UNIVERSITY OF TWENTE.

**Faculty of Electrical Engineering,
Mathematics & Computer Science**

# Using an Immersive Virtual Reality Simulation for Reflecting on Instructional Methods for Music Lessons

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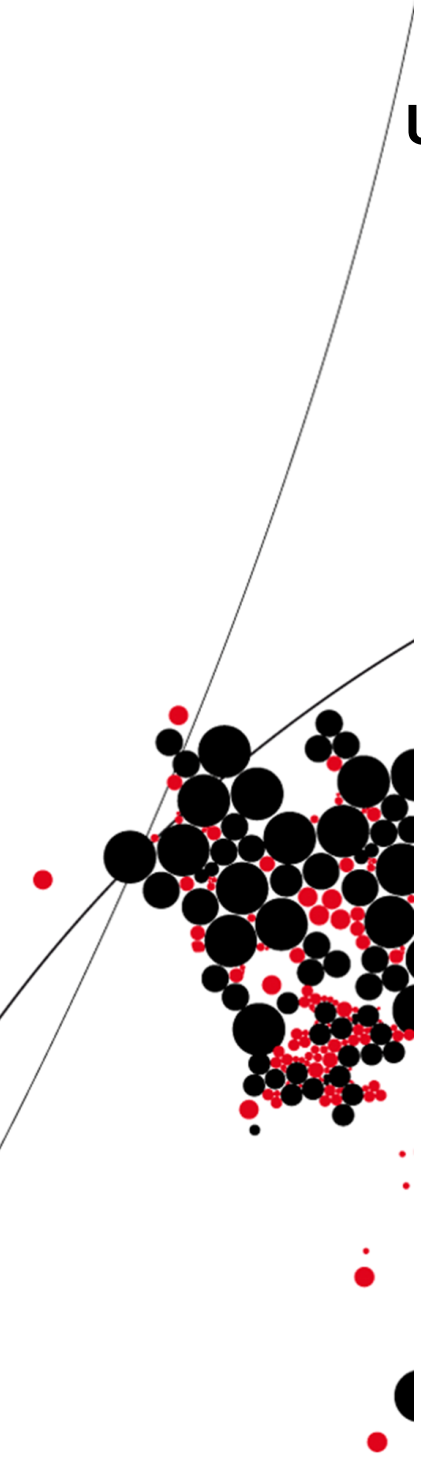

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# Summary

Since 1857, Dutch primary schools have been legally required to offer singing lessons. Since then music education in the Netherlands has changed to teach pupils the fundamental concepts of music. Although much thought has been spent researching the best ways music should be taught in the different years of primary schools, schools have struggled to find teachers who are able to teach music at the required level. One of the reasons why schools can't find teachers who can give music lessons is because teachers who graduate from the pedagogical academy for primary education (pedagogical academy for primary education (PABO)) often lack the musical knowledge and confidence to teach music. Although recent attempts from the government and changes to the PABO curriculum have shown to be effective, other attempts at solving it are still needed. One of these is an initiative started by Méér Muziek in de Klas to research how technology can be used to support teachers who need extra help with teaching music lessons. This study shows how the use of an Immersive Virtual Reality (Immersive-Virtual Reality (IVR)) Simulation can help pre-service teachers reflect on their instructional methods. The simulation developed for this study allow pre-service teachers to first give a music lesson and afterwards participate in their own lesson from the perspective of a pupil. This allows them to see how a pupil might experience their lessons. The research done for this study compared the reflections written after participating in one's own music lesson in IVR by sitting next to virtual pupils, to reflections written after watching a video of the lesson. The results of a study with 11 participants showed that while reflecting after participating in their own lesson does not lead to different insights in their reflections compared to reflecting using the video of the lesson. The IVR reflections from the group that first watched the video seem to be less critical of the mistakes they noticed when watching the video. After experiencing their own lesson, the mistakes they had previously noticed did not affect the lesson as much as they had thought. The results are similar to the results of related research that studied the effect IVR has on the reflection of pre-service teachers. More research is needed to determine whether the use of IVR for reflection can become a useful tool for teacher education.

# Contents

# List of acronyms

**PABO** pedagogical academy for primary education

**AR** Augmented Reality

**VR** Virtual Reality

**IVR** Immersive-Virtual Reality

**HMD** Head Mounted Display

**SBL** Stichting Beroepskwaliteit Leraren

**BPM** Beats Per Minute

**SO** Scriptable Object

# Chapter 1

# Introduction

## 1.1 Motivation

In 1857 the Netherlands implemented a law that required primary schools to provide singing lessons [1]. Research by Hartkamp in 2007 on the history of music education in the Netherlands shows that primary schools have had a hard time finding enough teachers who were capable and willing to give music lessons[1]. Although recent attempts to improve music education in primary schools have had some success, schools tend to rely on specialists to teach instead of the classroom teacher. This is largely because classroom teachers can not provide the same quality of music education that a specialist can [2] very often do not feel confident in their ability to give music lessons This results in schools needing more financial support from the government to be able to continue providing music lessons. Teachers also tend to rely on teaching methods during music lessons, instead of giving the lessons themselves [2]. This is often related to teachers not feeling confident enough in their abilities to give music lessons. Organizations like Méér Muziek in the Klas have started attempts to solve this problem by improving the music education pre-service teachers receive at the pedagogische academie voor het basisonderwijs (PABO), teacher training college for primary education [3]. B. Spieker from Méér Muziek in de Klas is researching how technology can support teachers in teaching music [4].

One of the areas where technology can help (pre-service) teachers improve is in their ability to reflect. Reflection is one of the competencies that a good teacher must have [5]. Technology such as videos has been well researched and has shown to help teachers reflect on their own lessons and learn from other teachers by watching videos of their lessons [6]. More recently, researchers have started looking at how immersive technology can be used for teacher development [7]. Immersive technologies allow for the creation of virtual experiences that are impossible to recreate

[1] G.M. Hartkamp (2005), *Het muziekonderwijs in Nederland tijdens de 20e eeuw: https://ap.lc/cVWSD*

in the real world [7]. Recent studies have shown that these immersive technologies can also be beneficial in improving the reflective abilities of teachers [7]–[9]. For this study a simulation was developed using immersive technology to allow pre-service teachers to not only practice giving a lesson in Virtual Reality (VR), but also experience their own lesson from the perspective of one of their pupils.

## 1.2 Framework

This research is part of a larger body of research that aims to find out how technology can support teachers in their music lessons. This research aims to give insight into how the use of Virtual Reality learning environments can be designed to help (pre-service) teachers reflect on how they teach music. The simulation developed for this study allows trainees not only to give a music lesson but also to participate in their own lesson sitting alongside virtual pupils. This is done by recording the movement the trainee makes when they give the lesson and when the trainee follows the lesson their movements are turned into an animation that will be played by a 3D character. This addition to the simulation allows pre-service teacher to self-reflect and see how their instructions look from the perspective of the pupils. This study aims to find out if this unique feature of IVR leads to better insights in how pre-service teachers can improve their instruction methods compared use a video for reflecting. Other related projects to this research are van der Ven's research on how haptic technology can help with recognising incorrect rhythms. Van de Ven created a learning environment by setting up 2 monitors that displayed 8 recordings of people who each played a rhythm on a drum pad, behind the screen were 8 speakers, each for one of the people on the screen. Van de Ven researched if a haptic band can help with recognising who of the 8 people on the screens play an incorrect rhythm by vibrating at the rhythm they are supposed to play. Van de Ven concludes that while the results do not show that the haptic feedback led to the participants recognizing the incorrect rhythm quicker the learning environment was deemed useful for training by expert participants[2]. Van de Ven does mention in her Future Work chapter that using a IVR environment could be a possible improvement, theorizing that it might help with connecting the sound made by the recorded people with the person playing that rhythm. Kruijhaars' research looked into how visual feedback can help teachers with recognising who of their pupils is singing off-tune. By providing pre-service teachers with a visual that shows how on-tune their pupils are singing Kruijshaar aimed to find out if that would allow them to give better feedback

[2]van de Ven, Hester. (2023) *Music Interaction Technology as a Learning Support for Pre-Service Teachers to Listen Better*

to their pupils. The qualitative results from the research indicated that the visuals did help PABO students with identifying which pupil was singing off-tune[3]. These studies show that technology has the potential to help pre-service teachers learn how to give music lessons and that more research might.

## 1.3 Research questions

This research aims to determine whether an IVR simulation depicting a classroom with virtual pupils can help pre-service teachers get more valuable insights reflecting on their instructional methods by experiencing it from the perspective of a pupil more effectively than using video-based self-reflection. The study seeks to answer the following research question:

*How can a IVR simulation help pre-service teachers reflect on their instructional methods for giving music lessons, and does it lead to more valuable insights when compared to reflections made using a video?*

## 1.4 Virtual Reality

Recent years have seen a large increase in the amount of papers published that study different uses of Virtual Reality (Virtual Reality (VR)) technologies, most of which focus on how they can be used for educational purposes [10]. Including using VR in the classroom or, more recently, for teacher education [7]. A review study done in 2011 by Mikropoulos & Nastsis aimed to map out how virtual learning environments were used in education and what made them effective. According to them, the most important concept of VR is presence. Presence is defined as 'having a sense of being in the virtual environment.' The feeling of being present in a virtual environment is done by immersing the user using multi-sensory interactions. The user not only perceives the virtual environment via visuals, but also hears the sounds of the environment. Mikropoulos & Nastsis conclude that the use of VR has the potential to help with learning it is important for future researchers to keep learning theories in mind during the design process of the virtual learning environments [11]. The VR environments used in the studies reviewed by Mirkopoulos & Nastis are less immersive than the VR environments made for newer technologies. This has led recent research to differentiate between two types of VR; VR where the virtual environment is displayed on a screen but users can perceive the real world

[3]Kruijshaar, J.M.R. (2020) *Technology supported music education: visual feedback for pre-service teachers in guiding a music class: http://essay.utwente.nl/83088/*

around it and require a keyboard & mouse [12], joystick, or controller for interaction, and Immersive Virtual Reality (IVR), which includes all Head Mounted Display (Head Mounted Display (HMD)) technologies that fully immersive the user into the virtual environment and provide more embodied ways of interaction [7], [10], [13]–[15]. There is also a third category of immersive virtual reality technology which is Augmented Reality (Augmented Reality (AR)), sometimes also called Mixed Reality (MR). AR is when virtual objects are placed within the real environment. There are also studies that found some effective results for learning when using AR technologies [16]. The goal of research in this field is to find out how this aspect of (I)VR technologies can best be used to get the intended learning outcomes. The possibility of creating a highly controlled environment in VR makes it particularly appealing to use for research. It allows researchers to study large groups of participants who will experience the exact same scenarios [15]. Another benefit of VR over technology like video is how easily it can be adapted to fit the times. When things like culture, lesson plans, and pedagogical practices change, VR environments can be changed so they stay relevant, whereas videos will need to be re-recorded [9]. The simulation made for the study done for this thesis was made for the Meta Quest 3 HMD, making it an IVR simulation.

## 1.5 Technical introduction

For the development of the VR simulation, a tinkering approach was used. This approach helped to find what works and what does not work in a music lesson training simulation. There were 2 goals for the simulation. First, it had to be an effective learning environment for practising one or more skills that teachers need when giving music lessons. Additionally, because it was not clear from the beginning which skill could best be practised in a virtual learning environment, the simulation had to be flexible so it was easy to add and test new features. Following the practices as suggested by the framework made by Harris et. al. the fidelity of the simulation is primarily focused on the elements that the users of the simulation need to reflect on [17]. This is achieved by using the then most recent Meta Movement SDK that allowed for the tracking not only the body of the used but also their hands and fingers. This allows the user to translate their hand gestures to the hands of the avatar they are controlling. This gives the user more freedom to express themselves in the virtual environment, leading to a higher level of presence and agency, something that is important for learning according to the CAMIL model [18]. Chapter 4 goes into more details on how the simulation was developed.

## 1.6 Report Organization

The thesis is organised as follows. In Chapter 2 some context is provided for the research, it shortly goes into the history and current state of music education in the Netherlands and explain the setting in which PABO students give music lessons during their internship. In Chapter 3 studies on using technology as a tool to help (pre-service) teachers reflect and (I)VR training simulations for teacher development are discussed. Chapter 4 details all the steps that went into developing the simulation and the tools used. Chapter 5 covers the methodology of the research. Chapter 6 presents the results. Chapter 7 examines the results and presents the finding and in Chapter 8 provides future implications based on the results and gives an answer to the research question.

# Chapter 2

# Background

This chapter provides some context for the research carried out for this thesis. This section summarises the results of a pre-study of which the results have been submitted as delivery of a previous course and explains the setting in which PABO student give music lessons.

