity Message | 0 references
22 private void Awake()
23 {
24     foreach (Sound s in sounds)
25     {
26         s.source = gameObject.AddComponent<AudioSource>();
27         switch (s.SoundType)
28         {
29             case SoundType.SFX:
30                 s.source.outputAudioMixerGroup = _sfxAudioMixer;
31                 break;
32             case SoundType.Music:
33                 s.source.outputAudioMixerGroup = _musicAudioMixer;
34                 break;
35             case SoundType.Dialogue:
36                 s.source.outputAudioMixerGroup = _dialogueAudioMixer;
37                 break;
38         }
39         s.source.clip = s.clip;
40
41         s.source.volume = s.volume;
42         s.source.pitch = s.pitch;
43         s.source.loop = s.loop;
44
45         if (s.SoundType == SoundType.Music)
46         {
47             _bgMusicList.Add(s);
48         }
49     }
50
51 @ Unity Message | 0 references
52 private void Start()
53 {
54     Invoke(nameof(playFirstSong), 1.0f);
55 }
56
57 1 reference
58 private void playFirstSong()
59 {
60     if (_firstMusicIndex < 0)
61     {
62         _firstMusicIndex = UnityEngine.Random.Range(0, _bgMusicList.Count);
63         _currentMusicIndex = _firstMusicIndex;
64         Play(_bgMusicList[_currentMusicIndex].clip);
65         StartCoroutine(playNextMusic(_bgMusicList[_currentMusicIndex].clip.length));
66     }
67
68 2 references
69 private IEnumerator playNextMusic(float pCurrentMusicLength)
70 {
71     yield return new WaitForSeconds(pCurrentMusicLength);
72
73     _currentMusicIndex++;
74     if (_currentMusicIndex >= _bgMusicList.Count)
75     {
76         _currentMusicIndex = 0;
77     }
78
79     Play(_bgMusicList[_currentMusicIndex].clip);
80     StartCoroutine(playNextMusic(_bgMusicList[_currentMusicIndex].clip.length));
81 }
82
83 7 references
84 public void Play(AudioClip clip)
85 {
86     Sound s = Array.Find(sounds, Sound => Sound.name == clip.name);
87     if (s == null)
88         return;
89     s.source.Play();
90 }
91
92 1 reference
93 public void Play(string pClipName)
94 {
95     Sound s = Array.Find(sounds, Sound => Sound.name == pClipName);
96     if (s == null)
97         return;
98     s.source.Play();
99 }
100 }
```

Figure 17 - Note. Final version of Audio Manager

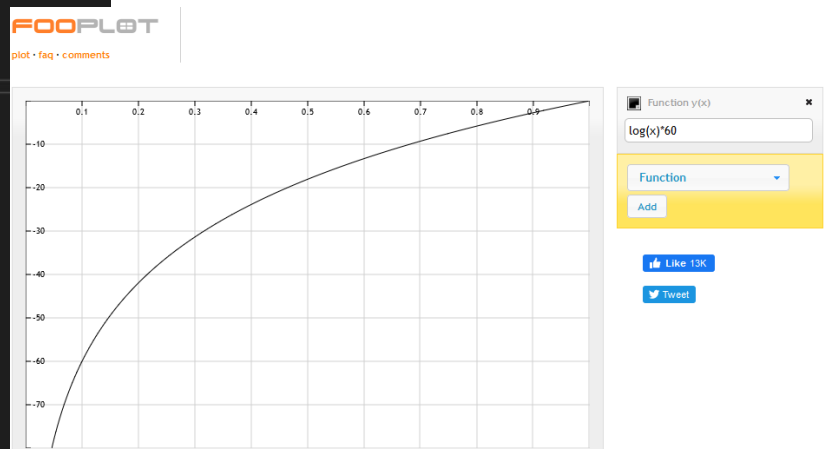


Figure 19 - Note. Calculator used for calculating the curvature the sound will increase decrease with (Venkatraman, 2021)

## 6. CONCLUSION

In this chapter the student will write a conclusion on the research and tests by taking each sub-question and concluding its answer, finally, the main question will be answered. Afterwards, in chapter 7 there will be a discussion on the project research.

### 1. **What types of audio feedback are there in video games?**

- There are multiple opinions on types of audio, with many different names being used. However, based on the research it seems clear they all end up in the same directions. Audio is generally going to be divided into two types in four categories, the types being diegetic and non-diegetic, meaning if a sound is present in the world of the game, or if the sound is an addition for the player that is played from outside the game space. The four categories are, one that establishes the tone of the game world and scene sounds that come from objects and entities that establish the world's reality, Additive sounds such as ambient music and combat music and finally sounds that give the user feedback, such as on the user interface or using an item from a character's inventory.

### 2. **How does audio differentiate from normal applications within AR?**

- Test results on this show that the participants seem to not think there is much difference. However, based on the research shown in chapter 4.1, the student suspects there is more to it than the results have shown by having too little user data with only nine testers as well as the choices of certain sounds have distracted some of the participants. According to the desk research of chapter 4.1 by adding spatial or 3D sounds the user will be able to move around the sound, which would cause the audio to come from different angles. It would also make changes based on the user's position such as pitch and volume, changing the experience.

### 3. **How does audio feedback influence the player experience?**

- The test results show that the sounds are a positive addition to the application, and while certain sounds affect the participants negatively it still shows it has a lot of power to influence the player. Audio can be used to affect the emotion of the players. By sad music during scenes portraying a sad event or giving information to the player in the form of recognisable sounds that are tied to specific items or reward

### 4. **What tools are available to implement audio feedback?**

- The overall conclusion is that for a full product for both indie and bigger companies using middleware for audio is almost a must, budgets are generally not a concern and they save a lot of back and forth between artist and programmer making their own tools. If you must learn a new tool it is generally better to learn the industry standards than make a custom one that only works for your specific niche. While for the prototype implementing the sounds without middleware worked well enough as the number of sounds that needed to be added was limited, in bigger projects, you would end up with more work as you would have less flexibility and control without coding it in first.

***Conclusion on How to implement audio feedback within Augmented Reality (AR) to enhance the player experience of a mobile AR game prototype:***

In conclusion, Sound most definitely has an impact on the user through changing the mood or playing a sound that hints at danger nearby. Because the sounds were poorly chosen and the lack of ability to do A and B (CMMMethods, 2020) testing with a bigger userbase because of the pandemic covid-19 (World Health Organization, 2020). Applications especially games would suffer from not having audio in them. However, it is also important to note that audio can be detrimental if sounds have been poorly chosen and do not fit what they are supposed to represent. Something the research is validating, but the test result does not show well. The other main takeaway is that middleware will almost always be a must. It would save the artist and other parties involved such as programmers a lot of time. Not having to spend time designing and then bug fixing and learning the new program will be the biggest gains. Aspiring audio artists would likely benefit from learning middleware software. It is even expected baseline by bigger companies to be able and work in multiple middleware such as FMOD and Wwise

## 7. DISCUSSION

To reflect on the conclusion the player will go through steps to formulate a discussion.

### Interpretations

The test results might suggest that audio is perceived the same in Augmented Reality and seems to contradict the statements from (UploadVR, 2017). Similar studies show that it is more likely the test is not accurate. It is more plausible that with better sound implementation by choosing better sounds and adding three-dimensional audio to the game would change the test results. Another factor is the small tester base resulting in a skewed end result.

### Implication

The results do not fit the theory that audio is perceived as different in Augmented Reality. The results build on the evidence that sound has a big role in making an application feel complete, as well as gives an insight into the relationship between augmented reality and audio design without using audio middleware. The research focused on audio middleware and the results demonstrate different results with the lack of features that audio middleware would have access too.

### Scope

The results are limited by multiple factors, such as the lack of ability to perform A and B testing (CMDMethods, 2020) amidst a global pandemic, COVID-19. (World Health Organization, 2020) As well as obstructing productivity caused by having to move from the office space to a work from home situation. The reliability of the data is impacted by the low number of testers and implementation methods used. However, the results displayed in this thesis still have purpose and add are valid for answering the research question. It complements the desk research and validates the research question hypothesis allowing the student to reach a conclusion.

### Recommendations

Further research and tests should be done to create a new test on the topic with a more integrated audio system that features three-dimensional sounds and used audio middleware. Later studies should account for more type of tests such as A and B testing (CMDMethods, 2020) and having a bigger test group. It should also take test with two groups, a control group which tests with different parameters such as different type of sounds or no sounds, and a sound group.

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## 9. APPENDIXS

### APPENDIX A – AUDIO ENCODING AND BITRATE

#### Part 1

##### **Format/Codec supported by android.**

*Lossless*: means that the file retains all original data from the recording and is compressed to reduce file size.

*Lossy*: cuts out data from the recording to reduce file size the harsher the compression the more data will be lost, and quality will be degraded, this does however result in a much smaller file size. (Calabrese, 2020)

##### **Potential picks for project**

two lossy formats are picked as potential file sizes for the prototype. These were picked based on their compatibility and small file size. As the extent of audio is limited to small audio feedback upon button presses or moving a pawn, size is a bigger vector than quality of the audio.

*mp3*: The most popular lossy file size, it compresses audio aggressively and cuts out data that is outside of normal human hearing range. Hard to hear frequencies are also degraded in quality.

*aac*: Developed to be the successor of mp3. It has better compression ratio than mp3 meaning it has better audio quality at the same bitrates while having similar small file sizes.

*Wav*: lossless used for unity sound effects.

##### **MP3 vs AAC VS WaV**

**Quality**: At lower bit rates (below 128 Kbps) AAC performs better on quality as it has a higher sample frequency range than MP3 (AAC: 8 kHz to 96 kHz vs MP3: 16 kHz to 48 kHz). (Bitton, 2020)

**File size**: Lowering file size by reducing bitrate gives AAC an edge over MP3 as it can retain quality better than MP3. Generally this means that AAC will have smaller file sizes while when compared to the same quality of MP3.

**Conclusion**: for music: AAC is the better choice as it retains quality better at lower bitrates meaning the file size will be lower than MP3. See Tables and figures below.

For Sound effects, Wav will be used as unity will compress it for build device.

Format / Codec	Encoder	Decoder	Details	Supported File Type(s) / Container Formats
<b>AAC LC</b>	•	•	Support for mono/stereo/5.0/5.1 content with standard sampling rates from 8 to 48 kHz.	<ul style="list-style-type: none"> <li>• 3GPP (.3gp)</li> <li>• MPEG-4 (.mp4, .m4a)</li> <li>• ADTS raw AAC (.aac, decode in Android 3.1+, encode in Android 4.0+, ADIF not supported)</li> <li>• MPEG-TS (.ts, not seekable, Android 3.0+)</li> </ul>
<b>HE-AACv1 (AAC+)</b>	• (Android 4.1+)	•		
<b>HE-AACv2 (enhanced AAC+)</b>		•		
<b>xHE-AAC</b>		• (Android 9+)	Support for up to 8ch content with standard sampling rates from 8 to 48 kHz	<ul style="list-style-type: none"> <li>• 3GPP (.3gp)</li> <li>• AMR (.amr)</li> </ul>
<b>AAC ELD (enhanced low delay AAC)</b>	• (Android 4.1+)	• (Android 4.1+)	Support for mono/stereo content with standard sampling rates from 16 to 48 kHz	
<b>--AMR-NB</b>	•	•	4.75 to 12.2 kbps sampled @ 8kHz	
<b>AMR-WB</b>	•	•	9 rates from 6.60 kbit/s to 23.85 kbit/s sampled @ 16kHz	<ul style="list-style-type: none"> <li>• FLAC (.flac)</li> <li>• MPEG-4 (.mp4, .m4a, Android 10+)</li> </ul>
<b>FLAC</b>	• (Android 4.1+)	• (Android 3.1+)	Mono/Stereo (no multichannel). Sample rates up to 48 kHz (but up to 44.1 kHz is recommended on devices with 44.1 kHz output, as the 48 to 44.1 kHz downsampler does not include a low-pass filter). 16-bit recommended; no dither applied for 24-bit.	
<b>MIDI</b>		•	MIDI Type 0 and 1. DLS Version 1 and 2. XMF and Mobile XMF. Support for ringtone formats RTTTL/RTX, OTA, and iMelody	
<b>MP3</b>		•	Mono/Stereo 8-320Kbps constant (CBR) or variable bit-rate (VBR)	<ul style="list-style-type: none"> <li>• MP3 (.mp3)</li> <li>• MPEG-4 (.mp4, .m4a, Android 10+)</li> <li>• Matroska (.mkv, Android 10+)</li> </ul>
<b>Opus</b>		• (Android 5.0+)		<ul style="list-style-type: none"> <li>• Ogg (.ogg)</li> <li>• Matroska (.mkv)</li> </ul>
<b>PCM/WAVE</b>	• (Android 4.1+)	•	8- and 16-bit linear PCM (rates up to limit of hardware). Sampling rates for raw PCM recordings at 8000, 16000 and 44100 Hz.	WAVE (.wav)
<b>Vorbis</b>		•		<ul style="list-style-type: none"> <li>• Ogg (.ogg)</li> <li>• Matroska (.mkv, Android 4.0+)</li> <li>• MPEG-4 (.mp4, .m4a, Android 10+)</li> </ul>

Table 1 – *note*. Table listing available codec including details for android devices - (Android Developers, 2020)

## File size and Bitrate

Bit rate is the maximum allowed file size for each frame of an audio file.