## 2.1 History of music education

Since the onderwijswet of 1857, which signed into law that primary schools must provide singing lessons, music education has not managed to reach the required quality. Although music education has evolved to involve more than just singing, schools have had trouble finding teachers who can educate their pupils at the level required by the curriculum. Research and interviews with primary school teachers show that after graduating from the PABO they do not feel qualified to give music lessons. Instead, they rely on music education tools that sideline the teacher and do not provide adequate individual feedback that pupils can expect to get from other lessons [2]. In the last decade, numerous attempts have been made to solve this problem. From government programmes, subsidies, and changes to how PABOs teach music. Some have been more successful than others. The current state of music education in the Netherlands shows that more solutions need to be explored to get more teachers to teach music to their pupils. This includes exploring how technology can help teachers feel more confident in their ability to give music lessons [4]. One of the solutions to explore is to employ IVR music lesson training simulations.

## 2.2 The setting in which PABO students learn how to give music lessons

PABO students have to stand in front of a class for their first year during their internship[1]. The classroom is generally setup in the follow way; there is the PABO student that provides the lesson, the PABO teacher that provides the student with guidance and feedback, and lastly, the pupils that together make up the class who follow the lesson from the student. Kruijshaar has identified the following three information flows[2]:

- From the class to the PABO student (the music being made by the pupils)
- From the student to the class (the instructions for the pupils)
- From the teacher to the student (feedback and guidance)

The research done for this thesis is focussed on the first information flow. The goal is to help pre-service teachers better understand and reflect on how they convey their instructions to the pupils. The SLO has different goals for music education for the 8 years that kids in the Netherlands are in primary school. The main overall goal for music education in primary school is to get the pupils to develop musically, to let them experience what music does to them, how it makes them feel, how they can make music themselves, and to get them to understand that music is a kind of communication[3].

[1] Hogeschool Rotterdam *Stage PABO voltijd jaar 1: https://www.hogeschoolrotterdam.nl/contentassets/c04139cdaccf4cafb6a6dcb48453d164/voorlichting-jaar-1-vt-en-acpa.pdf*

[2] Kruijshaar, J.M.R. (2020) *Technology supported music education: visual feedback for pre-service teachers in guiding a music class*

[3] https://www.slo.nl/thema/meer/tule/kunstzinnige-orientatie/kerndoel-54/muziek/

# Chapter 3

# Related Research

This chapter explains the current state of IVR training simulations, how technology has been used by (pre-service) teachers to help them with reflecting on their teaching methods and some recent research on how this can be done using IVR.

## 3.1 State of IVR training simulations

Training simulations have a wide range of applications. From learning how to perform certain surgeries [19] to helping people practice public speaking [20]. One of the main benefits of using VR for training is that it is experienced as being more immersive compared to more traditional training simulations that use a desktop [13]. This level of immersion provides allows designers of virtual simulations to elicit certain emotions from the users and make them feel more close to what they feel when they do the real-world equivalent. For example, people still feel a certain amount of anxiety if they have to present in front of a virtual audience [21]. However, recent large review studies have been quite critical of a large body of research on how effective training simulations are. Quite a lot of it was caused by the fact that over the past 2 decades of training simulation research no standardised language has emerged on how we discuss all the different aspects of training simulations. Other stated critiques are the lack of transparency in the design of the simulations used to conduct the studies [15], or that the studies did not account for well-known effects of VR use such as novelty effect [22], cybersickness [14], and cognitive load [23], [24]. This has led to researchers developing frameworks that provide recommendations on how the effectiveness of VR training simulation research should be measured. Two examples of these frameworks are the CAMIL framework [18] and the framework developed by Harris et. al. [17]. The two frameworks are similar in many ways; both focus on the ability of IVR to make users feel present in a virtual environment.

The Cognitive Affective Model of Immersive Learning (CAMIL) aims to provide

developers, designers, and researchers of IVR simulations with specific opportunities for learning in virtual environments. The model is built taking lessons from previous research on how cognitive and affective factors lead to learning when using immersive technologies. CAMIL identifies six these cognitive and affective factors that are important for the transfer of learning namely; interest, motivation, self-efficacy, embodiment, cognitive load and self-regulation. These six factors lead to a higher sense of agency and presence in the simulation, which are essential to learning. The researchers of the model also recognise the fact that incorrectly calibrated cognitive load, self-regulation and embodiment can be detrimental to learning. They highlight that because of the importance that future simulations get these factors right, more careful research is needed that helps to understand how learning outcomes of IVR systems can be maximised [18].

The second framework aims to provide future researchers that study the teaching potential of IVR systems with tools to measure the relevant aspects that lead to the transfer of learning of immersive simulations. Similarly to the CAMIL framework, the framework developed by Harris et. al. aims to help researchers understand the level of presence users feel when learning with an IVR system. They break presence into two parts, validity and fidelity. Validity is about how close a virtual environment represents its real-world equivalent. Fidelity is how close the simulation recreates the systems of its real-world equivalent in terms of how the user has to behave and the affective and cognitive states. They mention that these principles of their framework would apply better for simulations that aim to teach psycho-motor skills, but can also be used to test the effectiveness of other simulations [17].

## 3.2 Importance of reflection for teacher development

Being able to reflect and learn from experiences is one of the 7 main competences a primary school teacher should have according to Stichting Beroepskwaliteit Leraren (Stichting Beroepskwaliteit Leraren (SBL), *translation: Foundation for Professional Quality of Teachers*). According to the SBL, a primary school teacher should be able to analyse and understand their own behaviour and that of others, striving to improve themselves systematically[1].

According to Korthagen, being able to reflect is essential to become a good teacher. To help teachers reflect, Korthagen has developed 2 models. The ALACT model, which describes the reflection process [25] and the onion model, which describes what to reflect on [26]. The ALACT model has 5 phases; Action, Looking

[1]SBL *https://wij-leren.nl/SBL-competenties-leerkracht-primair-onderwijs.php: https://wij-leren.nl/SBL-competenties-leerkracht-primair-onderwijs.php*

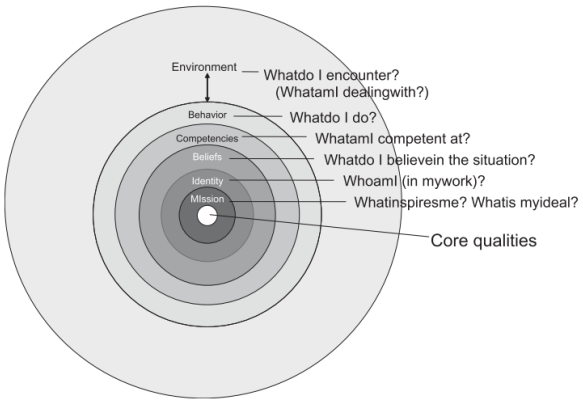


**Figure 3.1:** The levels of reflection of the onion model from Korthagen [26]

back at action, Awareness of essential aspects, Creating alternative methods of action, and Trial. These phases indicate the steps a (pre-service) teacher has to go through during the reflection process. Action is a specific moment during a lesson, looking back at action is when the teacher asks questions to help them better understand what happened, what they did, and how the pupil(s) experienced it (Table 6.1). During this phase, the (pre-service) teacher needs to make sure their reflection covers the dimensions of thinking, feeling, wanting, and acting. Once the teacher has reflected, they must find the essential aspects that need to be changed to better handle a similar situation in the future; this is where the second model comes in (Figure 3.1). Using the onion model, the teacher should not only understand what happened or what they and the pupils did, but also reflect on what kind of teacher they want to be and what their ideals are. This is what Korthagen calls 'Core Reflection'. Making reflecting focus on who the kind of teacher they are and want to be. The fourth phase involves devising different strategies to address the situation in a way that aligns more closely with their vision of the ideal teacher they aspire to become, followed by the Trial phase, where they implement these new methods to determine if they produce the desired results [27].

## 3.3 The use of technology for reflection

Alongside the more traditional methods of reflecting using portfolios [28], reflecting in groups with peers and with a teacher, videos have also been shown to be useful tools to help pre-service teachers reflect on their own teaching methods and on the teaching methods of other teachers [6]. Pre-service teachers that use video for self-reflection tend to be more critical than when reflecting without a video [29]. There are, however, also some drawbacks when it comes to using videos for reflection. The person who controls the camera is who determines what will be on the video, this

means that there is a risk that the situation a teacher wants to reflect on is not well documented on the video. A possible alternative that does not have these drawbacks is the use of 360 degree videos. These record the entire classroom, each frame. There are also different ways to watch a 360 video, on one or multiple screens with a keyboard or mouse to rotate the view, or using an HMD, which is the more immersive option [8]. A challenge with video and 360 video is that novice teachers often do not know how to reflect on the content [6]. This issue is often addressed by using annotations to highlight specific moments in the video and prompting the teacher to reflect on those moments, which is an area where VR technology excels because it allows the simulation to be tailored to focus reflection on a single aspect [6], [8].

## 3.4 (I)VR simulations for teacher development

As discussed in Chapter 1 researching how VR technologies can enhance education has been conducted for decades [14], and for teacher development in the last decade [7]. The review study by Huang et al. studied the effectiveness of previous research in this field using the CAMIL framework [18]. They found better results in relation to the intended outcomes with studies using IVR systems instead of lower immersive systems like the Second Life video game for simulation role-play lessons [12]. Using the framework, the researchers found a lack of studies that measured self-regulation and the cognitive load of the simulations, which according to CAMIL are relevant aspects of IVR simulations for the transfer of learning.

Two studies were found that specifically looked at the effect that IVR use has on the reflective abilities of pre-service teachers. Both studies compared the use of IVR with video and found that IVR leads to similar reflections [9] and shows the potential to improve the empathy skills of teachers [30]. In the study performed by Richter et. al. compared the reflections from pre-service teachers where one group reflected by watching a video of a lesson they themselves gave in IVR and the other group reflected on a video of a teacher in a real classroom. The results did not show significant differences between the reflections of the 2 groups. Indicating that IVR is just as effective a tool for reflections as using video, without the drawbacks of video discussed in the previous section.

The other study, performed by Stavroulia & Lantis. aimed to find out if using IVR to allow the pre-service teacher to see from the perspective of a student that is being bullied will help them feel more empathy for that student. Stavroulia & Lantis. evaluated a group that encountered the scenario enacted by real students against another group that underwent the scenario in IVR with pre-programmed virtual agents. The IVR group saw the scenario and experienced the scenario both from the perspective of the teacher and from the perspective of the student who was

being bullied. The study results showed that participants in the IVR group indicated that they could place themselves in the position of someone who is racially different, while participants in the real classroom disagreed. The researchers of both studies agree that while the results are promising, more research is needed to find out if the use of IVR actually leads to teachers who have better empathy and reflection abilities.

# Chapter 4

# Simulation Development

## 4.1 Ideation

Building on previous studies, it was determined from the outset that the initial prototype would involve a simulated music lesson aimed at helping PABO students improve or refine the necessary skills for music teaching. The main question was which of the skills a primary school teacher needs could best be practised using a simulation.

According to preliminary research, the immersive experience offered by IVR aids in the transfer of skills. In search of finding the best way to take advantage of the immersion aspect that IVR provides, different prototypes were made. The first prototypes explored ideas for using the simulation to train perception, learn from feedback, and practice giving instructions to get the pupils to play on the beat. After one of rounds of testing and discussing the simulation trying to find out what works and what does not, it became clear that it was too difficult to get the virtual avatars to respond in a realistic way to non-verbal instructions from a trainee. During the process of researching, developing, testing, and discussing the simulation with experts, the requirements for the simulation were determined. For the simulation to be beneficial and genuinely useful for PABO students, it must be realistic in the critical aspects related to the skills it aims to teach or practice, as well as functional and effective without the presence of an educator. This is important because if the simulation is to be used in PABOs, it should not create more work for the educators, but rather allow the students to practice by themselves. This tinkering design process eventually leads to the current prototype, where the simulation allows students to practice giving music lessons and improve by reflecting on how they give the lesson by experiencing their own lesson from the perspective of a pupil. The following are the critical aspects the simulation tries to feel as realistic as possible:

- Spatial audio

- Animations
- Controls

How these aspects were developed will be discussed in this chapter.

## 4.2 Tools

The following tools were use to develop the simulation:

- Meta Quest 3[1], VR headset
- Unity 2022.3.11f1[2], game engine to develop the simulation with.
- JetBrains Rider 2022.2.3[3], IDE for programming.
- Blender[4], 3D moddeling program to edit the character animations
- Rokoko Studio[5], motion capture tool ot record animations.
- Camo Studio[6], to wirelessly connect the second camera to a laptop with a webcam.
- FMOD Studio[7], for creating spatial audio.
- Mixamo[8], to download the 3D character models.
- Affinity Designer[9], to make the music sheets.
- Lenovo Legion Pro[10], AMD Ryzen 7 5800H Radeon, 32 GB Ram, laptop used for development.

## 4.3 Simulation Development

This section will discuss how the simulation was developed. It will go over how the setup of the learning environment, the architecture of the simulation, audio, and how the interaction with the virtual environment works.

[1] https://www.meta.com/nl/en/quest/quest-3/
[2] https://unity.com/
[3] https://www.jetbrains.com/rider/
[4] https://www.blender.org/
[5] https://vision.rokoko.com/
[6] https://apps.microsoft.com/detail/9pgm3qb3pdrd?hl=en-us&gl=US
[7] https://www.fmod.com/
[8] https://www.mixamo.com
[9] https://affinity.serif.com/en-us/
[10] https://www.lenovo.com/us/en/p/laptops/legion-laptops

### 4.3.1 Simulation Architecture

The architecture for the simulation is based on the talk by Ryan Hipple from Shell Games that he gave at Unite Austin in 2017 [31]. In this talk Ryan explains how at Shell Games they use Unity's Scriptable Objects and Event system to create a architecture within Unity that allows for rapid prototyping of ideas without the need for any extra programming, and easier testing of features in isolation.

#### Music Controller

The MusicController is arguably the most important part of the simulation, it is what communicates which note should be played. In the current version of the simulation this is done using the architecture described above. For this implementation, each note is an event wrapped up in a Scriptable Object (Scriptable Object (SO)). An SO is essentially a container for different types of data. The data that they will contain here is a list of listeners. The SimulationListener is a script component that, when added to an object, registers itself to a specific SimulationEvent. When the Event is called at any time, it will notify all of it's listeners. The current implementation of the MusicController is not the first version of it. From the start the idea was to use Midi[11] for the music controller, which would allow the use of songs in a midi format to be dynamically loaded and used to control the virtual pupils. However, this changed because there was no easy way to send data from loaded midi files on an Andriod device[12], the Operating System Meta Quest 3 uses, to an application build with Unity. This would still be a good improvement to the simulation, but making the interface that would allow this system to work was outside the scope of the study.

The MusicController is made to support only eighth- or quarter-notes. Each note is put in a list that the MusicController goes through in steps. The time between each step depends on the beats per minute (Beats Per Minute (BPM)). If the BPM is set to 60 the MusicController steps through the list with an interval of 0.5 seconds. There is 1 second between each beat, meaning that there is 0.5 seconds between each eighth note.

#### Easily Extending the Simulation

The main benefit of this architecture is how much easier it is to add technologies and new features to the simulation without having to change anything in the codebase. For example, if you want to count how often a certain note gets played, you only need to add the Listener script to the objects that have the script with the counting

[11] https://midi.org/about
[12] https://www.android.com/


**Figure 4.1:** MusicController script in the Inspector of Unity

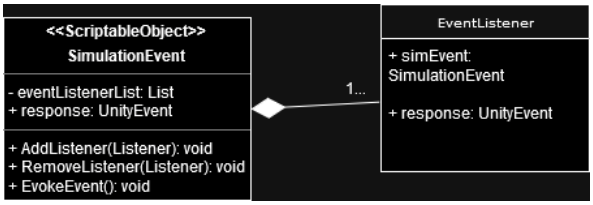


**Figure 4.2:** Class diagram of the event system

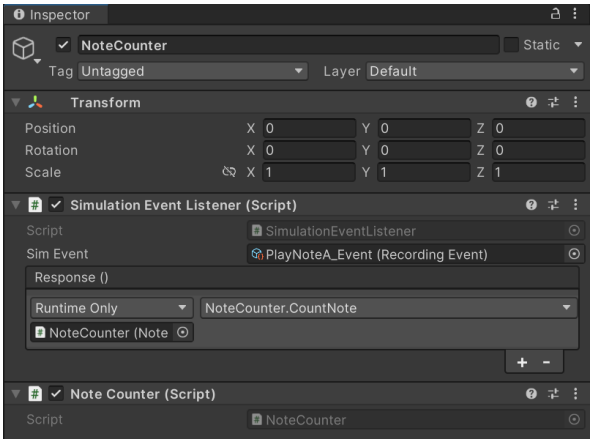


**Figure 4.3:** Example of how the use the Event System Scriptable Object Architecture

logic, add the note event SO you want it to count, and set the Response to call the counting function of that script. Figure 4.3 shows what this example looks like in Unity.

### 4.3.2 Animations

To make the simulation feel realistic, it was important for the animations to look as realistic as possible. Using the Rokoko motion capture tool, it was possible to make the animations by acting them out (Figure 5.1. The tool needs 2 cameras to be set up at a 45-degree angle. The animations made using Rokoko would then be re-targeted to the character models used in the simulation in Blender. Because the character has a different scale than the Rokoko character, the animations needed to be cleaned up before they could be used in Unity (Figure 4.5. Each character has a specific NoteEvent that they listen to, when the MusicController invokes a NoteEvent the character will start its animation.

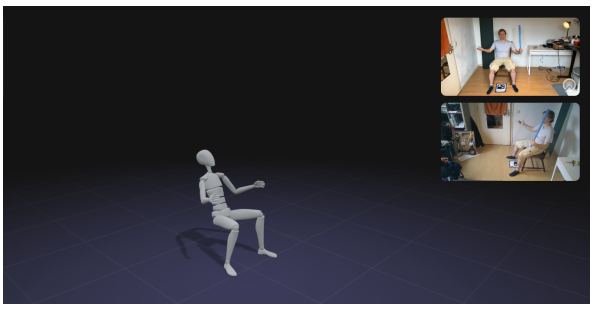

**Figure 4.4:** Motion capture using Rokoko

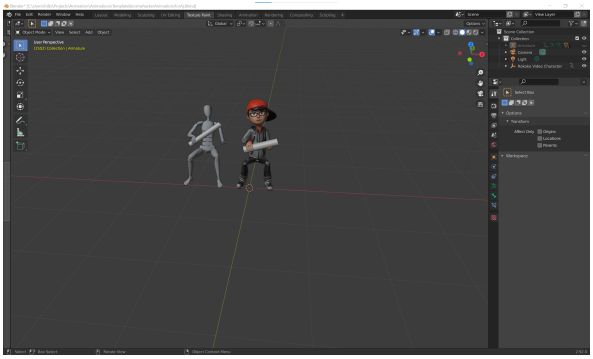

**Figure 4.5:** Blender

### 4.3.3 Movement Tracking

The Meta Quest 3 uses inside-out cameras to track its controllers. With the update to the Movement SDK to version 4.0 in December 2023 they can also be used to track hands and recognise hand gestures. This Software Development Kit was used in the simulation. This new version made it possible to re-target the hands of the wearer of the headset to the hands of a 3D character model. This made it possible not only for walking around in the virtual world of the simulation but also to see a virtual avatar move their hands in the exact same way. This allows PABO students to make the exact same hand gestures that they would use during real music lessons.

### 4.3.4 Interaction

During the first phase of the simulation, when the task is to give a music lesson, it is only possible to interact with the User Interface (UI). The UI exists out of floating menus with buttons that can be pressed to watch a preview of the lesson they will have to give, stop the simulation, or start the lesson. In the second phase, will have to be done while being seated, one of the controllers is also needed. This controller will look like a boomwhacker in the simulation, by hitting it on a table it will make a sound. The boomwhacker can also be used to interact with the buttons on the menus.

### 4.3.5 Audio

The audio is a very important aspect of the simulation. In order for the virtual classroom to feel like a real classroom, any sound had to seem to come from the direction of the source of the sound. In order to do this, FMOD Studio was used for all of the boomwhacker sounds, in combination with the Oculus Spatializer, a plugin made by Meta for FMOD Studio. The Oculus Spatializer is a plugin made for FMOD to use

**Figure 4.6:** Image of the perspective from a pupil

spatial audio in Meta Quest HMDs[13]. FMOD can be integrated with Unity. Unity tells FMOD the direction and distance from where the virtual representation of the headset is in the virtual environment from the source that made a sound. It then uses that information, together with the plugin made by Meta, to manipulate a sound to make it sound like it came from that distance and direction. In Unity, an event gets added to the animation at a certain time within the animation that gets called each time the animation reaches that point. This event calls for the function that plays the sound of the boomwhacker being hit. To make this as realistic as possible, it was important to find the right time for each animation to make the moment the sound is heard feel like the moment that it should make the sound. That is not at the exact moment in the animation that the boomwhacker hits a hand or leg, but right before (Figure 4.7).

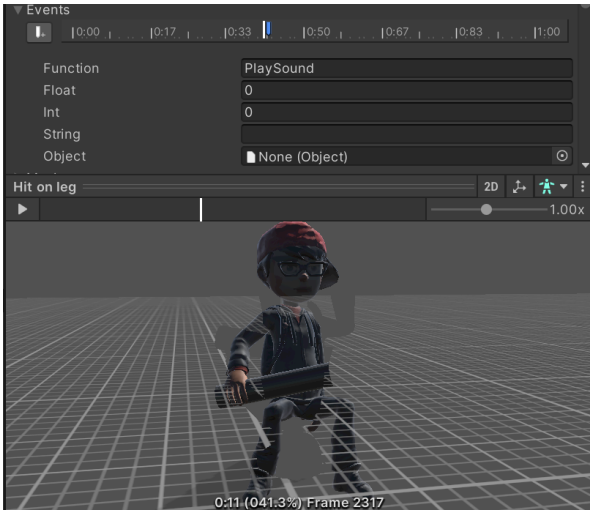


**Figure 4.7:** Animation event

[13]https://developers.meta.com/horizon/documentation/unity/audio-osp-unity-req-setup/

**Figure 4.8:** Image of the classroom

### 4.3.6 Environment

The environment was made to look like a primary school classroom. The characters are all from Mixamo. These characters have a humanoid rig that is compatible with Meta's movement tracking system. Unfortunately, the characters in Mixamo do not all have the same art style, there were only 2 character models that looked similar enough that they would fit together in the same simulation. For this reason, it was decided to not have the amount of children you would except to have in a classroom since with only two characters, these would be very difficult to differentiate from each other. Another benefit of having fewer characters in the environment is that it reduces the risk of cognitive overload [32]. Having to read the sheet music and point to the correct avatar on the beat can already require a lot of focus from someone, especially if they are not used to doing that. In the classroom, there is a sheet music stand with a song. The virtual agents, placed in the room in a half-circle, represent the pupils of the class who are programmed to play their boomwhacker when the MusicController calls the event for the note they have to play. This means that they do not react to any gestures from the trainee. This made it more difficult to tell the trainee if their instructions are correct and on time. To solve this, a second phase of the simulation was added. In this second phase, the trainee will take the position of one of the pupils and follow the lesson they gave in the first phase. This second phase begins after the trainee has finished the music lesson. This is possible because the avatar that was being controlled when the trainee was giving the lesson in the first phase all the movements were being recorded. In the second phase, this recording is replayed by the same avatar. Because the movements are the same, the trainee can see if their instructions were clear and on time during the lesson. This allows the trainee to reflect on their performance as a teacher from the perspective of a primary school pupil.

# Chapter 5

# Research design & Methodology

This chapter covers the methodology of the research.

## 5.1 Methodology

This section will explain all of the phases of the research from the recruitment of the participants to the

### 5.1.1 Recruiting participants

A total of 11 people participated in this study. Of which 10 were university students and 1 was an expert in teaching music to primary school pupils. Participants could apply for study by responding to a participation request and choose one of the available time slots. In this request, the participants were provided some general information about the study, namely that they would be using a VR training simulation in which they would learn how to give a music lesson. The true purpose of the study, comparing reflections after being a student of their own lesson in VR to reflections after viewing a video of the same lesson, was only disclosed to the participants during the interview at the end of their participation. The reason for hiding this information was to ensure that participants would have full attention to giving the lesson. Before participating, the participants were provided with an information and consent form. Age was the only criterion for participation. The participants needed to be between 17 (minimum age for someone starting at the PABO and teaching in a classroom) and 65 (retirement age in the Netherlands). Participants were split into two groups: group one first watched the video in which they could see a 3D avatar play an animation that was made by their movements during the lesson, and participated as a student in IVR in their own lesson after. Group two participated in their lesson as a student in VR first, and watched the video last. This design prevented any influence of order effects and allowed for effective comparison between

the first reflections, which were more detailed, and the second reflections one which were shorter for both groups because participants only added new insights. The study concluded with a semi-structured interview to gather feedback on the use of the simulation and its potential for reflection and learning how to give music lessons. Table 5.1 shows which participant belonged to what group.

### 5.1.2 Tutorial

The simulation tutorial exists out of 3 parts, first, participate in an example lesson. Second, getting used to controlling an avatar in VR. Third, learning the song for the lesson, and practising giving instructions to the pupils. The goal of this tutorial was to reduce the novelty effect and cognitive load by letting the participants get used to being in VR and understand how their movement is tracked and translated to the character they are controlling.