Stereo file sizes (16-bit 44.1kHz)	WAV	AIFF	FLAC (typical)	MP3 (320Kbps)	MP3 (192Kbps)
1 min	10.6 MB	10.6 MB	6.4 MB	2.4 MB	1.4 MB
4 mins	41.6 MB	41.6 MB	24.9 MB	9.6 MB	5.6 MB
1 hour	635 MB	635 MB	381 MB	144 MB	84 MB

Table 2 – *note*. Table listing a comparison between file sizes between codec using a time scale - (Triggs, 2016)

Sample time	(original) flac 44.1kHz	AAC 44.1kHz 192 kbps	MP3 44.1kHz 192 kbps
39 Seconds	7.81 MB	738 KB	936 KB

Table 3 – *note*. Personal test comparing .aac and .mp3 (free Sample: Blue Monday FM – Bee Moved <https://helpguide.sony.net/high-res/sample1/v1/en/index.html> )

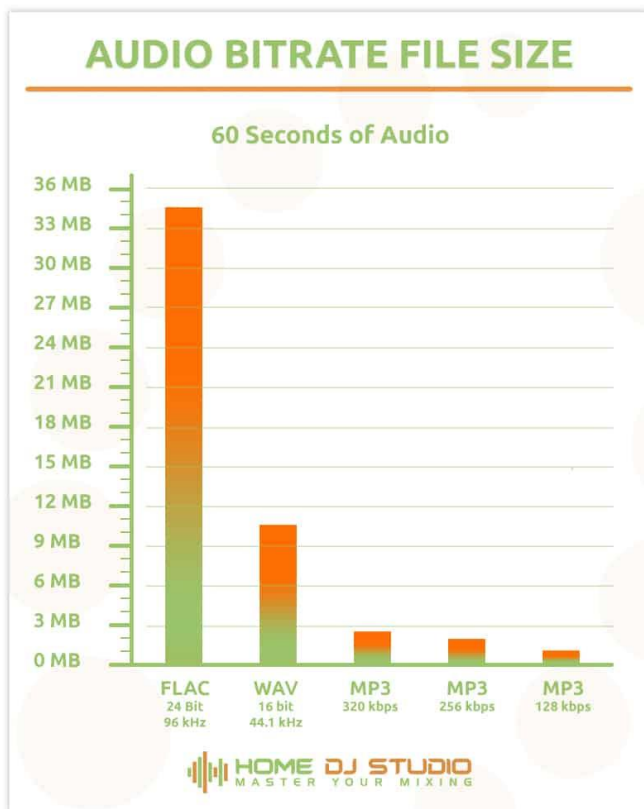


Figure 1 – *note*. A graph comparing file sizes - (Calabrese, 2020)

## Conclusion

Since the prototype is a game made with the unity engine it will be using wav files as unity itself will compress the files. (Unity Technologies, 2020)

## Naming Confection

### Music

File format: aac

Bitrate: 128 Kbps

Samplerate: 44.1kHz

Name\_Group\_Samplerate\_Bitrate

### Soundeffects

Fileformat: wav

Name\_Group

### Audio tools

Audacity

Ableton

FL Studio

Fmod

<https://www.audacityteam.org/>

## APPENDIX B – GAME DESIGN DOCUMENT

---

### SUMMARY AND GENERAL GUIDELINES

This Augmented Reality (AR) project is based around tabletop board games with a serious gaming twist. The gameplay needs to be simple to play (low skill floor) and engaging to invoke a sense of curiosity among a young audience within a school setting.

---

### FOCUS AND GOAL OF THE GAME

Should take about 10 to 15 minutes to complete one game.

its 2 to 4 players within the age range of 12-16.

The goal is to make people have fun while getting to know about Kronenkamp park in Neede through branding and fun facts about History, biology & geography.

---

### START AND WIN CONDITIONS

---

### JOINING A GAME

To join a game, you need to make your own lobby, which will give you a generated password (Six non case sensitive letters). This password can then be shared with other players to join your lobby. Once there is at least one other person in the lobby the start button will become available and you can start the game, the host\* can start the game once everyone in the lobby has pressed the ready button.

Or

You can join a lobby with a given password.

A single round of the game can be played by a maximum of four players, and a minimum of one (but a message should appear once you try to play solo that it is possible to play alone, however, it is recommended with at least 2 players.)

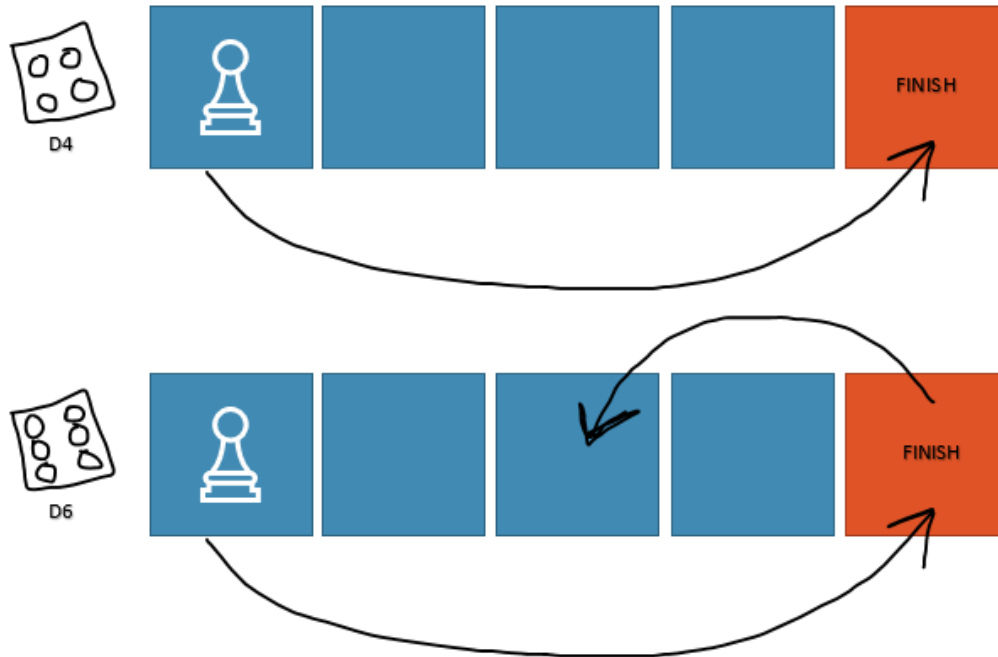
\*(The host is the player that created the lobby. Should the host disconnect the person who joined first to become the next host.)

---

## WINNING

The game ends when a player lands on the last tile. That player will be in first place, the other players will get second and third place based on whoever is the runner up.

To get to the last tile the player must throw the exact number of eyes. If the player needs 3 more tiles to land on the last tile but throws 5 eyes, the player will move 3 forward then 2 backwards. (see example picture below, pg.3)



---

## EXAMPLE GAMEPLAY

The boardgame is a sprint racing game where 4 players compete against each other to be the first to reach the end. Players use Dice to move their pawns along a grid patterned path, one eye on the dice is equal to one step forward on the board. The game is played with a single D6 dice.

---

## TURN BASED

The game is turn based, meaning, you have times where you must wait for the opponent to make a move. While this is inherently boring for that player, there will be things for the other player to look at while waiting for their turn, and there might still be effects or unique tiles that will affect all the players including the players that are waiting for their turn.

\*Players that are waiting will be able to see the Dice rolls and pawn movements of the other players. They can also click on the tiles to read their trivia and flavour text

---

## NORMAL TILES

Normal tiles do not have any effects. They serve as the general racetrack of the game. These tiles are shown in Yellow. These tiles can contain trivia and flavour text.

---

## EXAMPLE EFFECT TILES

Effect tiles are tiles that have a special interaction but are not unique to a single tile. The effect this tile gives is randomized upon landing on it. These tiles are shown in Lime green and have a question mark in them. The player will then get a random effect from the table below. Once an effect is used, it will be shuffled back into the bottom of the list of effects, so it will not appear again within a short amount of time.

Name	Description	Gameplay effect
Bat quiz	Random bat related Multiple-choice quiz question	If answered correctly, use bat flight to fly 2 steps forward. If wrong nothing happens.
Water treatment Quiz	Random water treatment related Multiple-choice quiz question	If answered correctly, throw the Dice again, if wrong, nothing happens.
History Quiz	Random history related Multiple-choice quiz question	If answered correctly, move any opponent 2 steps back. If wrong nothing happens.
Key	Gain a key	Keys can be used to open shortcuts, once opened the shortcut will be open for everyone
Re-roll	Roll the dice again	Player can roll dice once more
Switch!	(choice)Choice to switch with another player. Selected randomly	Randomly switch spaces with another player if chosen too.
Alternative Vampirism	Steal progress from another player.	Half of the next players turn dice roll will count for you instead.
Cleansing water	Get an out of jail free card.	Next time a negative effect happens, the negative side of it will be negated for you.
Aim, Steady, Fire!	Move to the History building	You will be moved to a specific tile.

---

## EXAMPLE UNIQUE TILES

Unique tiles have specific positions and will have the same effect every time. These tiles are shown in Orange/red.

Name	Description	Gameplay effect
(Touch)Sphinx Door	Gateway to shortcut	A door that can only be opened with a key, Players get paused at this tile no matter the number of eyes left. If they have a key, they can choose to take the short cut. If not, then they will continue down the normal path.
Information Tile	Tile that gives user answers	Trivia answers to help with the quiz questions
Filled with water	Get stuck in a silo, wait till it fills with water to get out	Skip a turn
Not the Beeeees!	Bees block your path!	Skip the next turn but throw dice twice the turn after, becus power of honey.
Bat cave	Destination	Finish line of the game. Who reaches this first end and wins the game?
Canon of Neede	Tile that gives player a history themed buff	Every other turn, when last in place, move times 3
Canon of Water treatment	Tile that gives player a water treatment themed buff	Every other turn set back a random player by 1
Canon of Bats	Tile that gives player a bat themed buff	Every fourth turn, eyes count double.



---

## EXAMPLE EVENTS

Events are gameplay modifiers that change the rules for all players if it is active.

Name	Description	Gameplay effect
Rainy day	It is raining! Better not to go outside for too long.	Thrown result -1 on every throw
Black Friday discount	Hurry up! before the sale expires!	Thrown result +2 on every throw
Heads or tails	Which do you gamble on?	1, 3, 5 = available 2, 4, 6 = unavailable
Question time!	Answer this question correctly and you get a key!	Key to skip certain tiles
Sudden death	Watch your steps! Don't trip into the grave.	Making the whole game board a trap (adding 30% more death tiles)
Switcheroo	Switch positions of the 4th place to 1st place and 2nd place to 3rd place.	Switching positions of the pawns.

---

## OTHER RULES

Quiz tile:

You will get a prompt that you landed on a question tile. Whenever this happens, a popup appears with a question on the UI. A voiceover questions the player, as the player also can read the question on his phone or through the AR headset, then a timer of 15 seconds ticks down to answer the multiple question. Whenever the player selects a multiple-choice question, the selected question will be then highlighted as the selected question as it will be locked after the 15 seconds timer has passed. Whenever the player answers it correctly, the player will get a boon. If the player answers it wrong, then the player gets a prompt that the player answered it wrong and gets the correct answer highlighted.

---

## GAMEPLAY TESTS

We have tested 4 designs of the game with 4 pawns in the early design stage to see how much time it takes to play a single session of the game. The tested designs contain 40 walking tiles because the original idea was to add around 25 tiles. The time to complete the game with 25 tiles was too fast. The targeted time is around 10 till 20 minutes of gameplay time. Some designs had event tiles that skips a player's turn and some contained multiple dice to see how fast the game would be completed.

Amount Tiles	Dice used	Events	Time required to completed	Additional details
40 tiles	1d6	No events	5 minutes 45 seconds	
40 tiles	1d6	Every 5 tiles a skip event tile is added	8 minutes 25 seconds	Took a long time to finish the game as the pawns were stuck at the end.
40 tiles	2d6	no events	3 minutes 32 seconds	The pawn that finished got lucky in its first try to roll towards the finish.
40 tiles	2d6	Every 5 tiles a skip event tile is added	6 minutes 13 seconds	All the pawns reached early to the end at 3 minutes but got stuck there looping around for another 3 minutes.

---

## CONCLUSION

We are going to focus on the 40 tiles with 1 dice and adding more event tiles when the game is being more fleshed out. The test with two dice was not pleasant to go through as the pawns proceeded too fast through the game. And being stuck for too long at the end of the game.

---

## TUTORIAL

Tutorial will be played first time the game is launched.

---

## MISC INFORMATION

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### HOW TO PLACE BOARD

The board is being placed at the start of the game after all players have readied their status in the lobby. The game will load, and the players will get a prompt to place their board on a flat surface. In this phase the players will see who have placed their board and who still must place their board on the flat surface. After everyone has placed their board on a flat surface, the game will start as the players will have to roll a dice to see who goes first. Whenever there is a tie. The remaining players that have a tie will be randomized into the order of turns to enhance the flow of the game playtime.