#### Participating in an example lesson

In the example, participants had to participate in a music lesson in VR. They had to sit in a seat and were given a controller that in IVR looked like a boomwhacker. In the virtual environment they could see the classroom, the virtual characters representing pupils and the virtual character representing a teacher, they also had a table in front of them. They were instructed to move the controller (that looked like a boomwhacker to them) until it hit the table, upon which the sound of a boomwhacker being hit could be heard, when they saw the teacher give them the instruction to play. Once the lesson started the teacher started moving and giving instructions to each of the pupils, and the participant, when to hit their boomwhacker. Once the song was done, the participant was told how to go to the next part of the simulation, controlling an avatar.

#### Controlling an avatar

Since most of the participants were not used to controlling an avatar in VR, this part was made to help them get used to it. For this part, the participant could look at the avatar they are controlling and see a clone of the avatar in front of them who mirrored all of their movements. The avatar was automatically scaled to the height of the participant. The goal was to give the participant some time to get used to controlling an avatar and see how their movement were translated to the movements of the avatar. The were encouraged to walk around, move their hands and fingers and look around.

### Practising the song

The last part of the tutorial is to let the participant learn the song they will have to teach and practice the instructions they will use to tell the pupils when to play. The participant could see a music stand with the song in front of them and see the pupils who were seated in a half-circle around them. The song was a simple children's song, a different one from the one in the example lesson, and the tempo is set to 45 BPM, slow enough to give the participant some time to look at the music sheet if they did not remember which note was next. Since it was important that people who do not know music notation could also participate in the study it was decided to use a simpler form of music notation that shows the name of the note displayed in the colour of the boomwhacker that plays that note. The participant also heard a metronome to help them keep tempo. The participant can let the pupils play the song a few times and is free to decide how they want to give the instructions to the pupils. Once the participant feels confident enough, they were told how to start the lesson.


**Figure 5.1:** Music sheet for song the participants used for the music lesson

### 5.1.3 Giving the lesson

Once the participant had decided to start the lesson, a countdown of 5 seconds was started to give them time to get into position. After 5 seconds a metronome will give the tempo for one measure before the song starts, and the participant has to start instructing the pupils when to play. Because the pupils are pre-programmed (unbeknownst to the participants), meaning they did not respond to the instructions given by the participants, they continued playing the song from start to finish. The simulation recorded all the movements made by the participants during the lesson. After the song was finished the recorded movements were saved to a file. Depending on which group the participant belonged to, they were either asked to sit in front of the laptop to watch a video where they saw a 3D character play an animation made by their movements or to keep the headset on and start the next part of the simulation where they will play the role of a pupil in their own lesson they just gave. In both cases the participants were requested to reflect on how the lesson was given to look for things that they thought went right or things that could have been better.

### 5.1.4 Watching the lesson on video

In the video, the participants could see that the avatar they controlled replay their exact movements made when they gave the lesson. The participants were told to look at the video and reflect on how they thought their lesson went. After watching the video, they were asked to fill out a reflection form. For the VR first group, they were told to do the same, but since they had already reflected on their performance as a teacher after participating in their lesson in VR, they only had to write down any new insights they noticed that they had not noticed in VR.

### 5.1.5 Participating in their own lesson in VR

This part was similar to the example lesson the participants followed before, except that now the 3D character representing the teacher was replaying their movements they made when they gave the music lesson. They were seated in the same position as one of the pupils and had to hit the boomwhacker when they saw the teacher instructing them to do so. In addition to this task, they were also asked to reflect on how the lesson was taught. After the lesson the participants could remove the headset and were asked to reflect by filling out a reflection form. For the video first group they only had to write down if they had any new insights they did not have by watching the video.

**Table 5.1:** Participants and the medium they first used for their reflection

| Participant | Video or VR |
|---|---|
| P1 | Video |
| P2 | VR |
| P3 | Video |
| P4 | VR |
| P5 | VR |
| P6 | Video |
| P7 | Video |
| P8 | VR |
| P9 | Video |
| P10 | VR |
| P11 | Video |

### 5.1.6 Interview

After the participant had written their reflections for the video and VR they were asked to participate in a short semi-structured interview. The goal of the interview was to learn what the simulation experience was like, what they liked about it, what parts felt realistic to them and if they saw any potential in the simulation being used to help pre-service teacher reflect on their instruction methods for giving music lessons. The answers helped to understand how present the participant felt in the virtual environment, and if there was anything that took them out of the immersion.

### 5.1.7 Reflection questions

For writing the reflections the questions from the ALACT model created by Korthagen was used (Table 6.1). This model is created to help (pre-service) teachers to not only reflect on what and how they handled a certain situation during a lesson, but also think about their emotional state and reflect from the perspective of their pupils [33]. During the actual study, participants were encouraged to answer with the first thoughts that came into their mind and be as elaborate as possible. In addition, they were also told to answer in the language they are most comfortable with. The researcher was also in the room to help clarify if the participant did not understand what they had to reflect on.

# Chapter 6

# Results

This chapter presents the results of the study. The findings were derived from the analysis of 22 reflections (each participant contributed 2) and 11 interviews. Two different coding procedures were used, an inductive one and a deductive one. For the deductive process, the coding scheme from [9] was adapted to fit with the answers to the reflections (Table 6.2).

## 6.1 Results from inductive analysis

The average word count for the reflections (6 for video first and 5 for VR first) is 499 words (VR 512.6 and Video 487.67 words). The reflections were coded in two ways, using a coding scheme used in a similar study to find out what the differences is between the 2 groups. The other way was a deductive approach aimed at finding themes in the reflections.

To find out of there are differences in the reflections between the group that first reflected after watching the lesson they gave in the simulation to the group that first reflected after being a student of their own lesson in VR a coding scheme was used. The coding scheme used is the one made by Richter et. al. in their study where they compared reflection from student teachers who wrote reflections after watching a video of a teacher and student teachers that wrote reflections after watching a teacher give a lesson in VR [9]. The coding scheme used by Richter et. al. is a slightly adapted version of the one made by Kücholl et. al. who developed it to study the differences in reflection when pre-service teachers use their own video or videos made of others [34]. This coding scheme fit for each of the reflections written for this study.

**Table 6.1:** *The questions from Korthagens ALACT model to help with reflection*

| | 0. What was the context | |
|---|---|---|
| 1. What did you want? | | 5. What did the students want? |
| 2. What did you do? | | 6. What did the students do? |
| 3. What were you thinking? | | 7. What were the students thinking? |
| 4. How did you feel? | | 8. How did the students feel? |

### 6.1.1 Difference in reflection between video and IVR

In Tabel 6.3 the results are shown using a chi-square test to analyse reflections using an inductive coding process using the coding scheme of Richter et al. [9]. Since the *p-value* is above 5% for both reflection content and reflection activities, this shows that there is no significant difference between the IVR and the Video group. These results are similar to those of Richter et al.

## 6.2 Results from deductive analysis

For this analysis themes were deduced during the coding process. During this process, some differences between the 2 groups were found. The participants in the video first group seemed to be less critical of their performance when comparing their reflections.

### 6.2.1 Differences between the reflections within the video first group

Although there were no significant differences in what the participants in the two groups reflect on or about, there were some interesting results when looking a little closer to the reflections of the video first group. 3 out of the 6 participants in this group were less critical on their instructions after participating in their IVR lesson than after seeing the video. Where the 3 participants first reflected on the way they

**Table 6.2:** Coding scheme adapted from the version from Richter et. al. [9]

| Reflection activities | Definition | Examples |
|---|---|---|
| | **Content of reflection: Learning environment** | |
| Description | Name and describe the organizational structure/teaching methods/social design of the learning environment that are designed to foster engagement with learning content and interaction processes | The colors of the boomwhackers were hard to discern and the students were not seated in a progressive note scale. |
| Interpretation | Justify and evaluate the instruction(s) in terms of organizational structures/teaching methods/social design of the learning environment that are designed to foster engagement with learning content and interaction processes | In the half-circle setup, it was comfortable to address each other and have a clear view of the pupils |
| Alternatives | Formulate alternative organizational structures/methods/social design of the learning environment that are designed to foster engagement with learning content and interaction processes | If the students did not do anything if the teacher had not given them any instructions, it would be more realistic. |
| | **Content of reflection: Teacher** | |
| Description | Name and describe the teacher's actions and states of mind regarding organizational structures/teaching methods/social design of the learning environment and engagement with learning content and interaction processes | The first half was as I had intended; clear eye contact and rhythmic hands that indicated the timing |
| Interpretation | Justify and evaluate the teacher's actions and states of mind regarding organizational structures/teaching methods/social design of the learning environment and engagement with learning content and interaction processes | During the lesson it was hard splitting my attention between the sheet music and the students |
| Alternatives | Formulate alternative teacher actions regarding forms of organizational structures/teaching methods/social design of the learning environment and engagement with learning content and interaction processes | After watching myself I would focus more on the body language aspect to engage with the student. |
| | **Content of reflection: Students** | |
| Description | Name and describe students' actions and states of mind regarding organizational structures/teaching methods/social design of the learning environment and engagement with learning content and interaction processes | I think they had no clue what was going to happen, only that they had a atick called a boomwhacker that would make a sound. |
| Interpretation | Justify and evaluate students' actions and states of mind regarding organizational structures/teaching methods/social design of the learning environment and engagement with learning content and interaction processes | Did not feel as if they did not want to participate. |
| Alternatives | Formulate alternative teacher actions regarding organizational structures/teaching methods/social design of the learning environment and engagement with learning content and interaction processes | If this had been a real lesson the students would have played incorrectly more often. |

**Table 6.3:** *Analysis of reflection content and activities and the results of the chi-squared test*

| | | Reflection Activities | | | $X^2(df)$ | p |
|---|---|---|---|---|---|---|
| | | Description | Interpretation | Alternative | | |
| VR | % | 46.10 | 35.06 | 18.53 | 1.08(2) | 0.58 |
| | *z-score* | 1.14 | 0.64 | -0.81 | | |
| Video | % | 45.74 | 39.53 | 14.73 | | |
| | *z-score* | 0.93 | 0.46 | -1.39 | | |
| | | Reflection Content | | | | |
| | | Teacher | Student | Environment | | |
| VR | % | 53.90 | 35.71 | 10.39 | 3.24(2) | 0.2 |
| | *z-score* | 1.15 | 0.13 | -1.29 | | |
| Video | % | 58.14 | 37.21 | 4.65 | | |
| | *z-score* | 1.13 | 0.18 | -1.30 | | |

gave the instructions by saying this:

> ”I made one mistake” [P1, Video reflection]
>
> ”Ik zag in een opname dat ik de leerlingen wel aankeek, maar onduidelijke aanwijzingen gaf” (*Translation: ”In the recording I noticed that I did look at the students, but my instructions were unclear”* [P7, Video reflection]
>
> ”The replay showed that I was consistently early with pointing compared to the music being played” [P3, Video refection]

After experiencing their own lesson in VR they wrote the following in their reflections:

> ”I did not notice the mistake as much”[P1, VR reflection]
>
> ”Naar aanleiding van wat ik eerder zei, dat ik het ideee had dat de handsignalen die ik gaf nogal onduidelijk waren, eigenlijk viel het me best wel mee.” (*Translation: Based on what I said earlier, that I had the idea that the hand signals I gave were rather unclear, actually, it wasn't that bad.*[P7, VR reflection]
>
> ”From the perspective of the student, it was clear how to follow the instructions.”[P3, VR reflection]

The 3 other participants also seemed to find the mistakes to be not as bad as they had thought when they had noticed them watching the video when they experienced the lesson in IVR:

> ”It does help more than just watching the video to actually participate in your own class in VR, I liked that.”[P6, VR Reflection]

> ”Het zag er eigenlijk duidelijker uit in VR dan op de video, ik kon een paar keer mijn eigen cue goed interpreteren...”[P9, VR reflection]

> ”It was actually better than I expected” [P11, VR reflection]

### 6.2.2 Differences between the reflections of the VR first group

In the IVR first group, one participant found no new insights after watching the video. Another found using the video to be less immersive than participating in the lesson in VR.

> ”Similar to previous except that it is harder to feel whether or not the actions taken by the teacher really had an effect on whether or not it would keep the pupils attention as much.” [P2, Video reflection]

Two other participants mentioned that they noticed mistakes when watching the video that they missed in IVR.

> ”I noticed my own movements as a teacher a bit more, and the students reactions to my instructions” [P8, Video reflection]

> ”Only when looking back from the screen I noticed a few more things that I could improve” [P4, Video reflection]

### 6.2.3 Reflection on the learning environment

Overall, the participants were very positive about the virtual environment. They thought it looked convincingly like a classroom in a primary school and that they felt like a teacher teaching a class. When asked what aspects of the simulation they experienced as realistic, most participants mentioned the motion tracking, especially the tracking of the hands and how it translated to the avatar they were controlling.