---

### HOW TO PLAY GAME

The game will have two modes. A handheld mode and an Aryzon Headset mode. With the handheld mode. Players will experience the game while holding on their phones in landscape mode. They can throw dice by making a swipe motion on the screen. When needed to answer a multiple-choice question there will be popup buttons for the player to press to give an answer.

With the Aryzon Headset mode. Players will be able experience the game in the same way. Except that the game will be controlled by your head with the gaze function. The gaze function is a pointer in the middle of the user's view, as the user can look towards the buttons to do the commands that the game is asking for.

---

### HOW TO WIN

The player that reaches the last tile while also being able to end his/her turn on that tile wins the game. Whenever the player wins the game, every player will receive a popup that a winner has been decided through the rules of the game. They will see who has won the game and will get the score screen who placed where on the rankings.

---

### HOW TO USE AR

The AR will play a role in enhancing the player's user experience. The player scans on a flat surface that the Augmented Reality part will be displayed onto the scanned flat surface.

---

## VISUAL STYLE

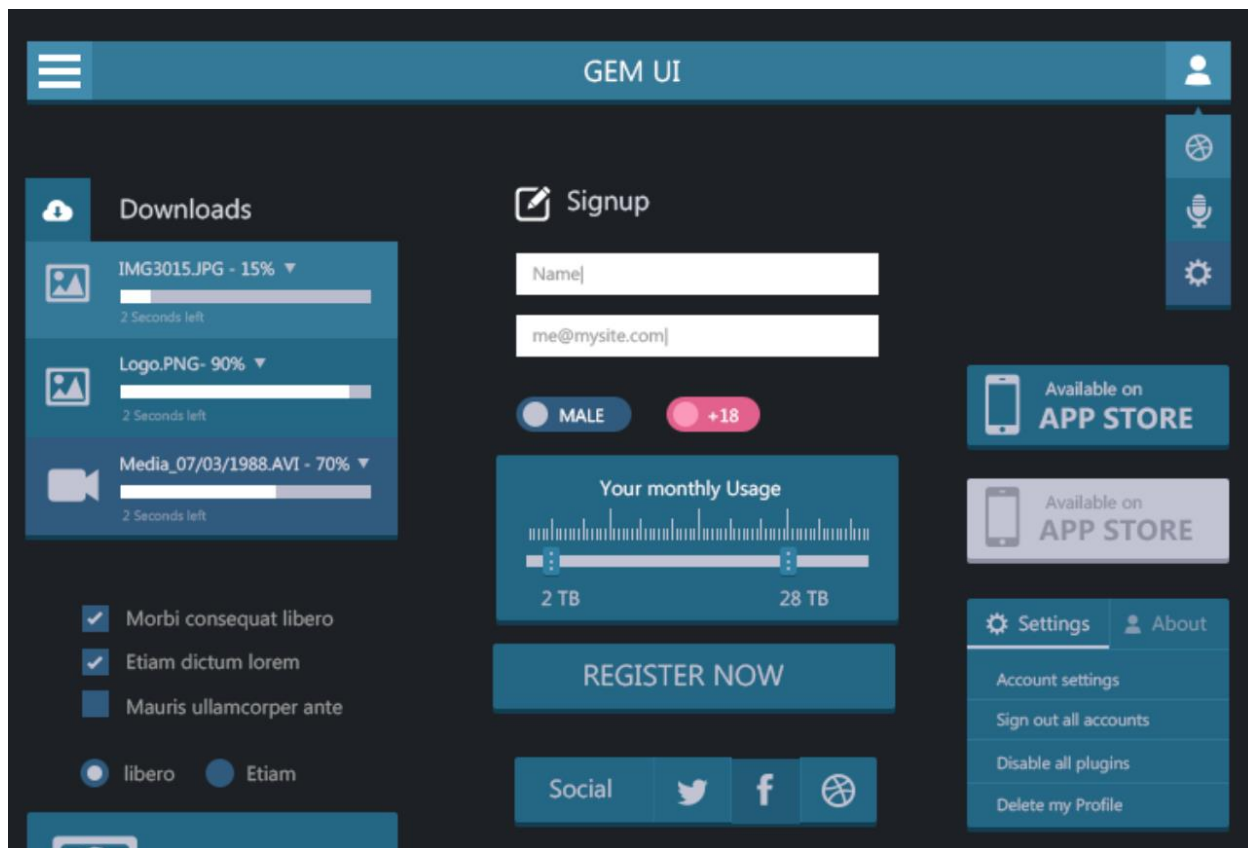
A mix between Gamelab Oost and Natuurpark Kronenkamp, with a low poly style to make it usable across as many devices as possible.

---

## UI

Flat UI style

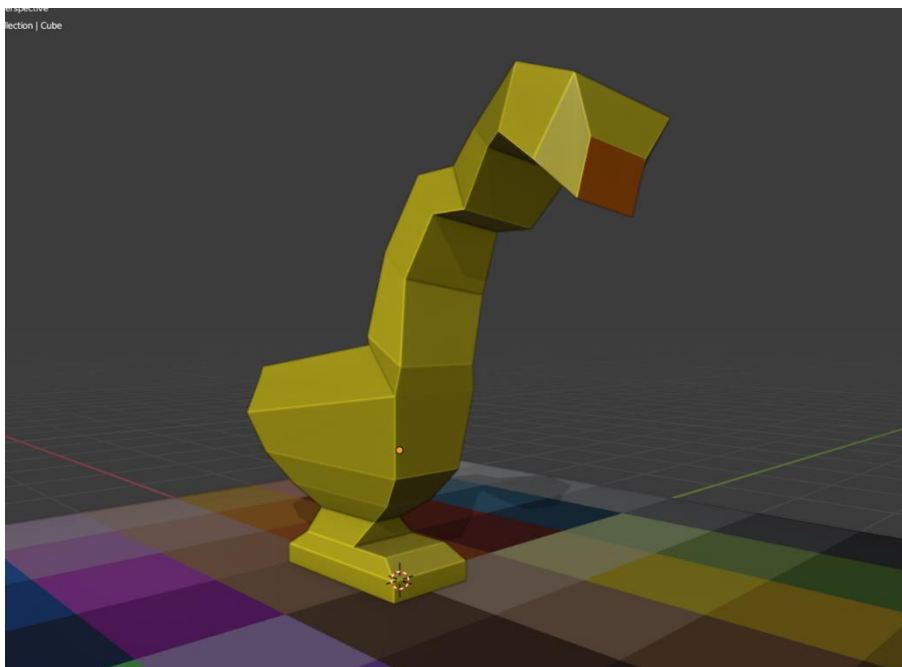
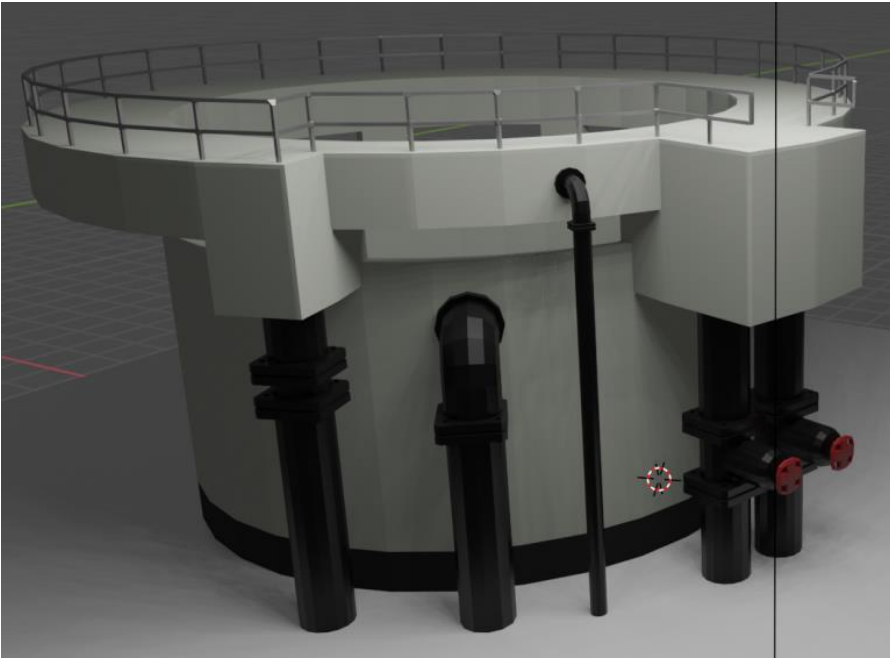
Example:



A

## MODELS

Low poly style



---

## TEXTURES

Shell shading, simple colours with lighting effects.

Example:



## APPENDIX C – TARGET AUDIENCE RESEARCH

We are going to do qualitative research for this project. As we are building a prototype for teenagers, we need to know what their needs, behavior, and views are to make a prototype suited for this target group. We are going to use the focus group method by having an A&B testing session. We will be making a wireframe/paper prototype for the target group as we will be holding a test at their school once we get permission from the school

We are going to divide the groups into different groups of age for the focus group to put them into different categories of age to determine what phones they have, if they know about Augmented Reality and if they have interest in Augmented Reality in their lessons.

<https://communicationmgmt.usc.edu/blog/4-research-methods-for-audience-analysis/>

<https://www.pointvisible.com/blog/complete-guide-target-audience-analysis-content-marketers/>

1. Speel jij video games?

1. Ja

2. Nee

1. Als Ja; Speel je op je telefoon ook wel eens spelletjes?

1. Ja

2. Nee

Weet jij wat Augmented Reality is?

. Ja, Pokemon go en Snapchat zijn ook augmented reality

a. Nee

1. Als nee: Weet jij wat Pokemon Go of Snapchat is?

1. Ja, Pokemon go en Snapchat zijn ook augmented reality.

2. Nee, Augmented reality is als je boven op de echte wereld met je camera iets toevoegt, zoals hoe je op een foto van jezelf een hondensnuit kan zetten.

Heb jij ooit bordspellen gespeeld?

. Ja

a. Nee

1. Als ja; Ken je het spel ganzenbord?

1. Ja

2. Nee

1. Als Ja, Vind je het spel ganzenbord leuk?

1. Ja

2. Nee

Denk jij dat het leuk is om Augmented reality te gaan gebruiken in de les?

. Ja

a. Nee

Heb je een smartphone?

. Ja

a. Nee

.Als Ja; Is jouw smartphone van voor of na 2016?

1. Voor

2. Na

3. Weet ik niet

Is jouw telefoon van het merk Apple?

. Ja

a. Nee

Ken jij de kartonnen doosjes die je voor je ogen zet en een telefoon in doet?

. Ja

a. Nee

## **The general conclusion without test results caused by new corona restrictions.**

### **The general conclusion based on personal observation and conjecture:**

a) phones will be variable as a lot of phones will be hand downs from older siblings / parents

b) Based on website articles the majority of teenagers have iphones, 52% in 2017 opposed to 44 a year earlier. which indicates there is a yearly growth. ([https://www.rtlnieuws.nl/tech/artikel/3915401/iphone-steeds-populairder-onder-nederlandse-jongeren?redirect\\_from=bright](https://www.rtlnieuws.nl/tech/artikel/3915401/iphone-steeds-populairder-onder-nederlandse-jongeren?redirect_from=bright))

c) We have no real way of knowing if teens between 11 and 16 year of age will know what Augmented Reality is or if they know that there is even a difference between Virtual Reality / Augmented Reality. We expect that the teens will not know what Augmented Reality entails.

We are quite sure however that most of the teens will have used Augmented Reality before. through apps like snapchat / instagram / memes / pokemon go / etc.

d) we expect everyone to have played board games before. especially games like monopoly.

Goose Board might be too old a game for them to have played however. but we expect them to know about it.

e) We believe teens will be interested in Augmented Reality within class rooms. especially if they are unaware as to what Augmented Reality is.

f) We think almost everyone will have an smartphone

We also think most of the android phone users will have at least android 7.0 and up.

g) We believe that people have at least seen phones housed in cardboard head mounted devices before. but they will likely think that was a Virtual Reality thing.

h) Of course kids play video games. come on...

### **CONCLUSION:**

We believe they have phones, it is likely there is at least a 50/50 split between android and IOS, however, we will only focus on android as IOS is not something we are interested in working with, especially since our product is going to be a prototype only.

IOS is hard to test the application, because of security reasons. The application takes up months through the security checks before it is applied into the app store.

We will assume people have used and are familiar with Augmented Reality, but not necessarily by name.

They will have played board games and video games before and know the basics of throwing dice and moving pieces.

We think they know the cardboard system for VR/AR but they will likely have never interacted with it. We do think with the cardboard system there will be a stimulant that makes it more interesting to interact with the game.

teacher primary target audience.



see if the aryzon is gonna be a flaw into the project.

make the game that it is required for you to go to the park.

- Talk about Nico & situation & that we talked him up to speed.
- Talk about we having a good convo with Niels
  - Research
  - Target group > not children 12+ but teachers as first target group. 2nd target group is children < (Ask natuurpark kronenkamp)
  - Our idea that was lacking a addon
  - If Aryzon was not going to be holding us back
- Talk about the flowchart.
  - We make a small part of the board game as an introduction tool. Which is a classroom app that contains elements of information about the park.