> ”It shows the body language really nicely.” [P2, VR Reflection]

> "Ja, ik vond wel, zeg maar die handgebaren, zeg maar, die kwamen wel heel realistisch over." (*Translation: "I did that, like the hand gestures, like, they seemed very realistic to me."* [P4, Interview]

> "The bewegingen van mijzelf, zeg maar, hoe die werden vertaald in het systeem was vrij realistisch." *Translation: "My movements, like, how those were translated by the system was quite realistic"* [P3, Interview]

When asked what aspects of the simulation they found to be less realistic, the aspects that were mentioned the most were that the pupils did not respond to mistakes, the boomwhacker double registering when trying to hit it and lack of facial expressions and eye contact.

> "... in het echt, zeg maar, dat het dan wel iets directer en duidelijker overgekomen was, omdat je dan ook echt iemand kan aankijken." (*Translation: "... in real life, like, it would have been more direct and clear, because you can actually look at someone."* [P4, Interview]

> "Op een gegeven moment was ik het kwijt. Ik had niet meer door waar ik was. Dan verwacht je eigenlijk dat zij dan ook stilvallen en twijfelachtig naar je gaan kijken. Maar dat gebeurd niet." (*Translation: "At a certain point, I lost it. I no longer realized where I was. Then you actually expect that they will also stop and look at you doubtfully. But that didn't happen."* [P9, Interview]

> "... if they would respond to me, I could learn quicker and not get confused." [P6, Video Reflection]

### 6.2.4 Reflection from an expert

There was one expert who participated in this study. The main theme in their reflection is the comparison of the simulation to the real world.

Simply having to be on time with pointing to the correct pupil is not enough, the expert missed some of the aspects that are essential to giving a music lesson, like the preparation, making sure the pupils understand what the goal of the lesson is and helping them when they make a mistake. The expert regretted that they did not do enough to engage the pupils during their lesson.

When comparing the reflections of the non-expert participants to the reflection written by the expert is that all of the non-experts mentioned in their reflection that they found it difficult to both look at the sheet music and point at the correct pupil on time to indicate they had to play, while the expert mentions how easy that is to

do, so easy that they did not see the need to really reflect on it. But the reflection of the expert is very similar to that of the non-experts where they mention that they noticed when reviewing their performance that they did not pay a lot of attention to the pupils.

# Chapter 7

# Discussion & limitations

## 7.1 Discussion

The results of the study show that the IVR simulation allows its users to reflect on a specific aspect of teaching music. The simulation enabled participants to reflect on their body language and assess whether they made the correct gestures towards the correct pupil in synchrony with the beat. Using the coding scheme from Richter et. al. showed that there are no significant differences between the first reflections of the video and IVR group. These results are similar to the results of Richter et. al. who also compared reflecting using video with using VR [9].

There does seem to be some difference in the reflections is in the 2nd reflections of the groups. All of the participants in the group that use VR for their second reflections altered their initial critique they wrote in their first reflection to be less harsh. It seems that after experiencing their own lesson in VR they found the way they gave the lesson to be more clear than they expected after seeing only the video. Where the group why wrote their second reflection after watching the video found more mistakes, did not see anything different, or confirmed the mistakes they noticed when they were in VR.

Participants who were more lenient in their self-assessments after experiencing their lesson in IVR are results similar to those documented by Walshe and Driver. In their research, the participants realised that they performed better than they initially thought after viewing themselves in a 360-degree VR video [35]. An observation made was that all of the participants went into the simulation with the goal of completing a task, their focus was completely on pointing to the correct pupil on the beat of the song. They did not pay much attention to what the pupils were doing. Some participants even wrote in their reflections that they realised only when reflecting that they had not even looked at the pupils during most of the lesson. Some participants mentioned that it was not until they had to write reflections from the perspective of the pupils that they realised how important it is not only to give instructions, but also

to pay attention to what the pupils are doing in the classroom. Designing a virtual environment so that users behave in the way they would in the real world equivalent is essential to learning according to Harris et. al. [17]. There was only one participant who also used verbal instructions by saying the notes out loud before pointing to the pupil. Based on the answers to the interview, the movement and especially the hand tracking of Meta Quest 3 helped the participants feel a greater sense of presence. The fidelity of the tracking allowed the participants to see what they would like to improve in the ways how they communicate to the pupils when to play their boomwhacker. During reflection, the participants also noticed what was not being tracked, namely eyes and mouth, which meant they could not reflect on if they were making eye contact or making certain facial expressions. Adding these features might improve the embodiment felt in the simulation even more, and since they are relevant to the skill the simulation aims to teach might make it more effective.

In IVR the pre-service teacher is in control of what they an see and thus what they can reflect on. For this study, the participants were given the specific task to participate in the lesson alongside having to reflect on the lesson is given. This led some to focus more on playing the boomwhacker correctly rather than on reflecting on the lesson. This might be an indication that having to do both of those tasks in IVR might cause a too high of a cognitive load. Further research would have to indicate if using the simulation multiple times makes it easier to do both tasks, or if it is better to another option available in the simulation where the trainee only has to reflect on the lesson and not also have to participate.

## 7.2 Limitations

This section discusses the limitations of simulation and design of research.

### 7.2.1 Technical limitations

While the answers to the interview questions seem to indicate that the realism of the simulation was adequate to convince the participants that they were giving a music lesson to primary school pupils, they did note some aspects that could be improved to enhance the feeling of presence in the simulation. The most mentioned one was the use of only 2 kinds of avatar for the pupils. This was caused by the fact that on Mixamo there were no other character models that looked like children that would be plausible to see in a primary classroom. Creating new characters was outside of the scope of the study. Another was that the pupils were pre-programmed to continue playing despite the participant not pointing to any of them. Although this did not impact the quality of the reflection, even participants who indicated that

they were lost during the lesson and were confused by the pupils still playing had valuable reflections on what they could do to improve; some kind of interaction with the pupils like making them stop and restart the song might have been beneficial. A case could be made to add these features to a future research study that uses this simulation. A third aspect was that there was no audio recording during the lesson, which was missing in the replay. Even though only one participant was trying to instruct the pupils when to play by calling out the note, this may be caused because in the example the teacher did also not use any verbal instructions. using verbal instructions to tell the pupils when and what to play is a common practice in primary schools, for future uses of this simulation adding the ability to record audio would be a valuable addition. This would also make it possible to add a 'instruction' part to the simulation where the trainee explains to the pupils which note they will be playing and which gestures they will be using to indicate when and how to play. This was also mentioned by the expert as one of the aspects that they were missing in the simulation because that is something you always have to do as a teacher.

It was observed that the participants during the lesson were only focused on pointing to the current pupil on the beat of the song, often lacking any kind of enthusiasm or looking in the direction of the pupil. During reflection, many participants mentioned that if they would have to give a music lesson again, they would like to be more enthusiastic and try to connect more with the pupils. Future studies might explore whether incorporating interactive elements with the pupils could encourage participants to consider the pupil's experience more during the lesson. Adding elements such as facial expressions for the pupils already leads participants to consider more carefully how their instructional methods are perceived.

### 7.2.2 Research design limitations

For this research, participants were recruited from the researcher's social circles and a group of experts in teaching music. A total of 11 people responded and participated in the study, 10 university students, and 1 expert. Since all students study at a technological university, they are likely to be more open and comfortable with the use of IVR technology. This might not be the case with pre-service teachers which could mean that a similar study with pre-service teachers could show different results. Although the results from the study were enough to show that the simulation allows for reflecting on the non-verbal communication used during a music lesson, there was a big difference in how the expert experienced the simulation compared to the other participants. This was mostly due to the expert having a different expectation of a simulator that is made to teach them how to give a music lesson. The expert expected to see more elements that they know are part of a music lesson,

which include a moment of instruction where the pupils are told what the goal of the lesson is and what they will have to do, a way of providing verbal instructions and seeing the pupils making mistakes. It is possible that these expectations were set by the way the simulation was explained in the information form. To not disclose the real goal of the study, participants were told that the simulation teaches them how to give a music lesson, which to someone who knows how music lessons are means more than playing the song with the pupils.

Due to the scope of the study, it was not possible to use the entire cycle of reflection from the ALACT model from Korthagen. It would, however, be valuable to do this in a future study, it could be a good study to find out what additional features could be added to the simulation to help with the reflection process. Currently, the simulation does not give any feedback during or after the lesson to help the trainee understand areas where they can improve that they may miss when they reflect on their own [36].

## 7.3 Future work

The results of this study show some promising results for how people reflect when they are placed in the position of a student in their own lesson. More research will be needed to determine how this way of reflecting can best be used. The highly controlled environment provided by the IVR simulation would make it useful for other research related to studying technology that should support (pre-)teachers with giving music lessons. New features like audio recording can be added to have pre-service teachers not only reflect on their non-verbal communication, but also on how well they can combine giving a lesson and singing at the same time. As mentioned in the limitations, additions like facial expressions and eye tracking could elevate the simulation to allow the trainees to reflect on more than how they give instructions using hand gestures.

By crafting scenarios that hone in on particular teaching aspects, pre-service teachers can identify the crucial elements they need to focus on during their lessons. This means that before IVR simulations are used in teacher education, educators need to be able to change the content to ensure that it fits better with the learning goals [16], [37]. Making it easy for educators to change the simulation to ensure it fits what they want to teach and has the right level of complexity for the trainee is essential if it is to be used in a curriculum [17]. The event systems discussed in Chapter 4 make it easier for developers to add new features and change existing ones, but they are too complex for an educator to use because it would require them to learn how to use Unity. It would be better if there were simple settings exposed in the simulation itself that allowed an educator to make changes. There is much to win

by adding ways within the simulation to create new scenarios. The implications of not having the right amount of complexity in the simulation can be seen by comparing the reflections of the expert to the other participants. The expert would have liked for the simulation to include more aspects of what a teacher is expected to do during a music lesson, not only telling the pupils when they need to play. However, this was already complex enough for participants who had never given a music lesson before.

# Chapter 8

# Conclusion

The study started with the goal of finding out if reflecting using an IVR simulation in which you can participate in your own lesson leads to more valuable insights when reflecting using a video of that same lesson. The results show that there is no difference in what is reflecting in terms of content and activities. The only real difference that was observed was when comparing the first and second reflections of the first group. Although they did not find a new insights after using VR compared to video, they did change what they thought of how they gave the instructions. In VR the mistakes they saw when watching the video and noted as bad, were now perceived to not be all that bad or to at least have less of an impact on the lesson as they initially thought. These findings support earlier research suggesting that IVR can serve as an equally effective tool for facilitating reflection compared to traditional video methods, but add reasons to explore how IVR learning simulations might benefit by having the option for the trainee to reflect by participating in their own lesson and not only observe it.

From the answers on the interview questions it can be derived that the participants experienced the environment as being realistic enough to give them the feeling of really giving a lesson to primary school pupils. One of the aspects that was experienced as being particularly realistic was the tracking of the hands and fingers. This shows that the current state of the Meta Quest 3 allows for good enough tracking that allows users to reflect on their non-verbal communication.

Despite this having been a small-scale study, there are some interesting findings that could be explored with future research. Using VR to have someone reflect on their own performance seems to lead to less harsh critique compared to when they used a video for reflection. Current VR hardware is capable of also tracking eyes and even faces, adding that to the simulation might help by adding mroe relevant information that people would like to reflect on when watching their own performance back. It will allow for more embodied interaction. The current setup for this study had the participants both participate in the lesson while also having to reflect on

their performance. The reflections of some of the participants indicate that this may have lead to a too high cognitve load which prevented them of paying attention to the details they wanted to relfect on.

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# Appendix A: Reflections

## A.1 Participant 1 video reflection

**Q0. What was the context?**

We were in a classroom doing a music exercise. There were 5 different keys which were played by kids. It was a bit hard to fully go along with it without studying the song a lot before hand. So I missed one note. Good overall experience, avatar was very reactive and was cool environment.

**Q1. What did I think?**

First thing was that it was kind of hard to hit the thing on the table the way it was angled so I had to slant my hand. From the teachers perspective, was pretty straight forward.

**Q2. How did I feel?**

Was a bit stressed before because I wanted to make the song right. Made one mistake but that was fine. After I gave them an applause to positively reinforce them.

**Q3. What did I want?**

My goal was to do the song as perfectly as possible but that did not fully work out. After I realized I could have made some more movements to get the class hyped a bit more.

**Q4. What did I do?**

I was pretty bland with it, but straight forward. I would maybe make some more movements to engage the class more. I could have given the count before hand a bit more clear to get the pupils in rythem.

**Q5. What did the pupils think?**

Maybe they noticed the mistake. They probably thought it was a bit bland and boring.

**Q6. How did the pupils feel?**

Afterwards they probably felt a sense of accomplishment because they did pretty good. The instructions were pretty straight forward.