  - Teachers > The things that they can ask or test the children with biology/history lessons
  - The children will play the game in their lesson to gather knowledge of the map & awareness of Kronenkamp to at least know the layout. (recognition of the park)
  - The teachers/school can organize a excursion with the children to the park
  - At the excursion the children can use the application again to scan the QR codes around the park and get more information about bats or history of the park. & AR HEADSET only for game loop you can look up close the bats (autonomy) or history of the park.
  - After all this, the children will get knowledge and hopefully spread a positive light to their parents as their parents can consider coming to the park. Also if the kids really liked it, and haven't collected all the AR codes that they are allowed to come back again.
  - With this we create awareness in the long run for this nature park.
  - With this we create a way for more people to play this game.
- Decision making.
  - Follow A: Which is keeping the current idea and work on the board game first.
  - Follow B: AR addon first and make a small version of the board game.
- Need schools to participate in a field research (Teachers) > Contact schools

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### COMPETITION RESEARCH BY JORDY SCHOLTENBERG

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#### POKÉMON GO

Pokémon Go is a mobile game where the goal is to catch and collect as many pokémon as you can. The game uses Google Maps to create the overview of where the player is located. On this map PokéStops and Gyms are placed so the player can collect resources and battle in Gyms. These PokéStops and Gyms are located near important locations like churches, statues, tourist attractions etc. Close to the player, pokémon will spawn on random locations within a certain radius. This means if the player wants to collect more pokémon they would have to walk around in real life. The player can tap a pokémon they wish to catch. They will then reach a scene where the screen uses the back camera. Somewhere in this view the pokémon is located and the player has to hit it with pokéballs in order to catch it. A lot of people play this game but don't know that the scene where you catch the pokémon with your camera is actually using Augmented Reality.

---

#### STRENGTHS:

Pokémon Go was the first released game with Augmented Reality functionality. This in combination with everybody knowing Pokémon already from their youth, attracted a lot of people into trying out the game.

This game makes people walk around in real life, this means people will have more motivation to go outside for walks and play the game in the meantime. This was also one of the goals of the developers, to make it so that gaming can be healthy and fun at the same time.

---

#### WEAKNESSES:

There is little to no battle scenery in Pokémon Go. When playing Pokémon, people are used to battling random in game trainers constantly to train their pokémon. Now this can only be done by fighting in Battle Leagues and in Gyms.

Most of the players turn off the Augmented Reality option so that the game won't use the back camera but its own scene to catch the pokémon. This is more convenient and faster. With the Augmented Reality feature the user has to look around with their phone in order to catch the pokémon, in public places people might find this a burden. When disabling the AR function, the pokémon will just be centered in the games scene and easier to catch.

---

#### ORACLES CIVIL WAR BOARD GAME KICKSTARTER

Oracles Game is a 2-to-10 players team-oriented combat strategy game that combines the use of augmented reality (AR) with conventional elements to deliver a game that is immersive, convenient and easy to play.

The game is designed to be played with the exclusive AR mobile application as a co-operative board game. With the help of a leader using the AR application, the main objective of the game is to occupy the enemy's tavern while encountering mystery chests and mystic creatures on the journey.

The hybrid game has three different play modes:

- **Oracles Play Mode:** Only the leaders of the two teams have access to the AR and are guiding their team members.
- **Full AR Mode:** In this mode, all players have access to the AR application via invitation from the game owner and the help of either smartphones, VR glasses or AR projected onto a wide screen.
- **Non-AR Mode:** The game is played as a regular conventional board game without the aid of the AR application

Sadly the kickstarter raised only € 2741 out of their € 190,757 goal (Oracles Game. 2019, March 5).

---

#### STRENGTHS:

Good 3D models, sounds and animations.

The layout looks really good, you can see they have put a lot of time into it.  
Would be really appealing for a target group that enjoys games like Dungeons & Dragons.

---

#### WEAKNESSES:

The target group is too small.

All the 3D models, animations and layouts make it so that the user will need a high end smartphone to be able to play the game without any stuttering.

The player will need to hold a smartphone in his hand continuously to be able to see all the AR features. This might be a burden when trying to roll the big amount of dice the player has to roll which goes up to 12.

---

#### TILT FIVE

Tilt Five is a whole new way to play games, in Augmented Reality (AR), with freaking holograms(Tilt Five. 2020, August 26)!

When you slip on the Tilt Five glasses and look at the game board, a vibrant 3D world opens up to you. Suddenly chasms seem to drop infinitely into your table, and game characters and monsters spring up from the game board. This is gaming unlike anything you've experienced before (Tilt Five. 2020, August 26).

Out of the box you'll have access to free games as well as thousands of officially licensed RPG adventures, and a multitude of classic tabletop, action video, puzzle, and party games (Tilt Five. 2020, August 26).

***"When we started designing the Tilt Five system our focus wasn't on the technology for technology's sake. We wanted to provide an amazing gaming experience that blends the things you love about video games and board games. And we wanted it to be just as fun when playing solo, together with your friends, or even when you're apart."*** Jeri Ellsworth, Co-Founder & CEO of Tilt Five.

The kickstarter raised \$2,293,496 out of the \$450,000 goal.

---

#### STRENGTHS:

Lightweight and comfortable

Playable solo, in a group and in a group that is apart.

Multiple free games provided, also an option to buy more games.

Affordable for most consumers.

Implemented hand gestures.

---

#### WEAKNESSES:

Some younger consumers might not be able to afford the \$300 price tag

You need to wear glasses while playing a game

You need a computer to plug in the board

---

#### HOLENS

HoloLens 2 offers the most comfortable and immersive mixed reality experience available, with industry-leading solutions that deliver value in minutes, all enhanced by the reliability, security, and scalability of cloud and AI services from Microsoft (Microsoft. n.d.).

---

#### IMMERSIVE

See more holograms at once through the greatly increased field of view. Read text and see intricate details on 3D images more easily and comfortably with industry-leading resolution (Microsoft. n.d.).

---

## ERGONOMIC

Wear HoloLens 2 longer and more comfortably with a dial-in fit system designed for extended use. And keep your glasses on—the headset slides right over them. When it's time to switch tasks, flip the visor up to step out of mixed reality (Microsoft. n.d.).

---

## INSTINCTUAL

Touch, grasp, and move holograms in ways that feel natural—they respond a lot like real objects. Log in to HoloLens 2 instantly and securely using just your eyes with Windows Hello. And voice commands work even in noisy industrial environments through smart microphones and natural language speech processing (Microsoft. n.d.).

---

## UNTETHERED

Move freely, with no wires or external packs to get in your way. The HoloLens 2 headset is a self-contained computer with Wi-Fi connectivity, which means that everything you need goes with you while you work (Microsoft. n.d.).

---

## STRENGTHS:

State of the art technology.

Implemented hand gestures.

Will be able to handle high quality apps.

Made by Microsoft, so already a lot of people will hear about the HoloLens by default.

The HoloLens 2 headset is a self-contained computer with Wi-Fi connectivity.

---

## WEAKNESSES:

Extremely expensive.

Need to wear glasses to be able to play.

Not built for gaming.

---

## CONCLUSION

After doing research it became clear that there are not many Augmented Reality tabletop projects that are not using some kind of AR glasses, Oracles Civil War was an exception and this barely got funded on Kickstarter.

This might either mean that investors see no future in tabletop gaming through the phone's camera or that there is a loophole still to be found. This could mean that working together with Aryzon might be the way to go.

Most projects that have the basic consumer as a target group, try to focus on keeping their product cheap and lightweight. This is something to keep in mind when designing our product as well. Luckily this is what Aryzon has been focussing on as well and are doing a great job doing so, the Aryzon glasses only cost €30,- and are very lightweight and supposedly comfortable.

If a project would be focussed on medical or scientific purposes, it would not be a problem to use more state of the art technology which is more expensive but has way better performance.

If the end product would need the consumer to purchase AR glasses, they would have to offer the buyer a game platform with multiple free to play and in-app purchasable games to play. The consumer will not spend money on glasses that are only usable on one serious game.

---

## REFERENCES

Microsoft. (n.d.). *HoloLens 2—Overview, Features, and Specs | Microsoft HoloLens*. Retrieved September 30, 2020, from <https://www.microsoft.com/en-us/hololens/hardware>

Oracles Game. (2019, March 5). *Oracles Game Inc. | Hybrid Augmented Reality Board Game*. Kickstarter. <https://www.kickstarter.com/projects/seantoussi/oracles-game-inc-hybrid-augmented-reality-board-ga?fbclid=IwAR1RV7t3VYVTCHObffuonf78GbJNZVhU-6xZCsssE1vGun2oKMJ6xi6JmEM>

Tilt Five. (2020, August 26). *Tilt Five: Holographic Tabletop Gaming*. Kickstarter. <https://www.kickstarter.com/projects/tiltfive/holographic-tabletop-gaming>

# Default Report

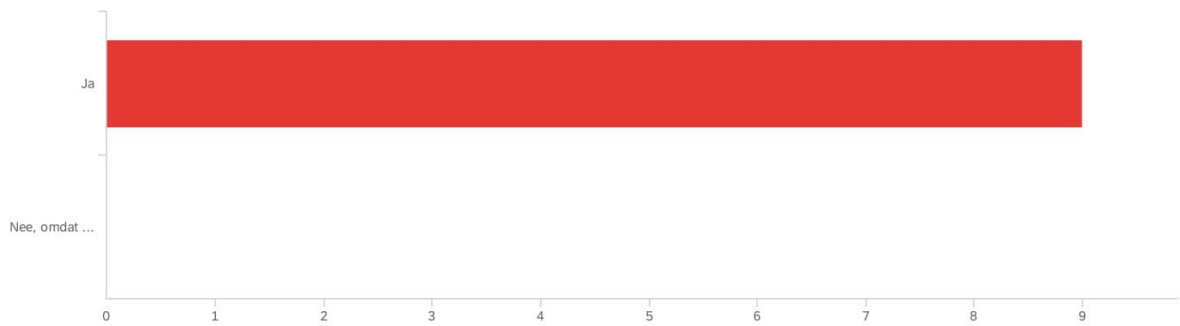
Augmented Reality Project - Prototype Testing  
January 6, 2021 1:09 PM MST

## Q1 - Wat is uw leeftijd?



Q2 - Ziet de stijl van het menu tot het creëren van een lobby in het prototype geheel

eruit?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Ziet de stijl van het menu tot het creëren van een lobby in het prototype geheel eruit? - Selected Choice	1.00	1.00	1.00	0.00	0.00	9

#	Field	Choice Count
1	Ja	100.00% 9
2	Nee, omdat ...	0.00% 0

9

Showing rows 1 - 3 of 3

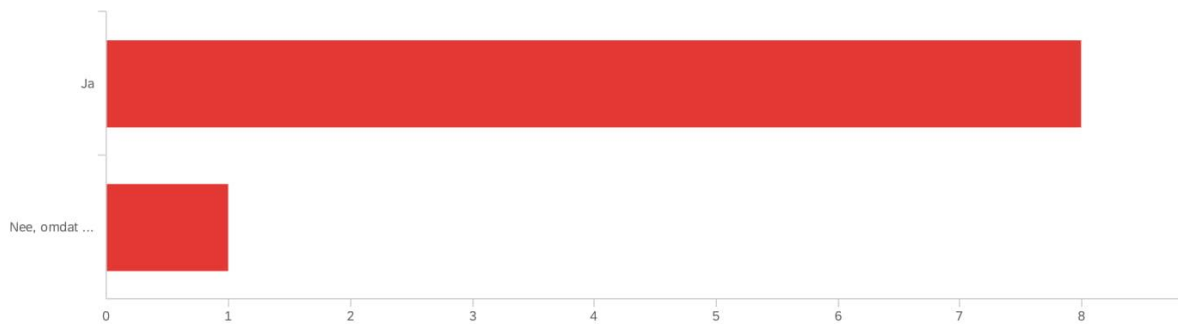
Q2\_2\_TEXT - Nee, omdat ...

Nee, omdat ...



Q3 - Het prototype gebruikt een kleurencombinatie van twee stichtingen. Maakt deze

kleuren het prototype geheel?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Het prototype gebruikt een kleurencombinatie van twee stichtingen. Maakt deze kleuren het prototype geheel? - Selected Choice	1.00	2.00	1.11	0.31	0.10	9

#	Field	Choice Count
1	Ja	88.89% 8
2	Nee, omdat ...	11.11% 1

9

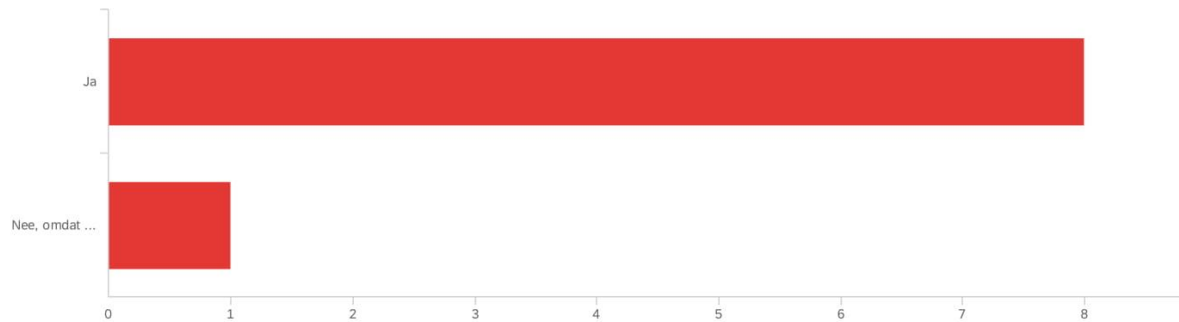
Showing rows 1 - 3 of 3

Q3\_2\_TEXT - Nee, omdat ...

Nee, omdat ...

Overall its complete, however I think it misses a bit of personality and looks flat

Q4 - Het prototype bevat veel interactie knoppen. Zijn deze helder in kleur, grootte en gebruik?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Het prototype bevat veel interactie knoppen. Zijn deze helder in kleur, grootte en gebruik? - Selected Choice	1.00	2.00	1.11	0.31	0.10	9

#	Field	Choice Count
1	Ja	88.89% 8
2	Nee, omdat ...	11.11% 1
		9

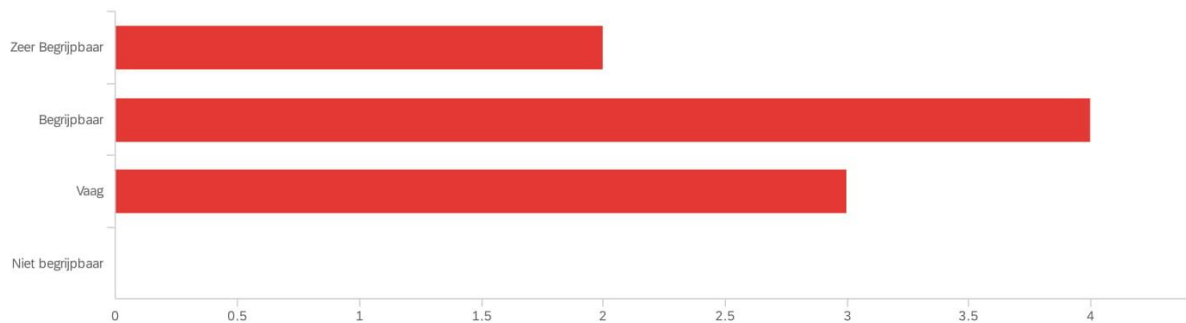
Showing rows 1 - 3 of 3

Q4\_2\_TEXT - Nee, omdat ...

Nee, omdat ...

The Dice button is too far in the corner. De return to home button doesn't work.

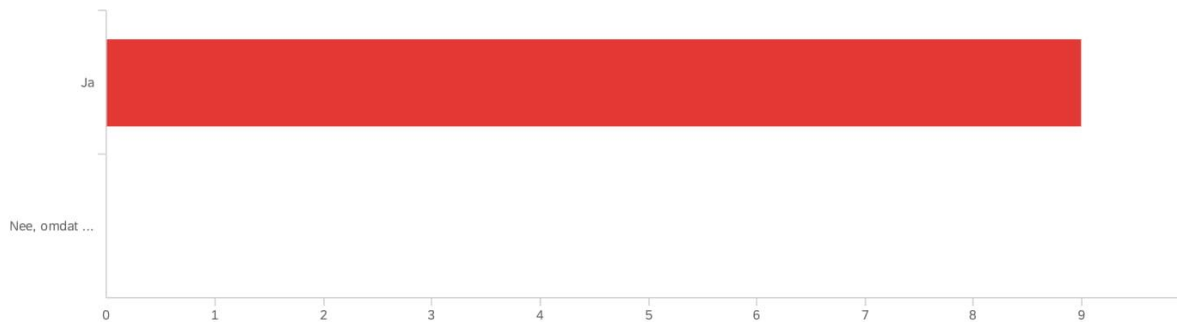
Q5 - In het prototype wordt Augmented Reality (AR) gebruikt om het spelbord neer te plaatsen om daarna het spel te kunnen starten. Is de gameplay (spel in Augmented Reality) begrijpbaar zonder een tutorial?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	In het prototype wordt Augmented Reality (AR) gebruikt om het spelbord neer te plaatsen om daarna het spel te kunnen starten. Is de gameplay (spel in Augmented Reality) begrijpbaar zonder een tutorial?	1.00	3.00	2.11	0.74	0.54	9

#	Field	Choice Count
1	Zeet Begrijpbaar	22.22% 2
2	Begrijpbaar	44.44% 4
3	Vaag	33.33% 3
4	Niet begrijpbaar	0.00% 0

Q6 - In het prototype bevat veel User Interface (UI) elementen. (zoals knoppen, tekst popups en meer.) Zijn deze UI elementen makkelijk te begrijpen?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	In het prototype bevat veel User Interface (UI) elementen. (zoals knoppen, tekst popups en meer.) Zijn deze UI elementen makkelijk te begrijpen? - Selected Choice	1.00	1.00	1.00	0.00	0.00	9

#	Field	Choice Count
1	Ja	100.00% 9
2	Nee, omdat ...	0.00% 0

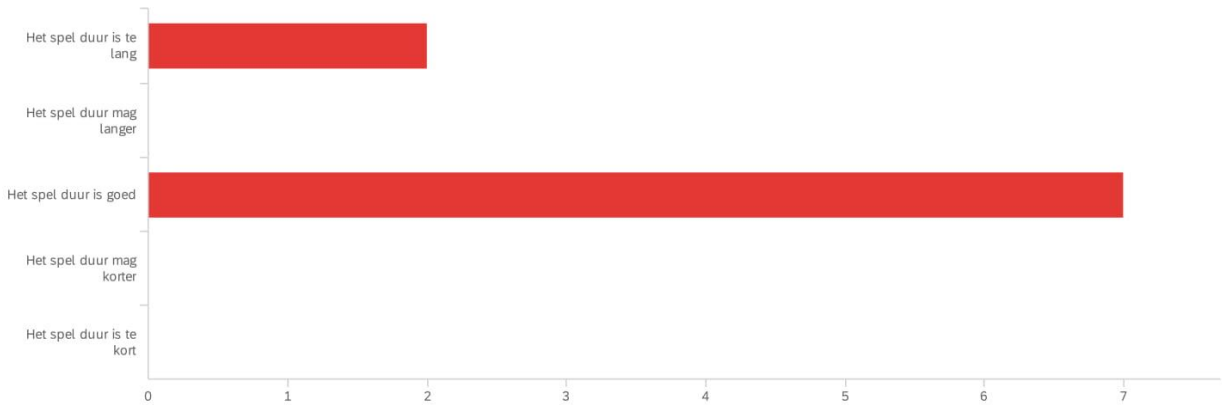
9

Showing rows 1 - 3 of 3

Q6\_2\_TEXT - Nee, omdat ...

Nee, omdat ...
----------------

Q7 - Het prototype heeft bij het testen gemiddeld ongeveer een spel duur van 15 tot 20 minuten. Wat vond je van het spel duur bij het actueel spelen.

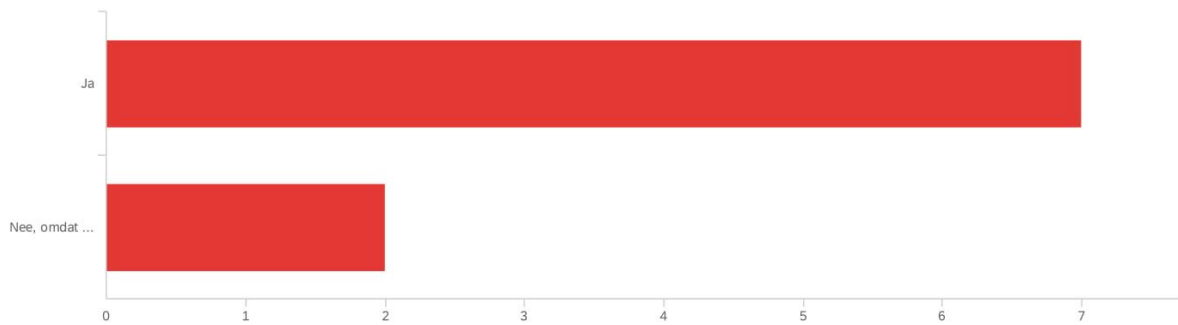


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Het prototype heeft bij het testen gemiddeld ongeveer een spel duur van 15 tot 20 minuten. Wat vond je van het spel duur bij het actueel spelen.	1.00	3.00	2.56	0.83	0.69	9

#	Field	Choice Count
1	Het spel duur is te lang	22.22% 2
2	Het spel duur mag langer	0.00% 0
3	Het spel duur is goed	77.78% 7
4	Het spel duur mag korter	0.00% 0
5	Het spel duur is te kort	0.00% 0
		9

Showing rows 1 - 6 of 6

Q8 - Het prototype heeft gameplay elementen. (zoals quiz tegels waarbij je een vraag moet beantwoorden of bij het staan van positieve of negatieve tegels waarbij je karakter twee tegels naar voren of naar achteren loopt.) Zijn deze visuele elementen begrijpbaar?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Het prototype heeft gameplay elementen. (zoals quiz tegels waarbij je een vraag moet beantwoorden of bij het staan van positieve of negatieve tegels waarbij je karakter twee tegels naar voren of naar achteren loopt.) Zijn deze visuele elementen begrijpbaar? - Selected Choice	1.00	2.00	1.22	0.42	0.17	9

#	Field	Choice Count
1	Ja	77.78% 7
2	Nee, omdat ...	22.22% 2

9

Showing rows 1 - 3 of 3

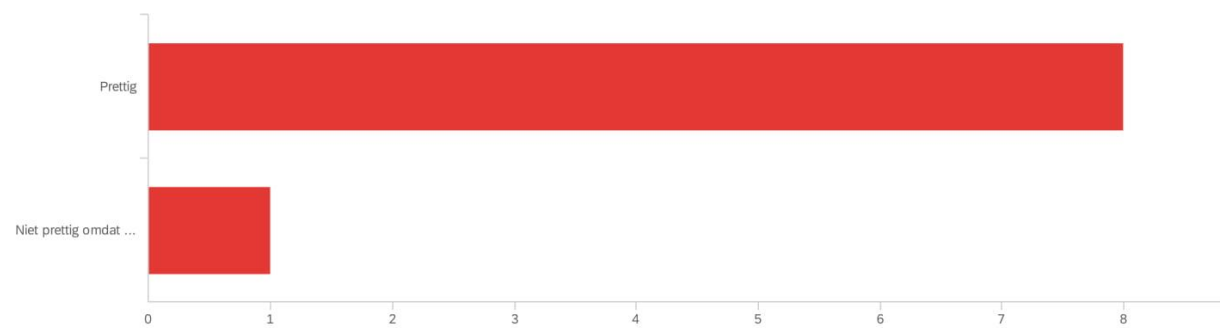
Q8\_2\_TEXT - Nee, omdat ...

Nee, omdat ...

De standaard tegels mengen te veel met de ondergrond ten opzichte van de speciale tegels.

quiz should be 2d UI as on phone in 3d space it gets hard to read.

Q9 - Was de Augmented Reality ervaring van het spel prettig? (zonder de uitkomst van het spel mee te rekenen)



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
---	-------	---------	---------	------	---------------	----------	-------

1	Was de Augmented Reality ervaring van het spel prettig? (zonder de uitkomst van het spel mee te rekenen) - Selected Choice	1.00	2.00	1.11	0.31	0.10	9
---	--	------	------	------	------	------	---

#	Field	Choice Count
---	-------	--------------

1	Prettig	88.89% 8
2	Niet prettig omdat ...	11.11% 1

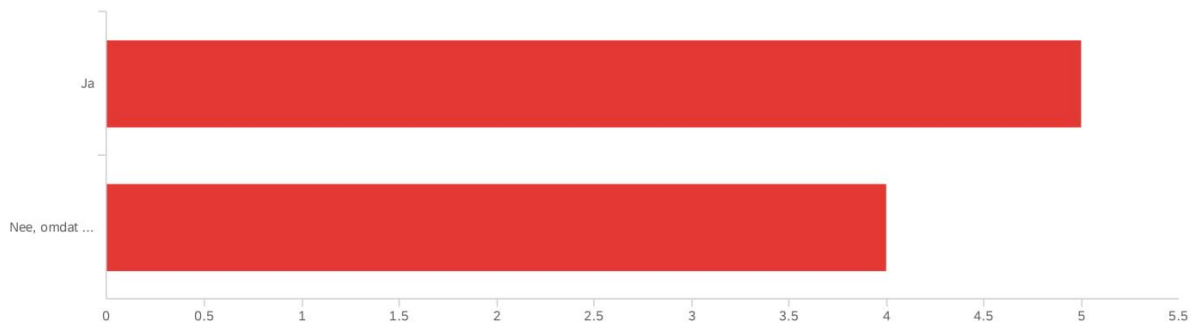
9

Showing rows 1 - 3 of 3

Q9\_2\_TEXT - Niet prettig omdat ...

Niet prettig omdat ...