**Q7. What did the pupils want?**
They seemed pretty onboard, no one didnt play when I pointed at them.
**Q8. What did the pupils do?**
Nothing in particular

## A.2 Participant 1 IVR reflection

**Q0. What was the context?**
Same.
**Q1. What did I think?**
Same.
**Q2. How did I feel?**
Felt good after, there was hype from the teacher.
**Q3. What did I want?**
Same.
**Q4. What did I do?**
Fix the mistake and more hype from the beginning.
**Q5. What did the pupils think?**
I did not notice the mistake that much.
**Q6. How did the pupils feel?**
Same.
**Q7. What did the pupils want?**
Same.
**Q8. What did the pupils do?**
Same.

## A.3 Participant 2 IVR reflection

**Q0. What was the context?**

I was in a kids classroom with a teacher and a few students (either I was one of the kids or the teacher). Basic music class of following the teachers timing for a kids song which is basic but fun. Everything worked well and I didn't notice anything particularly wrong except that when boomwacker would hit the table sometimes the hitbox registered twice and would play twice instead of once. It was a strong showing of what I would be like if I were to teach when I was teaching (which is just more proof to me why I won't be a teacher). It shows the body language really nicely. For the preparing for the class having a preview and getting to do it multiple times is really good for confidence as well.

**Q1. What did I think?**

I tried to copy the example from the beginning with a focus on getting the notes correct since I was not super familiar with the song. I think simple pointing and timing is good for this type of basic class. I did realize during what mistakes I was making and afterwards I got to see how bad my body language was for engaging with the kids and that simply pointing with one hand is not enough. The example teacher from the beginning did this way better though

**Q2. How did I feel?**

Nervous the first time and trying to learn the song but after practicing it a couple times it was way better and I felt more prepared for the lesson itself. During it I was nervous as well but I worried less than I thought I would.

**Q3. What did I want?**

I managed to be relatively accurate with the music timing and note which is what I wanted but after watching myself I would focus more on the body language aspect to engage with the student.

**Q4. What did I do?**

I ended up pointing with separate hands to each note, switching between the two so that the student would have more time to see it was about to be their turn but it ended up not being engaging enough even though it would cause relative accuracy for the song itself. What I wanted did com through and I can see what I need to change about it

**Q5. What did the pupils think?**

The pupils did pay attention although I would say it was not engaging. They followed instructions perfectly regardless of how I came across.

**Q6. How did the pupils feel?**

There could definitely be some confusion since, without the face looking at them it becomes harder to really know it is their turn to play. Thankfully the kids basically knew the song already.

**Q7. What did the pupils want?**

I did not necessarily feel as though there was a want to not participate but it could be considered boring.

**Q8. What did the pupils do?**

It was not vague but it could be clearer how the hand movements were to say it was their turn and what the timing was. A bigger movement would keep the attention better. Although they did do what was wanted.

## A.4 Participant 2 video reflection

**Q0. What was the context?**

The answer is the same as previous except for the fact that it is way less immersive, as in you don't feel like you're there to the same extent.

**Q1. What did I think?**

The same as previous

**Q2. How did I feel?**

The same as previous

**Q3. What did I want?**

Similar to previous except it is harder to feel whether or not the actions taken by the teacher really had an effect on whether or not it would keep the pupils attention as much. The idea of whether or not it is eye capturing if the pupil is looking a different direction is not there

**Q4. What did I do?**

The same as previous

**Q5. What did the pupils think?**

The same as previous

**Q6. How did the pupils feel?**

Its harder to tell whether or not the movements of the teacher keep attention as much, with the lesser head swaying and lack of staring off while the teacher tries to get their attention for their turn in the song.

**Q7. What did the pupils want?**

The same as previous

**Q8. What did the pupils do?**

The same as previous

## A.5 Participant 3 video reflection

**Q0. What was the context?**

I was in a classroom, first I was asked to follow a music lesson and simultaneously observe how the teacher was teaching. Afterwards, I was asked to practice giving a music lesson and finally give my own music lesson. It mostly went well, however near the end i felt like I was sometimes forgetting where I currently was in the song. The replay also showed I was consistently early with pointing compared to the music being played. Overall, I felt like it went okay and it was an enjoyable experience.

**Q1. What did I think?**

Before I was curious how was going to do, as the practice could have gone better. My approach was quite simple as I'm just following the initial lesson given by the system, and applying what I learned in the practice.

During the lesson I felt like I was focussed on pointing in the right direction at the right time. I wasn't thinking about much else.

After the lesson I was quite happy with my performance as it went better than the practice, although in the end it could have gone better.

**Q2. How did I feel?**

Before: Curious, excited During: Focused After: Happy, slightly proud

**Q3. What did I want?**

My goal was to give the lesson perfectly in timing all the notes right, this almost succeeded but I think I could have done better by practicing one more time.

**Q4. What did I do?**

I gave the instructions based on the initial lesson shown by the system by pointing at the student I want to play a note. Initially during practice I was also consistently looking at the student when I wanted them to play a note. However I learned that this isn't necessary and pointing was enough. I noticed it was sometimes easier for me to just point and not look at a student when I wanted them to play a note.

**Q5. What did the pupils think?**

The students seem to pay full attention and understand what to do.

**Q6. How did the pupils feel?**

I didn't pay attention to the students' emotions, however it seemed they did not seem confused. Perhaps the F children were not confident as indicated by their facial expression. G and E seemed more confident. None of the children seemed happy.

**Q7. What did the pupils want?**

The students seemed to want to follow the lesson, I did not notice anyone not wanting to participate.

**Q8. What did the pupils do?**

No students seemed to stand out, it felt like all the students were responsive to my instructions

## A.6 Participant 3 IVR reflection

**Q0. What was the context?**

I was in a classroom where I was asked to follow the recording of my own lesson from a perspective of the student. It went well and was an an enjoyable experience. As I experienced it, nothing went wrong.

**Q1. What did I think?**

Same as previous form

**Q2. How did I feel?**

Same as previous form

**Q3. What did I want?**

Same as previous form

**Q4. What did I do?**

Same as previous form

**Q5. What did the pupils think?**

From the perspective of a student, It was clear how to follow the instructions. However, this is only because I have experienced following and giving the lesson before. I think there was no clear instruction on what exactly to do, although it felt quite intuitive from the start.

**Q6. How did the pupils feel?**

I felt confident and not confused, I cannot speak on the behalf of other students but I was happy.

**Q7. What did the pupils want?**

The students seemed to want to follow the lesson and nobody seemed to not want to participate.

**Q8. What did the pupils do?**

No student seemed to stand out to me as I was mostly paying attention to the instructor. It was clear what the instructor communicated to me by pointing at me when he wanted me to play a note.

## A.7 Participant 4 IVR reflection

**Q0. What was the context?**

I was in a classroom with a few children holding a boomwracker. Here I was the teacher and saw a sheet of music in front of me with the musicnotes on them, these were in different colours so that I could also see which child would play the note. The children when given them the task with my hand played their note by slamming the boomwracker on their leg, with this we played the song ”zie je de kastanjes”.

**Q1. What did I think?**

At first I thought it would be rather difficult giving a music lesson to children but when I saw the sheet of music in front of me with the colours on it I thought that it would be doable. During the music lessons I found myself directing the children quit good and I enjoyed it as well. Afterwards I found that it went really good.

**Q2. How did I feel?**

Before I found myself a bit nervous maybe because I did not know what to expect but during I found myself enjoying and afterwards I found myself happy to have given the lesson and I look back with a positive view.

**Q3. What did I want?**

My goal was to really teach the children something by pointing very direct at them so there could be no misunderstanding in who I pointed at. I also wanted to point correctly at the children with every note, so not accidentally point at the wrong child. I think I reached my goals in this since I pointed directly and also at the right child. But what could have gone better is also looking at the child a bit more directly so they would really know I pointed at them.

**Q4. What did I do?**

I wanted to stand straight up with a positive appearance so that the focus of the children was with me. Also I wanted to be direct so there would be no confusing while teaching and making music together. I did this all to make sure the children's attention was with me and not with each other or with the rest of the environment. What I can improve in this is also look with my whole body as to say, so also you really looking at the child who had to play their boomwracker right before so they know their note is coming when I pointed my hand at them.

**Q5. What did the pupils think?**

I think they first had no clue what was going to happen only that the had a stick called a boomwracker which would make a sound. During I think they where really focused on when to slam their boomwracker when given them the order to. I think afterwards they would have enjoyed it since they made music together and also a song came out while playing. I also think they had more of an idea what to do and why to do it in that specific order.

**Q6. How did the pupils feel?**

I think first they felt confusion on what to do, during I think it got more clear and they had to focus but also that they enjoyed themselves and were happy to be playing music. Afterwards I think they felt the joy of playing music together and really playing a song that they might know could contribute to this feeling as well.

**Q7. What did the pupils want?**

It felt like the children were eager to learn music and play an instrument. They were focused on what was happening and really wanted to make sure the song was played correctly. I did not however had the feeling they really did not want to participate or that they hated making music together. So overall a positive atmosphere was there.

**Q8. What did the pupils do?**

Before they sat still and waited for the lesson to begin, during they slammed their boomwracker when they were pointed at by the teacher to make their musicnote come out. I think they followed the instructions more clearly when the teacher would also look at them so they could prepare themselves for slamming their boomwracker. I think the children anticipated on the behavior of the teacher and also the instruction

of the teacher.

## A.8 Participant 4 video reflection

**Q0. What was the context?**

Here I have nothing new to add the environment when giving the lesson was the same.

**Q1. What did I think?**

The same went through my head. Only while looking back from the screen I saw a few more things I could improve.

**Q2. How did I feel?**

These stayed the same.

**Q3. What did I want?**

Same goals, only when looking back I could have given the tempo to the kids as well maybe with my other hand so they could also be introduced to keeping rhythm as well and they would maybe find themselves also when exactly they had to play their note.

**Q4. What did I do?**

I answered this as well in Q3

**Q5. What did the pupils think?**

I still think they the instructions were clear but I think my directness could be more direct.

**Q6. How did the pupils feel?**

I still think they feel the same.

**Q7. What did the pupils want?**

I still felt that they wanted to participate I only think that when given more direct instruction they maybe should have had a little less focus and so they could enjoy themselves more.

**Q8. What did the pupils do?**

The actions were the same, only maybe when given more direct instruction it was more clear for them when to slam their boomwracker.

## A.9 Participant 6 video reflection

**Q0. What was the context?**

I was in a simulated primary school classroom, acting as the music teacher guiding students in playing a song together. I am not sure if you would call that wrong, as this was for practicing anyway, but I sometimes lost track of where I was at in the

sheet music and could not guide them accurately. I think I would have appreciated also having a version where they only play according to what I do, as it caught me by surprise that they still kept playing in the correct way when I made the mistake - this made it more difficult for me to try independently. I thought initially that the beat was like a metronome guiding me, but got the rhythm wrong because of that and also found it difficult to look at both the sheet & the children at once, mainly because of the scale or height. All in all though, it was pleasant and I enjoyed the VR environment and the experience.

**Q1. What did I think?**

I am not sure that this was the best way as it was my first attempt, but I got inspired by the short lesson and it just made sense that I would try to look and point at the student that should play at that time. Before the lesson, I tried following as a student and getting inspiration for my teaching, during I was trying to stay afloat and focus on everything at once.

**Q2. How did I feel?**

First, I adjusted to a new setting and was discovering how everything felt, during I sometimes felt surprised when I realized the beat was already the song playing and not a metronome, that the students continued to do it right even when I made a mistake, but I was mainly just focused.

**Q3. What did I want?**

If I could keep better track, I would have liked to manage to look and point at whoever should play at the time more consistently. I struggled sometimes to look at both the sheet music and the students (did not always know who had which color for instance, also since this was a first attempt).

**Q4. What did I do?**

You can see in the video when I am confused and am looking around. It would be more clear if I could look and point at the right moments. I would also improve my posture and make bigger and sharper gestures as I get more comfortable and confident.

**Q5. What did the pupils think?**

It does not feel like they paid attention, as they played correctly regardless, which I would change. It was nice to preview and practice during as they played correctly anyway, but now if they would respond to me, I could learn quicker and not get confused.

**Q6. How did the pupils feel?**

They seemed to already know how to play, so they did. I honestly could not pay attention further regarding how they felt.

**Q7. What did the pupils want?**

I did not notice them not wanting to participate, they just wanted to play.

**Q8. What did the pupils do?**

I was not always clear, but they played the song correctly, following their previous knowledge, rather than my (sometimes faulty) instructions.

## A.10 Participant 6 IVR reflection

**Q0. What was the context?**

A few additions: I do like the controls within the game, the gestures are intuitive after learning them and also the white dot on the stick makes sense. One thing regarding the color & note matching (or this research itself): it might be a problem if someone is color blind.

**Q1. What did I think?**

-

**Q2. How did I feel?**

-

**Q3. What did I want?**

-

**Q4. What did I do?**

It does help more than just watching the video to actually participate in your own class in VR, I liked that. I should be more clear where I point.

**Q5. What did the pupils think?**

-

**Q6. How did the pupils feel?**

-

**Q7. What did the pupils want?**

I think I did notice for a moment this time that one girl was moving in her chair, I had not noticed this before.