By moving the phone the bord sometimes moves as well. There is no way of replacing the bord if this happens

Q10 - Augmented Reality (AR) is de technologie die wij gebruiken hebben om het spelbord boven op de realiteit te plaatsen. Is de AR functionaliteit een belangrijke toevoeging voor de immersie van het prototype?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Augmented Reality (AR) is de technologie die wij gebruiken hebben om het spelbord boven op de realiteit te plaatsen. Is de AR functionaliteit een belangrijke toevoeging voor de immersie van het prototype? - Selected Choice	1.00	2.00	1.44	0.50	0.25	9

#	Field	Choice Count
1	Ja	55.56% 5
2	Nee, omdat ...	44.44% 4
		9

Showing rows 1 - 3 of 3

Q10\_2\_TEXT - Nee, omdat ...

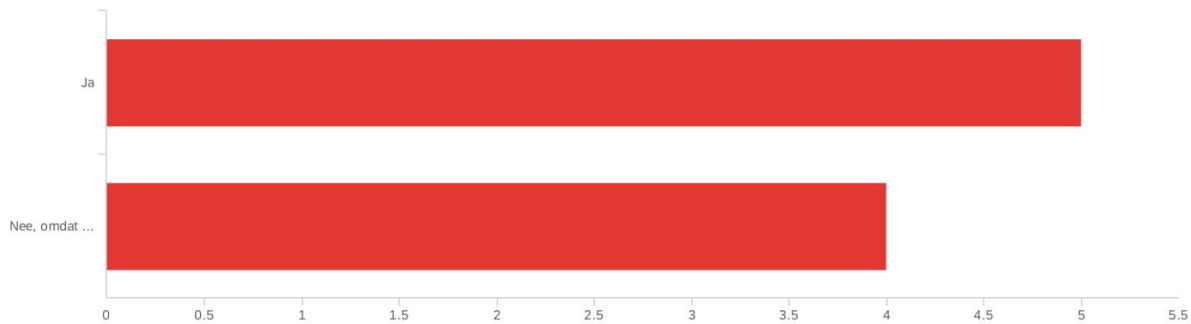
Nee, omdat ...
Ja en nee, het is leuk dat het AR is doordat het net is alsof je een echt bordspel speelt, maar tegelijkertijd heeft het geen toegevoegde waarde
It is only a visal gimmic, fun for one or 2 times, a hassle for more then that.
Without any gameplay effecting AR features all AR adds is a new visual way of playing a board game.



Nee, omdat ...

Niet genoeg

Q11 - Is de Augmented Reality functionaliteit stabiel genoeg zodat dit de gameplay niet verhindert?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Is de Augmented Reality functionaliteit stabiel genoeg zodat dit de gameplay niet verhindert? - Selected Choice	1.00	2.00	1.44	0.50	0.25	9

#	Field	Choice Count
1	Ja	55.56% 5
2	Nee, omdat ...	44.44% 4

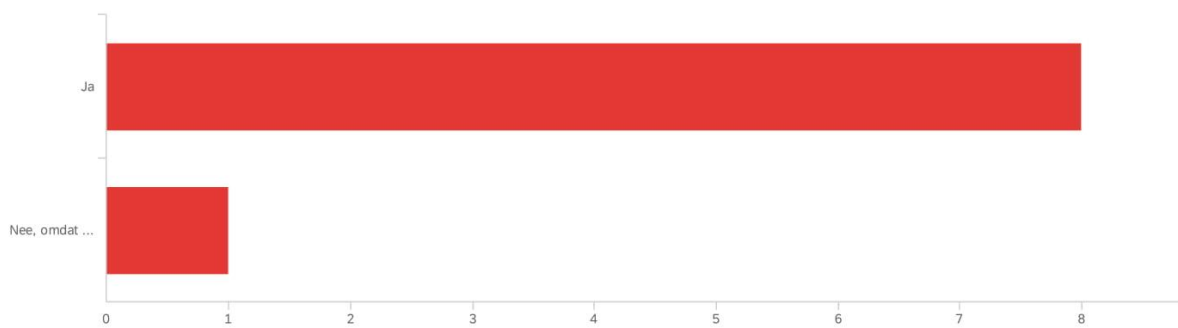
9

Showing rows 1 - 3 of 3

Q11\_2\_TEXT - Nee, omdat ...

Nee, omdat ...
Niet kunnen testen.
quite unstable.
The bord sometimes moves when moving the phone
niet ervaren

Q12 - Het spel heeft nu het thema Natuurpark Kronenkamp, de stijl, vragen en informatie gaat daarom ook hierover. Het zou zo kunnen zijn dat dit jou niet aanspreekt. Stel het spel heeft een onderwerp wat jou wél aanspreekt, is de opbouw van het spel een leuke en goede oplossing om op een educatieve manier meer te leren over het onderwerp?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Het spel heeft nu het thema Natuurpark Kronenkamp, de stijl, vragen en informatie gaat daarom ook hierover. Het zou zo kunnen zijn dat dit jou niet aanspreekt. Stel het spel heeft een onderwerp wat jou wél aanspreekt, is de opbouw van het spel een leuke en goede oplossing om op een educatieve manier meer te leren over het onderwerp? - Selected Choice	1.00	2.00	1.11	0.31	0.10	9

#	Field	Choice Count
1	Ja	88.89% 8
2	Nee, omdat ...	11.11% 1

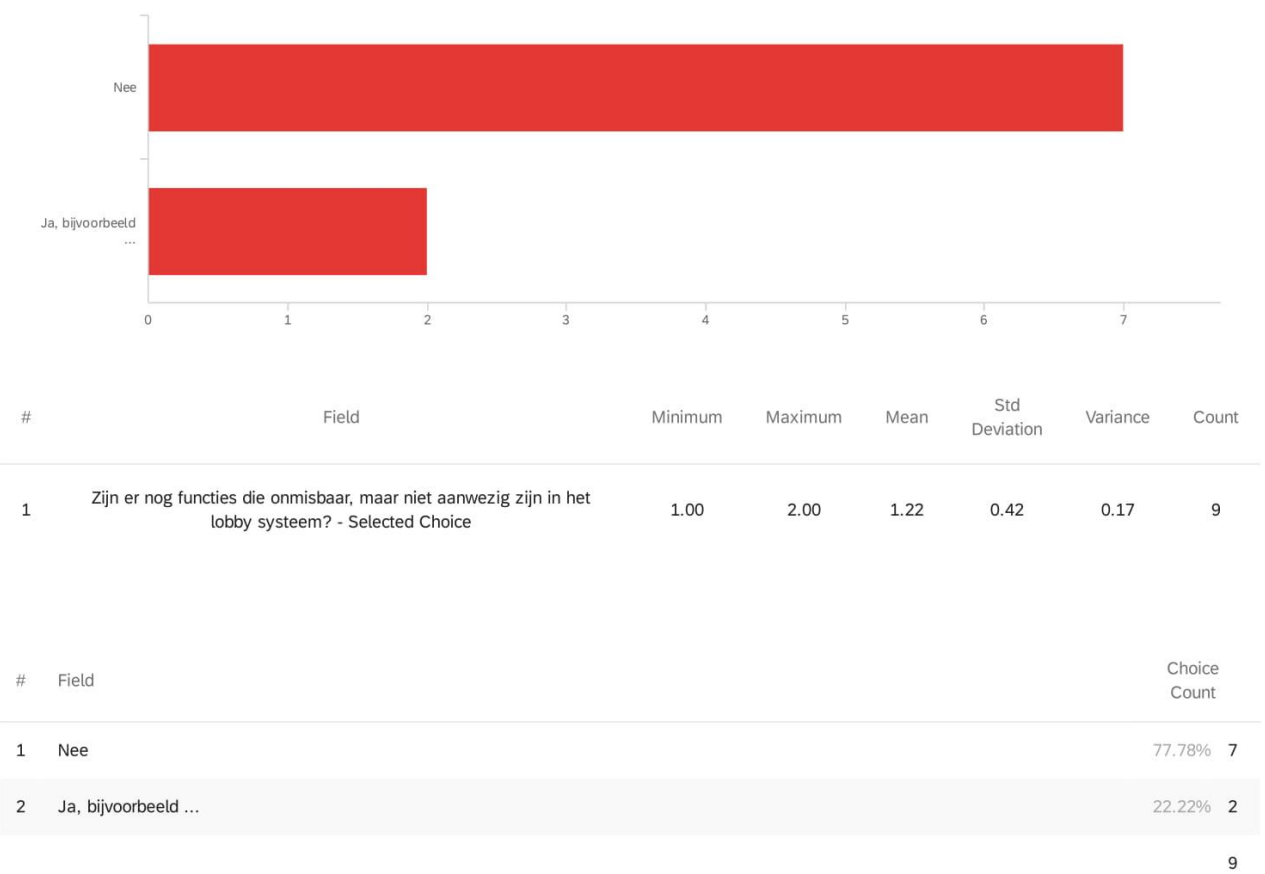
9

Showing rows 1 - 3 of 3

Q12\_2\_TEXT - Nee, omdat ...

Nee, omdat ...
Wil ja zeggen maar een extra toelichting geven. Het idee is leuk en zal een jonger publiek zeker aanspreken, maar het mag wel iets kleurrijker i.p.v. de semi-realistische kleurkeuze.

Q13 - Zijn er nog functies die onmisbaar, maar niet aanwezig zijn in het lobby systeem?



Showing rows 1 - 3 of 3

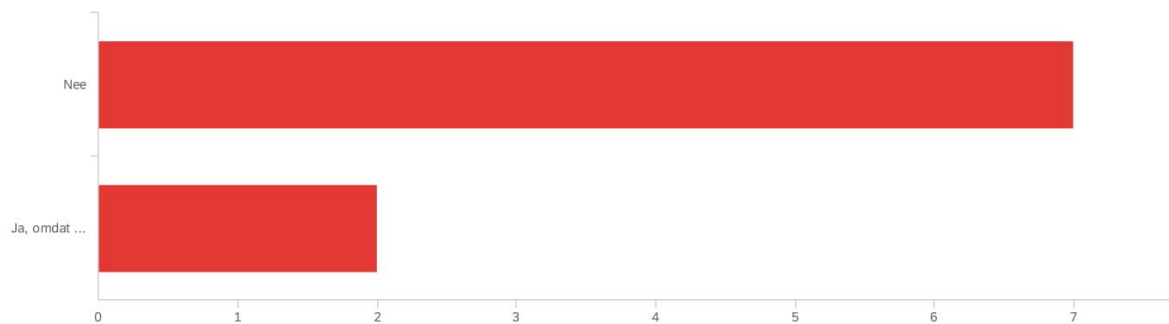
Q13\_2\_TEXT - Ja, bijvoorbeeld ...

Ja, bijvoorbeeld ...

Een tutorial

Multiplayer geeft niet echt het gevoel dat ik met andere spelers interactie heb.

Q14 - Ervaart u de audio in Augmented Reality anders dan bij normale vormen van media. Zo ja, wat dan?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
---	-------	---------	---------	------	---------------	----------	-------

1	Ervaart u de audio in Augmented Reality anders dan bij normale vormen van media. Zo ja, wat dan? - Selected Choice	1.00	2.00	1.22	0.42	0.17	9
---	--	------	------	------	------	------	---

#	Field	Choice Count
---	-------	--------------

1	Nee	77.78% 7
2	Ja, omdat ...	22.22% 2

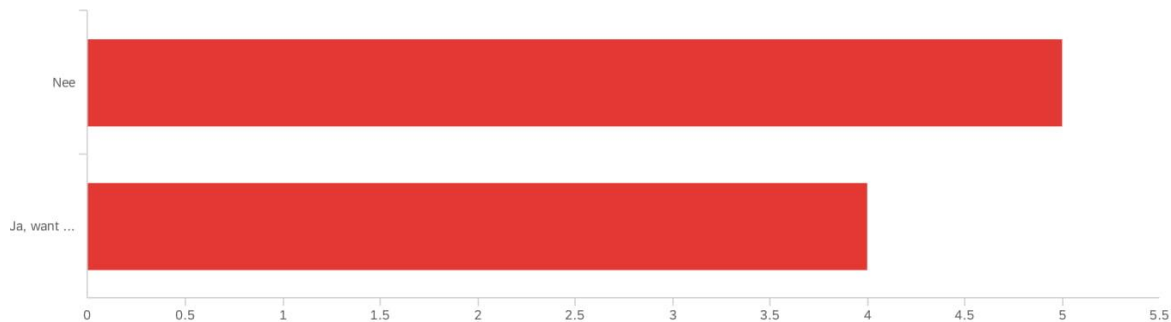
9

Showing rows 1 - 3 of 3

Q14\_2\_TEXT - Ja, omdat ...

Ja, omdat ...
---------------

Q15 - Hebben de audio geluiden invloed op hoe u denkt over gebeurtenissen in het spel?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Hebben de audio geluiden invloed op hoe u denkt over gebeurtenissen in het spel? - Selected Choice	1.00	2.00	1.44	0.50	0.25	9

#	Field	Choice Count
1	Nee	55.56% 5
2	Ja, want ...	44.44% 4

9

Showing rows 1 - 3 of 3

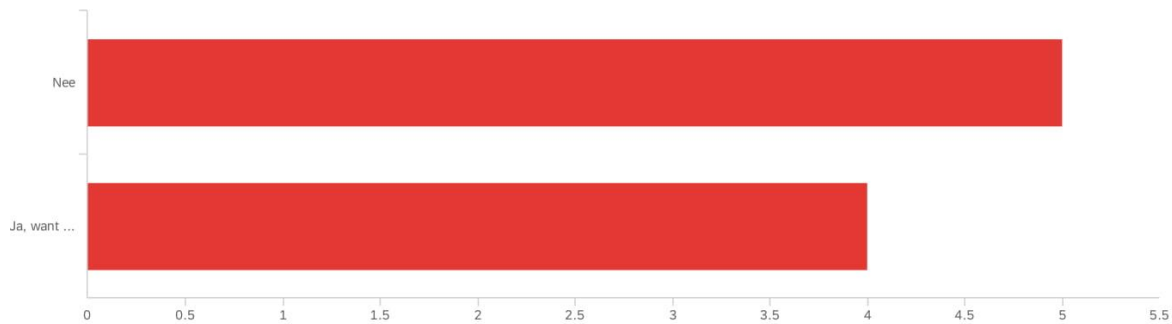
Q15\_2\_TEXT - Ja, want ...

Ja, want ...

de niet realistische dier geluiden leiden enorm af. De kikker brult elke keer als een leeuw, de bij klinkt als een racewagen die voorbij zoemt, de eend is een irritante piep en de vleermuis een sonar geluid.

gelukkig geluidje voor goede dingen en slechtere for mindere

Q16 - Heeft u het gevoel dat de audio geluiden ervoor zorgen dat u op een andere manier reageert op een event?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Heeft u het gevoel dat de audio geluiden ervoor zorgen dat u op een andere manier reageert op een event? - Selected Choice	1.00	2.00	1.44	0.50	0.25	9

#	Field	Choice Count
1	Nee	55.56% 5
2	Ja, want ...	44.44% 4

9

Showing rows 1 - 3 of 3

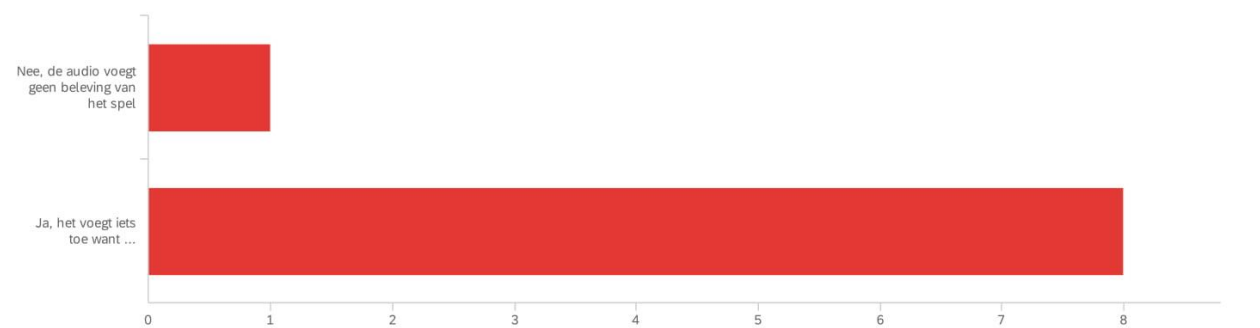
Q16\_2\_TEXT - Ja, want ...

Ja, want ...

zelfde als er boven

It makes it more clear if an event is positive or not

Q17 - Voegt de audio iets toe of verminderd het de beleving van het spel?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Voegt de audio iets toe of verminderd het de beleving van het spel? - Selected Choice	1.00	2.00	1.89	0.31	0.10	9

#	Field	Choice Count
1	Nee, de audio voegt geen beleving van het spel	11.11% 1
2	Ja, het voegt iets toe want ...	88.89% 8

9

Showing rows 1 - 3 of 3

Q17\_2\_TEXT - Ja, het voegt iets toe want ...

Ja, het voegt iets toe want ...

het geeft feedback met betrekking tot de gebruikeracties.

het geeft indicatie wanneer het jouw beurt is. Ook geeft het audio indicatie wanneer je op een bepaalde tegel beland.

zonder audio is het een dulle experience.

het voegt sfeer toe aan het spel

Maakt het leuker en af

Een game zonder geluid is geen game

End of Report



## Resultaten Doelgroep onderzoek

Er hebben in totaal 51 mensen meegedaan aan de vragenlijst. Van de 51 waren er 5 mensen waarvan de antwoorden niet goed zijn ingevuld, deze respondenten zijn niet meegenomen in de analyses. Er blijven dus 46 nuttige respondenten over.

In tabel 1 is de verdeling tussen de mannelijke, de vrouwelijke en de respondenten die zich als 'anders' identificeren te zien. Er zijn 25 jongens, 20 meisjes en 1 iemand die zich als anders identificeert. Het is aannemelijk dat in de populatie deze verdeling reëel is, dus representatief voor het onderzoek.

**Tabel 1**  
*Respons van het onderzoek*

Geslacht	Percentage	Aantal
Jongen	54.35%	25
Meisje	43.48%	20
Anders	2.17%	1
<b>Totaal</b>	<b>100%</b>	<b>46</b>

De gemiddelde leeftijd van de respondenten is 13.91 jaar met een standaarddeviatie van 2.51. De oudste respondent is 20 en de jongste is 12.

**Tabel 2**  
*Leeftijd*

	Leeftijd
Jongste	12
Oudste	20
Gemiddelde	13.91
Std deviatie	2.51

Er is gevraagd waar de respondenten geïnteresseerd in zijn qua bezienswaardigheden. In tabel 3 is te zien dat de meeste belangstelling uitgaat naar natuurparken. Als tweede is er veel interesse in dierentuinen. Historische bezienswaardigheden komt op de derde plek. Ook geven 10 respondenten aan dat er geen interesse is in de gegeven opties. Dit betekent echter niet dat er helemaal geen interesse is in bezienswaardigheden, maar het kan zijn dat de interesse van die respondent er niet bij stond. Bij deze vraag konden de respondenten meerdere antwoorden aanklikken daardoor is het totaal van de antwoorden 71.

**Tabel 3**  
*Interesse*

Antwoord	Percentage	Aantal
Dierentuin	28.17%	20
Natuurpark	30.99%	22
Historische bezienswaardigheden	26.76%	19
Geen van bovenstaande	14.08%	10
<b>Totaal</b>	<b>100%</b>	<b>71</b>

*Noot: bij deze vraag konden er meerdere antwoorden worden gekozen*

De volgende vragen gaan over de smartphone van de respondenten.

Als eerste werd er gevraagd of de respondenten in het bezit zijn van een smartphone. Dit is een cruciale vraag aangezien

de app hierop moet worden gedownload.

In tabel 4 is te zien dat het grootste deel van de respondenten een smartphone heeft. 2 gaven aan niet in het bezit te zijn van een smartphone.

**Tabel 4**

*Smartphone bezit*

	Leeftijd
Wel smartphone	44
Geen smartphone	2
<i>Totaal</i>	46

Voor het eindproduct is het handig om te weten wat voor besturingssysteem en welke versie daarvan de respondenten op hun smartphone hebben. Zo kan het product worden gemaakt voor het systeem wat het meest wordt gebruikt. 27 respondenten geven aan een smartphone te hebben met een Android besturingssysteem en 17 gebruiken IOS. Er is dus een grote meerderheid aan Android gebruikers.

**Tabel 5**

*Besturingssystemen van smartphones*

Systeem	Percentage	Aantal
Android (Samsung, HTC, Oneplus, etc.)	61.36%	27
IOS (Apple)	38.64%	17
<i>Totaal</i>	100%	44

*Noot: hier zijn alleen de respondenten die een smartphone hebben meegenomen*

In tabel 6 is te zien dat 14 respondenten IOS 9.0 of hoger gebruiken. 12 respondenten gebruiken Android 7.0 of hoger. 6 respondenten zeggen dat ze oudere besturingssystemen hebben en 12 geven aan dat ze geen idee hebben welke versie ze gebruiken.

**Tabel 6**

*Versies van besturingssystemen*

Versie	Percentage	Aantal
IOS 9.0 of hoger	31.82%	14
Android 7.0 of hoger	27.27%	12
Lager dan bovenstaande opties	13.64%	6
Geen idee	27.27%	12
<i>Totaal</i>	100%	44

*Noot: hier zijn alleen de respondenten die een smartphone hebben meegenomen*

Ook is er gevraagd naar wat er op de smartphone wordt gedaan. Dit om meer inzicht te krijgen in de interesse in het spelen van games op de smartphone.

Als eerst werd er gevraagd naar het gebruik van Instagram en/of Snapchat. Ook bij deze vraag konden er meerdere antwoorden worden geselecteerd. Veel van de respondenten (29) hebben een Instagram account. En 23 gaven aan dat ze gebruik maken van Snapchat. 12 respondenten gebruiken geen van beide sociale media.

**Tabel 6**

*Versies van besturingssystemen*

Sociale media	Percentage	Aantal
Snapchat	35.94%	23
Instagram	45.31%	29
Geen van beide	18.75%	12

<i>Totaal</i>	<i>100%</i>	<i>64</i>
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*Noot: hier zijn alleen de respondenten die een smartphone hebben meegenomen*

Daarnaast is er gevraagd of de respondenten wel eens een game op hun smartphone spelen. Bijna alle respondenten (41) gaven aan dat ze wel eens een spelletje spelen op hun telefoon. Maar 3 respondenten spelen geen spellen op hun smartphone.

**Tabel 7**

*Games op smartphone*

<b>Games op smartphone</b>	<b>Percentage</b>	<b>Aantal</b>
Ja	93.18%	41
Nee	6.82%	3
<i>Totaal</i>	<i>100%</i>	<i>44</i>

*Noot: hier zijn alleen de respondenten die een smartphone hebben meegenomen*

Aangezien het eindproduct voor een groot deel in Augmented Reality te zien is, is er onderzocht of de doelgroep hier al iets over weet. Bij het stellen van de vragen is kort uitgelegd wat AR is zodat de respondenten duidelijkheid hebben. Op de vraag “Heb jij wel eens van Augmented Reality (AR) gehoord?” gaven 29 respondenten “ja” als antwoord en de overige 17 gaven aan nooit van AR gehoord te hebben.

**Tabel 8**

*Gehoord van AR*

<b>Gehoord van AR</b>	<b>Percentage</b>	<b>Aantal</b>
Ja	63.04%	29
Nee	36.96%	17
<i>Totaal</i>	<i>100%</i>	<i>46</i>

Vervolgens werd er gevraagd of de respondenten wisten dat populaire sociale media, zoals Snapchat en Instagram, en Pokémon Go een AR functionaliteit hebben. Het grootste deel van de respondenten (36) gaven aan te weten van de AR functies in deze apps. 10 respondenten zeiden dat ze het niet wisten.

**Tabel 9**

*Kennis van AR in populaire apps*

<b>Kennis van AR in populaire apps</b>	<b>Percentage</b>	<b>Aantal</b>
Ja	78.23%	36
Nee	21.74%	10
<i>Totaal</i>	<i>100%</i>	<i>46</i>

Het eindproduct word een bordspel in AR. Daarom is er onderzocht of de doelgroep bordspellen speelt en deze leuk vind. Bij deze vraag zijn er ook voorbeelden van bordspellen gegeven zodat er geen verwarring ontstaat.

In tabel 10 is te zien dat 44 van de respondenten wel eens een bordspel hebben gespeeld. Dus 2 respondenten hebben nooit een bordspel gespeeld.

Van de respondenten die bordspellen spelen vind 1 het niet leuk om te doen. De overige 43 vinden bordspellen wel leuk.

**Tabel 10**

*Bordspellen gespeeld*

<b>Bordspellen gespeeld</b>	<b>Percentage</b>	<b>Aantal</b>
Ja	95.65%	44
Nee	4.35%	2
<i>Totaal</i>	<i>100%</i>	<i>46</i>

**Tabel 11***Bordspellen leuk*

Bordspellen leuk	Percentage	Aantal
Ja	97.73%	43
Nee	2.27%	1
<i>Totaal</i>	<i>100%</i>	<i>44</i>

*Noot: hier zijn alleen de respondenten die ja op de vorige vraag hebben beantwoord meegenomen*

Ook is er onderzocht of de respondenten denken dat AR lessen leuker kan maken. Een groot deel van de respondenten (40) lijkt het leuk om les te krijgen met AR. 6 mensen geven aan hier geen interesse in te hebben.

**Tabel 12***AR lessen*

Interesse in AR lessen	Percentage	Aantal
Ja	86.96%	40
Nee	13.04%	6
<i>Totaal</i>	<i>100%</i>	<i>46</i>

34 respondenten denken dat vakken zoals biologie en geschiedenis leuker worden met het gebruik van een AR game. 4 van de respondenten vinden de vakken zo saai dat AR niet zou helpen het leuker te maken. En 8 hebben geen idee.

**Tabel 13***Bio en Ges leuker*

Bio en Ges leuker?	Percentage	Aantal
Ja	73.91%	34
Nee	8.70%	4
Geen idee	17.39%	8
<i>Totaal</i>	<i>100%</i>	<i>46</i>

Er bestaat een kans dat het eindproduct gebruik gaat maken van een Augmented Reality cardbox headset. Daarom is aan de respondenten gevraagd of ze er ooit van hebben gehoord, ze het misschien een keer hebben gebruikt en er interesse in hebben.

Ongeveer 82% van de respondenten heeft gehoord van een AR cardbox headset. De overige 8 geven aan er nooit van te hebben gehoord.