**Q8. What did the pupils do?**

-

## A.11 Participant 7 video reflection

**Q0. What was the context?**

Ik was midden in een klaslokaal met een stuk of 5 leerlingen om me heen aan hun tafeltjes. Ze hadden allemaal een instrument om een bepaalde toon te produceren. Ik zag een lied geschreven met de verschillende tonen die de kinderen allemaal konden maken. Ik heb ook voor de les zelf een les meegemaakt vanuit het perspectief van een leerling. (Translation: *I was in the middle of a classroom with*

*about 5 students around me at their desks. They each had an instrument to produce a certain tone. I saw a song written with the different tones that the children could all make. I also participated in the lesson myself from the perspective of a student.*)

**Q1. What did I think?**

Ik keek naar de instructies die ik eerst zelf kreeg toen ik er als leerling zat, die heb ik geprobeerd na te doen. Ik vond het moeilijk om de kleuren van de instrumenten van de leerlingen in mijn hoofd te krijgen. (Translation: *I looked at the instructions I first received when I was there as a student, I tried to do the same. I found it difficult to remember the colors of the students' instruments.* )

**Q2. How did I feel?**

Ik vond het eerst vrij eng om te proberen het lied door te geven aan de leerlingen. De preview hielp heel erg, daarna voelde ik me wat meer zelfverzekerd. Nog steeds was het tijdens de les lastig om de goede leerlingen aan te wijzen wat ik jammer vond. Na de les vond ik het vervelend dat het niet precies ging zoals ik had gehoopt. Ik vond het lesgeven wel leuk en ik zou het het liefst nog een of twee keer willen doen totdat het precies gaat zoals ik dat wil. (Translation: *I initially found it quite scary to try to teach the song on to the students. The preview helped a lot; after that, I felt a bit more confident. During the lesson, it was still difficult to point out the right students, which I found unfortunate. After the lesson, I felt annoyed that it didn't go exactly as I had hoped. However, I enjoyed teaching and would like to do it one or two more times until it goes exactly as I want.*)

**Q3. What did I want?**

Ik wilde graag, denkend aan hoe de les gegeven werd toen ik er zat als leerling, dat zo goed mogelijk na doen. Hierin zag ik dat de leraar precies wist wanneer welke leerling moest slaan op zijn tafel, en dat ook vrij duidelijk communiceerde door naar de kinderen te kijken en zijn hand al op te steken voor de noot, om vervolgens in de maat zijn hand naar beneden te halen als signaal. (Translation: *I wanted to, thinking about how the lesson was given when I was a student, to emulate that as closely as possible. In this, I noticed that the teacher knew exactly when each student should hit their table, and communicated this quite clearly by looking at the children and raising his hand before the note, then lowering his hand in time as a signal.*)

**Q4. What did I do?**

Zoals ik net zei ik wou graag de leraar nadoen omdat ik vond dat hij het goed deed. Ik zag in de opname dat ik wel de leerlingen aankeek maar ik vond dat ik zelf soms nog onduidelijke signalen gaf. Ook heb ik een paar noten gemist omdat ik niet precies wist welk kind die toon had die op dat moment gespeeld moest worden. Voor en na de les heb ik niks gedaan, ik weet niet meer of de leraar toen wel iets deed, echter kan ik me bedenken dat het wel een goed idee was geweest om de klik te communiceren om het lied in te tellen aan het begin. (Translation: *As I said*

*earlier, I wanted to imitate the teacher because I thought he did a good job. I saw in the recording that I did look at the students, but I found that I sometimes gave unclear signals myself. I also missed a few notes because I did not know exactly which child had the tone that had to be played at that moment. Before and after the lesson, I did nothing. I don't remember if the teacher did anything then, but I can imagine that it would have been a good idea to communicate the click to count in the song at the beginning.*)

**Q5. What did the pupils think?**

Ik denk dat ze aan het begin niet heel goed wisten wat ze moesten doen, ook omdat ik niet echt het begin van het lied aan ze heb gecommuniceerd. Ook denk ik dat ze soms niet wisten wat ze moesten doen omdat ik de verkeerde leerling aanwees, of helemaal niemand. (Translate: *I think that at the beginning they didn't really know what to do, also because I didn't really communicate the start of the song to them. I also think that sometimes they didn't know what to do because I pointed to the wrong student, or no one at all.*)

**Q6. How did the pupils feel?**

Ik denk dat ze dit idee wel leuk vonden, ik vond het zelf wel grappig toen ik de les kreeg aan het begin. (Translation: *I think they liked it, I thought it was funny to be a student in the lesson*)

**Q7. What did the pupils want?**

Ik denk dat de leerlingen graag wel de les willen volgen omdat dit lied maken met de stokken best een leuk idee is. (Translation *I think the student did want to follow the lesson because this song with the sticks is a fun idea.*)

**Q8. What did the pupils do?**

Ik vond dat ze niet echt een reactie hadden op iets wat ik deed. Ik moet ook toegeven dat ik minder op hun heb gelet, en eigenlijk vooral heb gefocust op het lied en de handsignalen. (Translation: *I found that they didn't really have a reaction to anything I did. I must also admit that I paid less attention to them and actually focused mainly on the song and the hand signals.*)

## A.12 Participant 7 IVR reflection

**Q0. What was the context?**

-

**Q1. What did I think?**

-

**Q2. How did I feel?**

Nu dat ik dit nog een keer zie wil ik alleen maar liever nog een keer de les geven. (Translation: *Now that I see it again, I only would like to do it again even more.*

**Q3. What did I want?**

-

**Q4. What did I do?**

Naar aanleiding van wat ik eerder zei, dat ik het idee had dat de handsignalen die ik gaf nogal onduidelijk waren, eigenlijk viel het me best wel mee. Ik zag dat ik richting het eind wel uit de maat was maar voor de rest het helemaal niet slecht ging. (Translation: *Based on what I said earlier, that I had the idea that the hand signals I gave were rather unclear, actually it wasn't too bad. I saw that towards the end I was out of sync, but otherwise it wasn't bad at all.*)

**Q5. What did the pupils think?**

-

**Q6. How did the pupils feel?**

Ik denk inderdaad dat ze op het eind verward waren met wie wat moest doen toen ik het zelf ook een beetje kwijtraakte. (Translation: *I do think they were confused at the end about who had to do what when I myself lost track a bit.*)

**Q7. What did the pupils want?**

- **Q8. What did the pupils do?**

-

## A.13 Participant 8 IVR reflection

**Q0. What was the context?**

I was in a stylized classroom with students, trying to learn/teach music. At first i was participating in the class as a student, and managed to make some music with the other students using a boomwhacker. I mis-played sometimes by accidentally whacking the table. Other than that it was pretty straightforward as a student. The teacher gave clear instructions. As a teacher, i felt a bit overwhelmed at first. The music went pretty fast and i couldnt keep up with it. The actual lesson went decently i think. I missed some notes, but the students played well regardless.

**Q1. What did I think?**

I was orienting myself based on the lesson I received previously, trying to emulate the movements. When it came to actually giving the lesson, it was a bit too fast for me to keep up, especially because the children were so far apart in the room. By the time I had realized where the student i was looking for was, the next note was already playing.

**Q2. How did I feel?**

I felt a bit overwhelmed at first, but it was nice to see an example lesson beforehand, so i knew what to expect.

**Q3. What did I want?**

I got a bit lost during the lesson trying to keep up with the music. I had some difficulties remembering where each student sat. My goal was to give a similar lesson to the one I received previously, but that didnt quite work. I think with some more practice it would have been fine. It was nice to watch my lesson back as a student to see the effect
appearance i gave.

**Q4. What did I do?**

I decided on the instructions based on the test lesson i received previously. Apart from the timing, the instructions I gave did look very similar to what I wanted to achieve. I think the directions I gave were okay, compared tot he test lesson, except for missing some notes/getting lost.

**Q5. What did the pupils think?** I think the students did very well despite my confusion at times. I would expect that they think of me as a teaching student trying my best. I think they did understand the instructions i gave, because the movements did not differ much from the example. At times I was a bit confused, which probably was visible to the students as well.

**Q6. How did the pupils feel?**

They seemed rather confident, perhaps more so that I was feeling. If i missed a note they played regardless. I think I might have confused them a bit with my lesson, since it was less practiced/smooth than the example.

**Q7. What did the pupils want?**

I think the pupils were very attentive and followed any instructions well. I did not see any lack of motivation.

**Q8. What did the pupils do?**

The pupils were moving around a bit before the lesson. During the lesson they seemed very attentive and followed my movements/instructions. I was a bit confused about the two pupils on the left with the same color instrument, as they stood out from the rest that were sitting alone.

## A.14 Participant 8 video reflection

**Q0. What was the context?**

I noticed my own movements as a teacher a bit more, and the students reaction to my instructions. They often played earlier than i gave the instructions, since i was lagging behind

**Q1. What did I think?**

nothing new

**Q2. How did I feel?**

nothing new

**Q3. What did I want?**

nothing new

**Q4. What did I do?**

my body language and directions seemed a bit confused and lagging behind. I think i should have practiced more before giving the lesson.

**Q5. What did the pupils think?**

I think they might have noticed my confusion and being unsure. They were playing the right notes before i gave the instructions even.

**Q6. How did the pupils feel?**

they seemed confident/experienced even with my struggling teachings.

**Q7. What did the pupils want?**

nothing new

**Q8. What did the pupils do?**

nothing new

## A.15 Participant 9 video reflection

**Q0. What was the context?**

Ik was in een klaslokaal, ik probeerde een groep jonge kinderen te dirigeren zonder dat zij zelf bladmuziek hadden. Een hele uitdaging om zowel de muziek, het ritme en de kinderen tegelijk te verwerken. Een aantal keer was ik zelf kwijt waar op de bladmuziek we waren en daardoor ik eigenlijk geen cues kon geven. Ook het aanwijzen en dat er kort erna nog een noot gespeeld moest worden was wel moeilijk. (Translation: *I was in a classroom, trying to conduct a group of young children without them having sheet music. It was quite a challenge to manage the music, the rhythm, and the children simultaneously. Several times, I lost track of where we were on the sheet music, making it impossible to give cues. Also, pointing out notes and having them played shortly afterward was difficult.*)

**Q1. What did I think?**

Ik kan achteraf wellicht wat beter een aanpak kunnen bedenken. Door de docent voorafgaand leek het relatief makkelijk maar het viel toch tegen om alles tegelijk te doen. Ook om aandacht aan de kinderen te geven ipv alleen op mijn papier te kijken. Ik had eigenlijk niet echt een concrete aanpak, en had achteraf wellicht betere nog een keer kunnen oefenen. (Translation: *In hindsight, I could perhaps have thought of a better approach. The teacher made it seem relatively easy beforehand, but it was quite challenging to do everything at the same time. Also, giving attention to*

*the children instead of just looking at my paper was difficult. I didn't really have a concrete approach and, in hindsight, I should have practiced again.*)

**Q2. How did I feel?**

Gestrest, paniekerig, opgejaagd. (Translation: *Stressed, panicky, rushed*)

**Q3. What did I want?**

Ik had eigenlijk geen concreet doel. Ook wellicht omdat die niet duidelijk werd gesteld of van mij werd verwacht. Ik had beter kunnen oefenen zodat de kleuren beter in mijn hoofd zaten en ik de muziek beter kende. (Translation: *I actually didn't have a concrete goal. Perhaps also because it wasn't clearly set or expected of me. I could have practiced better so that the colors were better in my head and I knew the music better.*)

**Q4. What did I do?**

Ik probeerde wel eerst naar een leerling te wijzen om vervolgens met een opwaartse beweging aandacht te trekken en met de neerwaartse beweging het exact moment van aanslaan te markeren.