**Tabel 14***Gehoord van AR cardbox headset*

Gehoord van AR cardbox headset	Percentage	Aantal
Ja	82.61%	38
Nee	17.39%	8
<i>Totaal</i>	<i>100%</i>	<i>46</i>

Van de 38 respondenten die hebben gehoord van de headset zijn er 26 die deze headset wel eens hebben gebruikt. 12 respondenten zeggen dat ze er nooit één hebben gebruikt.

**Tabel 15***AR cardbox headset gebruikt*

AR cardbox headset gebruikt	Percentage	Aantal
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Ja	68.42%	26
Nee	31.58%	12
<b>Totaal</b>	<b>100%</b>	<b>38</b>

*Noot: hier zijn alleen de respondenten die ja op de vorige vraag hebben beantwoord meegenomen*

Het grootste deel van de respondenten (34) toont interesse in het gebruiken van een AR headset. 10 geven aan dat ze er geen interesse in hebben. De overigen hebben niet gehoord van

**Tabel 16**

*Interesse in proberen van AR cardbox headset*

Interesse in proberen van AR cardbox headset	Percentage	Aantal
Ja	77.27%	34
Nee	22.73%	10
<b>Totaal</b>	<b>100%</b>	<b>44</b>

*Noot: dit zijn er 44 omdat*

## Conclusie

Als eerste werd er gevraagd of de respondenten interesse hadden in verschillende bezienswaardigheden. Bijna de helft van de respondenten toonde interesse in Natuurparken. In de andere 2 opties was ook veel interesse, maar net iets minder dan bij Natuurparken. Maar 10 van de 46 respondenten gaven aan helemaal geen interesse te hebben in de bezienswaardigheden die werden genoemd. Er is dus voldoende interesse in natuurparken zoals Natuurpark Kronenkamp.

Omdat het eindproduct op een smartphone gedownload moet kunnen worden is er gevraagd of de respondenten een smartphone hadden. Een grote meerderheid is in het bezit van een smartphone. 2 respondenten gaven aan er geen te hebben.

Daarna is onderzocht wat voor smartphones de respondenten hebben. De meeste zijn in het bezit van een smartphone met een Android besturing. De rest van de respondenten heeft een IOS besturing. Vervolgens is er gevraagd naar de versie van het besturingssysteem. 12 van de respondenten wisten niet welke versie ze hadden. 14 hadden IOS 9 of hoger en 12 hadden Android 7 of hoger. De overige respondenten hadden een oudere versie.

Uiteindelijk is er voor gekozen om voor een focus op het Android besturingssysteem te gaan. Dit omdat het gemakkelijker is om te testen voor de engineers en de verdeling toch bijna 50/50 is.

Ook is er onderzocht of de respondenten al iets wisten van Augmented Reality. Daarom is er eerst gevraagd naar het gebruik van de sociale media Snapchat en Instagram. Deze sociale media maken gebruik van AR door middel van camera filters. Er zijn 12 respondenten die geen van beide gebruiken. Dit betekent dat de meerderheid bekend is met deze media en waarschijnlijk de filters ooit heeft gebruikt.

Als tweede is gevraagd of de respondenten spelletjes op hun telefoon speelde. Een grote meerderheid gaf aan wel eens spelletjes te spelen op hun smartphone. De meeste respondenten zijn dus bekend met smartphone games en zullen het eindproduct snel oppakken.

Meer dan de helft van de respondenten heeft wel eens gehoord van AR. En nog meer geven aan dat ze weten van AR in populaire apps zoals Snapchat, Instagram en Pokémon GO. Dit laat zien dat er voldoende kennis is over het bestaan van AR zodat er niet te veel uitleg in het eindproduct zelf gegeven hoeft te worden. Toch is het vreemd dat sommige respondenten eerst aangeven dat ze niet weten wat AR is en in de volgende vraag toch zeggen dat ze weten van het

bestaan van AR in populaire apps. Maar het kan zijn dat door het geven van een voorbeeld de respondenten toch AR in die apps herkende.

Vervolgens is er gevraagd naar de interesse in bordspellen. 44 respondenten geven aan wel eens bordspellen gespeeld te hebben. 1 hiervan speelt wel eens een bordspel, maar vindt dit niet leuk.

Er is dus voldoende interesse in bordspellen en deze worden in de meeste gevallen ook leuk gevonden.

Verder is er gevraagd of de respondenten denken dat AR de lessen op school leuker kan maken. 6 van de respondenten lijkt het niet leuk om les te krijgen met AR. Maar het grootste deel lijkt dit juist wel leuk. Ook werd er gevraagd of AR de lessen Biologie en Geschiedenis leuker zou maken. Over het algemeen zijn dit de vakken die als saai worden beschouwd. De meerderheid denkt dat AR deze lessen leuker zou maken. 4 vinden de lessen hoe dan ook saai en de overige 8 hebben geen idee.

Deze resultaten laten zien dat er voldoende interesse is in het leren met AR.

Als laatste is er gevraagd of de respondenten weten wat een Augmented Reality cardbox headset is en of hier interesse in is. 38 van de respondenten geven aan gehoord te hebben van deze headset en 26 daarvan hebben er wel eens één gebruikt. 34 van de respondenten geven aan wel interesse te hebben in het proberen van een Augmented Reality cardbox headset. Dit betekent dat er over het algemeen voldoende kennis en interesse is onder de gebruikers, zo wordt de headset niet als vreemd ervaren.

In conclusie is er dus voldoende interesse voor alle aspecten van het eindproduct. En is er voldoende kennis over de aspecten, zoals AR en de headset, van het product. Ook zijn de meeste respondenten in het bezit van een smartphone, dus is het eindproduct erg toegankelijk en kan het door veel mensen worden gespeeld.

## REFLECTION

1. **Technical research and analysis.** Together with a group of students, I developed a mobile Augmented reality application for a foundation in the Netherlands, Neede. During the time with this project, my main task has been Audio and working on the design of the gameplay. I made the game design guidelines and implemented the audio. I also made some concept art and the team logo. Originally, I intended to work on Concept art and 2D assets. My tasks were to find out how to implement audio, see how and what type of influence audio has player, Design the game guidelines. During the project, I consulted with my teammates about the game design, I also consulted with the other members of the group about audio and its implementation as well as with a music expert about what to use with the unity engine in terms of the file extension. Originally, I aimed to work with FMOD as audio middleware. I the end I chose to instead go for the build-in unity sound features. This allowed me to learn how to implement audio into unity directly without middleware and how to do it with C# coding. I am satisfied with the result of the audio; the sounds all play when they should and most of the sounds fit with the game and its theme while in the prototype. I am satisfied with learning some more coding, which is a completely new venture for me, as I have already used FMOD in the past.

To reflect, If I where to start the project over I would probably try to use both FMOD and C# implementation to get better and more detailed test results. Overall, I am happy with where it landed, however, I do wish I had had more time to find better and more fitting sounds and even potentially make some of my own sound's trough foley. But the corona restrictions had an impact on me in these areas.

2. **Designing and prototyping.** Together with the other members of the team, I worked on iterations of the game design besides on working on the audio and conceptual art, I designed the game design guidelines for the prototype which would eventually be used to test the research question. Throughout the project, we consulted each other as well as perform individual research on target audiences, competition, and stylesheets. The result is a prototype that has a designed user interface and features that the audio can enhance.

To reflect on designing and prototyping and what I would do differently if I were to approach the topic again is that I would put a bigger emphasis on iterative design for audio and producing my audio samples. I shifted from my original goal of focusing on 2d art and concept art after the project starts this limited the amount of work. This meant I had to limit my scope more.

3. **Testing and rolling out.** The team and I developed multiple iterations using by using the marvel app, to create paper prototypes. We used colleagues and other project groups at Gamelab Oost to test our paper prototypes. I used iteration to implement audio by testing what worked before adding more features to the scripts. To allow for a smooth development process I kept adding smaller features one by one. I made sure each step worked correctly before moving on. The result allowed me to have the features I needed for testing at a satisfactory speed, without experiencing problems with the mechanics used to implement the audio.

In hindsight. If I started from the beginning on how to implement audio. I would likely have made a bigger effort in making separate versions of the tests. One with unity audio another with FMOD using the different types of audio such as spatial and mono and put them against each other see how users interact differently.

4. **Investigating and analyzing.** I used new tools and found new ways to use old tools. I used these tools to create a prototype augmented reality board game for mobile apps. I also explored how FMOD works and handles audio. I used and learned C# to make my audio system within unity. I used tools to find sound samples and analyzed what each file extension meant. I also found out how bit rates influence the quality and size of the file. The result is a prototype that features the sounds intended and has most sounds fit the game theme and style.

To reflect if I were to do it again, I would structure myself better and switch around a few processes, for example, what I found out later would have been good to know earlier on. Such as the way I was going to implement audio with unity instead of FMOD.

5. **Conceptualizing.** I performed tasks with some experience and research. I created diverse suggestions during brainstorm sessions and aimed to be open-minded to new ideas that did not align while offering arguments and counterarguments. One of the tasks I kept busy with is formalizing a concept and bringing it forward. Creating possibilities for the other group members to build on or give feedback, as a result, I believe the choices made in the project have generally been the best of the possible choices.

In reflection, I believe the best choices from the selection have been made. The selection regarding the method and way audio was to be tested could have been expanded upon. I did originally intend to use an A/B test and a survey. however, because of COVID-19 and the difficulty, it caused in reaching our intended target group only a survey has been performed with a target group older than the intended target audience.



6. **Designing.** I found myself well within the project in terms of design, I can give the other designers valued input in multiple regions, such as UI, concepts and modelling. I can visualize ideas and design user experience. my task has been to combine those elements and enhance them with audio feedback. Give the user a more complete experience when interacting with the prototype. I added background sounds and put sounds on actions resulting from player input such as in the UI or when the player rolls some dice. I also aimed to make the different pawns have character. As a result, the overall experience is much more complete however I do not feel entirely confident that I reached the goal adding personality to the pawns.

In reflection, I believe if I had more incremental steps in deciding on the pawn sounds, I could have reached better test results.

7. + 8. **Enterprising competences.** I dedicated additional time into making this prototype have value for the client, I worked on this project within a budget and have made choices to minimize costs. Thought has also been put into how the client can use this prototype, and how they can utilize it after the prototype stage. Our task was to build a prototype, not a full product and such our goal and our actions were made to bring this prototype to a state where it could be taken as a foundation to be developed on further. The result is that, and the client will be given a product with complimentary advice to instruct them how they can utilize it.

In reflection, I believe this was handled as well as it could have been, we had multiple talks with the client which constated mainly out of senior and elderly volunteers. About what they can and should expect from us and what is outside of the scope. Our aim was not to market for them but to create the foundation of a piece they can use in a larger campaign. However, because of the pandemic and their senior volunteer positions, this has caused problems in their availability as well as the park being closed for an extended period.

9. **Working in a project-based way.** If this assignment were not project-based and team orientated, I believe that I would have struggled, as I have in past attempts. Being able to converse on a peer-to-peer basis with members of the team helped motivate me as well as allowed me to motivate them, my task has been to assist with team roles and make sure that together we lift each other. I promoted doing a daily stand up every morning as well as wrote nodule for these stand-ups. I also try to always think of some way to give input even if it's not my area of expertise to give an outside perspective. I helped in problem-solving and tie the knots in decision moments. Because of COVID-19, I suggested we'd join a voice call during work. To make working from home more effective. This helped keep each team member motivated, making it easier to communicate when help was needed.

To reflect, I believe the atmosphere of the group and team was good. while we had one member with personal issues leave the team at the early stages and a new member joins. We made sure that we kept morale high and kept each other motivated to work, as well as having team building games on Fridays.

10. **Communication.** was very important especially once we started working from home where communication went from meeting in an office every morning and doing a physical stand up to meeting online. I aimed to be open and communicate what bothered me or when I needed help instead of waiting.

In reflection, there are times where I did fall back a bit and should have communicated a bit more sternly when a deadline was not going to be achievable but overall, I feel I consistently communicated on all aspects. And believe I managed to keep communication between stakeholders and myself very positive.

11. **Learning ability and reflectivity.** I often reflect on my actions and choices and I brought this aspect with me to this project. When I developed or designed something I asked for input and asked people to criticize it, and I aim to learn new skills, a big reason why I chose to focus on audio is to learn something new and show I can deliver. While the results are far from an industry ready when it comes to audio, I am very aware of this, nor did I expect to get complete mastery over it during this project.

On reflection, I am happy I chose to focus on something outside of my experience it allowed me to work on new things and learn a different type of toolset. And it proves to myself I can pick up something new and make progress while offering more to the table in future endeavours.

12. **Responsibility.** I see myself as a someone who holds himself responsible when it comes to working in a project, while in the past I would have opted for a project lead position I purposely chose not to and learn how to work better under the lead of another in a project-based setting. My aim was to learn how to not take on everything and focus on my own expertise. However, while I did feel I achieved this I did meddle and tried to be there to lift the team when necessary, something I feel everyone in the team contributed too.

In reflection. I am glad I decided to put my focus on my own research and tasks instead of taking on the additional burden of a leadership role, it allowed me a different perspective and be more freed up to focus. While I did miss being the contact person for the client. I did still assist where I could make sure the lead of the project did not share a big burden as I experienced myself in the past.