Ik had wellicht concreter en eerder de opwaartse beweging kunnen inzetten door ook goed gebruik te maken van twee handen. En ook een concrete sein te verzinnen voor snel opvolgende noten. Daarnaast door beter de muziek en kleuren te kennen had ik meer aandacht aan de seinen en de kinderen kunnen geven. (Translation: *I first tried to point at a student and then use an upward movement to attract attention and a downward movement to mark the exact moment of striking. I could have used the upward movement more concretely and earlier by making good use of both hands. Additionally, I could have devised a specific signal for quickly consecutive notes. Furthermore, by knowing the music and colors better, I could have given more attention to the signals and the children.*)

**Q5. What did the pupils think?**

De kinderen zaten in ieder geval aandachtig te kijken. Volgens mij begrepen ze wat ze moesten doen. Alleen voelde het ook onnatuurlijk dat de kinderen doorspeelden als ik geen goeie sein gaf bijvoorbeeld. Waardoor ze dan bijvoorbeeld voor liepen. Ik denk dat het veel chaotischer was geworden als dat niet was gebeurd. Daarnaast verwacht ik dat de kinderen in ieder geval het concept al snappen, dus dat dit al eerder is uitgelegd. (Translate: *The children were at least watching attentively. I think they understood what they had to do. However, it also felt unnatural that the children continued playing if I didn't give a good signal, for example. This caused them to, for example, go ahead. I think it would have been much more chaotic if that hadn't happened. Additionally, I expect that the children at least understand the concept, so this has probably been explained before.*)

**Q6. How did the pupils feel?**

De kinderen zagen er tevreden uit maar ik kan me voorstellen dat in een echt

scenario ze iets minder zelfverzekerd voelden als ze ook mijn stress ervaren. Maar daar merk je hier niks van. (Translation: *The children looked content, but I can imagine that in a real scenario, they felt a bit less confident if they also experienced my stress. But you don't notice any of that here.*)

**Q7. What did the pupils want?**

Ja, dat is een beetje lastig te zeggen. Misschien heb ik dat wel helemaal gemist door mijn concentratie. Maar volgens mij deden ze allemaal goed mee. Maar achteraf wel echt niet bij stilgestaan. (Translation: *Yes, that's a bit difficult to say. Maybe I completely missed it because of my concentration. But I think they all participated well. But afterwards, I really didn't think about it.*)

**Q8. What did the pupils do?**

Ze deden volgens mij goed mee. Maar ook kom ik er eigenlijk achter dat daar weinig focus op lag en dat ik wellicht te veel bezig was met het dirigeren. (Translate: *They participated well in my opinion. But I also realized that there was little focus on it and that I might have been too occupied with conducting.*)

## A.16 Participant 9 IVR reflection

**Q0. What was the context?**

Inderdaad nu ervaren dat in een cue miste, zoals ik zelf ook door had. Voor de rest na de vorige vragen nu iets bewuster gekeken naar de mede leerlingen en hoe zij zich gedroegen. Maar door de taak om mee te doen ook al snel daar de focus op. (Translation: *Indeed, now experienced that I missed a cue, as I had also noticed myself. Furthermore, after the previous questions, I now paid a bit more attention to the fellow students and how they behaved. But due to the task of participating, the focus was quickly on that again.*)

**Q1. What did I think?**

Niet veel anders dan voorheen. (Translation: *Not much different than before.*)

**Q2. How did I feel?**

Niet veel anders dan voorheen. (Translation: *Not much different than before.*)

**Q3. What did I want?**

Ja nog steeds inderdaad was ik de draad kwijt en dat merk je meteen, omdat je vage of te late seinen krijgt. Voor de rest niet veel meer. (Translation: *Yes, still indeed I was lost, and you notice that immediately because you receive vague or late signals. Otherwise, not much more.*)

**Q4. What did I do?**

Niet veel anders dan voorheen. (Translation: *Not much different than before.*)

**Q5. What did the pupils think?**

Het zag er eigenlijk duidelijk uit in VR dan op het scherm, ik kon een paar keer mijn eigen cue goed interpreteren, en tegelijk op het moment dat ik het kwijt was kan je inderdaad niet zo veel als kind. (Translation: *It actually looked clearer in VR than on the screen, I could interpret my own cues well a few times, and at the same time, when I lost it, you indeed cannot do much as a child.*)

**Q6. How did the pupils feel?**

Niet veel anders dan via de video. Kreeg in VR meer de focus mee van de kinderen. (Translation: *Not much different than via the video. In VR, I got more focus from the children.*)

**Q7. What did the pupils want?**

Niet veel anders dan via de video. Door mee te doen kon ik wat gemakkelijk de andere kinderen in de gaten houden en die lekken goed mee te willen doen. (Translation: *Not much different than via the video. By participating, I could easily keep an eye on the other children and make sure they wanted to participate as well.*)

**Q8. What did the pupils do?**

Ja nog steeds deden ze wat ik wou, maar mijn handelen had daar in VR volgens mij geen invloed op. (Translation: *Yes, they still did what I wanted, but my actions, according to me, had no influence on that in VR.*)

## A.17 Participant 10 IVR reflection

**Q0. What was the context?**

As a fictive music student, it was easy to make a distinction who was being addressed or pointed at. Eye contact was key, besides the hand gestures. Giving the lesson, it was hard to split attention between the sheet music and the students. At one point, I had to focus fully on the sheet music, which I later (as a student) experienced as the teacher losing connection due to the lack of eye contact. In the half-circle setup, it was comfortable to address each other and have a clear view of all the other actors.

**Q1. What did I think?**

I tried to read and ”predict” the music forward so I didn’t have to keep looking at my sheet music. Maintaining eye contact was key for me. During the lesson, I felt a little rushed because I didn’t know the song that well, I found it hard to match the color to the seat intuitively and I had a very hard time not having the students seated in a progressive scale. Afterwards, I felt slightly disappointed I couldn’t give the lesson intuitively, but had to work actively throughout the lesson to match the students to the notes.

**Q2. How did I feel?**

After only experiencing it as a student, I felt very confident that I could do it. However, after seeing the sheet music, I became slightly nervous as I didn't know the song by heart (unlike the first song), the colours were hard to discern, and the students were not seated in a progressive note scale. After doing the first 8 beats relatively well in my experience, I felt more confident again, perhaps luring me into slacking off, which caused me to lose track in the second half of the song. It was very hard to recover where one is on the sheet once you're out of the rhythm. I felt slightly panicked in the last 4 beats.

**Q3. What did I want?**

I wanted to focus on perfect timing and clear gestures. I think I managed relatively well in the first half of the song. I couldn't make as clear gestures in the second half because my attention was absorbed by reading the sheet music carefully and matching the colours to the kids. I could have practiced the song more beforehand to know intuitively which note would come when. This intuitive approach, however, would have been limited for me by the fact the kids weren't sitting in the place where I expected the respective note.

**Q4. What did I do?**

The first half showed my actions as I intended; clear eye contact and rhythmic hands that indicated the timing. In the second half, I was not able to convey this anymore because the sheet music became harder to read and took up more of my attention.

**Q5. What did the pupils think?**

I think the pupils understood the directions given to them. I can imagine they become more unsure when there is no eye contact. This creates a difficult conflict with reading the sheet music. The students were paying attention perfectly, if they were watching each other instead of me, it would have been much harder.

**Q6. How did the pupils feel?**

I think the pupils experienced excitement as they were exclusively pointed out. I would have expected them to be more confused as I trailed off a bit in the second half. They seemed to enjoy themselves.

**Q7. What did the pupils want?**

I think the pupils are keen to be included and want to partake in the song. I try to connect with them trough eye contact, to keep them engaged. Everybody seemed happy to participate.

**Q8. What did the pupils do?**

The pupils did what I wanted them to do. There wasn't any pupil that stood out for me.

## A.18 Participant 10 video reflection

**Q0. What was the context?**

Similar to last answers.

**Q1. What did I think?**

I was hunched a little, giving an introverted look. This was not intended, and perhaps due to lack of bodily awareness in VR.

**Q2. How did I feel?**

Similar to last answers.

**Q3. What did I want?**

Looking back again, I think it went better than I initially remembered. As teacher, I mostly focussed on the few mistakes, but in a bigger picture it went quite okay. The goals of having everyone participate in a musical lesson were achieved and I think the pupils enjoyed it.

**Q4. What did I do?**

I didn't intend to be hunched, I would have liked to stand up more straight and move more cheerful. I was too occupied with the sheet music to pay attention to my body language. I think this is also more difficult for me in VR.

**Q5. What did the pupils think?**

Similar to last answers

**Q6. How did the pupils feel?**

Similar to last answers

**Q7. What did the pupils want?**

Similar to last answers

**Q8. What did the pupils do?**

Similar to last answers

## A.19 Participant 11 video reflection

**Q0. What was the context?**

I was a music teacher, standing in front of the (small) class. It was in a primary school classroom. I was teaching the class to play a simple song. The kids had to hit the boomwacker to play a certain note. I lost the rhythm a few times, which messed up the timing. Especially the second and third verse. It was pretty fun to do. But also quite difficult, because I didn't know the song

**Q1. What did I think?**

I was trying to stick to the rhythm mainly. That was the biggest concern. I decided to follow the example video and just point at the people that had to hit a certain note.

**Q2. How did I feel?**

It's a bit of a stretch but I felt very slightly nervous, as I was trying to stick to the rhythm. I felt somewhat happy when the song turned out alright.

**Q3. What did I want?**

My goal was that the kids played the song correctly. Nothing extra really.

**Q4. What did I do?**

When rewatching from the kids' point of view, I notice that I was not very enthousiastic. I just pointed at the people when it was their turn. What I would improve is two things: 1. Be more clear whose note it is. Not just pointing at but stretching my arm towards that person. 2. Slightly aim my arm towards the next kid/note. Then they can see my arm coming and they know that the next note is theirs.

**Q5. What did the pupils think?**

In the simulation they looked very focussed. But that's probably just because they are programmed that way ;). I think in practice they would prefer me to be more clear by doing the improvements I wrote in Q4.

**Q6. How did the pupils feel?**

I think the pupils would be happy after the lesson. They looked like they enjoyed the lesson. Maybe they felt some slight annoyance when I was late with pointing at the next kid/note.

**Q7. What did the pupils want?**

They all seemed to want to follow the lesson. I saw no indication that they didn't want to participate. They all hit the notes when they had to.

**Q8. What did the pupils do?**

During and after the lesson they didn't seem to be doing anything. During the lesson they just hit the notes; nothing else.

## A.20 Participant 11 IVR reflection

**Q0. What was the context?**

Now I was the pupil. I had to play the red note. It was actually better than I expected.

**Q1. What did I think?**

No new insights.

**Q2. How did I feel?**

No new insights.

**Q3. What did I want?**

No new insights.

**Q4. What did I do?**

One thing I noticed as a pupil is that it was very confusing/distracting if the ”teacher” was looking in my direction. The teacher should only be looking at the pupil that should be playing the note.

**Q5. What did the pupils think?**

No new insights.

**Q6. How did the pupils feel?**

I felt quite happy after being the pupil of my own lesson. I did a bit better that I expected after performing the lesson at first.

**Q7. What did the pupils want?**

No new insights.

**Q8. What did the pupils do?**

Something I did, but the other pupils didn’t, is hitting the boomwacker on the table a few times. Just to get used to it, or just to play around.

# Appendix B: Interviews

## B.1 Participant 1 interview transcribed

**Wat was jou ervaring van de VR simulatie?**
(Translation: *What was your experience in the VR simulation?)*

Ja grappig om jezelf ook terug te kunnen zien. De environment zag er ook leuk uit.
(Translation: *Yes, it was funny to be able to see yourself. The environment was also nice*)

**Waren er ook dingen waardoor het realistisch aanvoelde?**
(Translation: *Were there things that made it feel realistic?*)

De hands tracking vond ik wel nice.
(Translation: *De hands tracking vond ik wel nice*)

**En over de omgeving of the avatars?**
(Translation: *And about the environment or the avatars?*)

Nou, die vond ik een beetje static. Kreeg het gevoel dat je helemaal niks terug krijgt van de avatars.
(Translation: *Well, I though those were a little static. It felt like the avatars did not respond to anything.*)

**Waren er bepaalde dingen die je uit de immersion haalde?**
(Translation: *Was there anything that took you out of the immersion?*)

Nee, dat niet. Alleen de angle van de boomwhacker. Soms moest ik zo slaan

dat ik dacht van, ja, dat voelde niet helemaal handig.
(Translation: *No not that. Only the angle of the boomwhacker. Sometimes I had to hit like this, that did not feel correct.*)

**Maar de feedback van waneer je op de tafel sloeg was wel goed?**

Ja, dat klopte allemaal.
(Translation: *Yes, that was correct.* )

**Denk je dat deze simulatie gebruikt kan worden om te verbeteren hoe je een muziekles geeft door te reflecteren op hoe je de les geeft?**
(Translation: *Do you think the simulation can be used to improve how you give music lesson by being able to reflect on your own lesson?*

Ja, dat denk ik wel.
(Translation: *Yes, I think so*)

**Zijn er dingen die jij mist die de simulatie beter kunnen maken?**
(Translation: *Are there things that could be added to improve the simulation?*)

Ja, de facial expressions. Dat is voor de kinderen ook wel belangrijk. Dan weet je beter of het goed gaat.
(Translation: *Yes, the facial expressions. That is for the pupils also important. To show if it goes well.*)

## B.2 Participant 2 interview transcribed

**What was your overal impression of the simulation?**

It is nice. I will always like VR, but this is really, really good because if throws you into the setting of the situation. You know, practicing at home is always practicing the movements with maybe like a bunch of plushies instead of students would maybe help. But with this, you feel like you are actually there. So you feel the nervousness.

**Where there parts of the simulation that felt particularly realistic?**

Well, I mean, if I got the kids to know that song and really stick to the beat that well, isn't all that realistic. I would assume that they would wait until you point at them before they start hitting the boomwhacker. I do not that's realistic. But outside

that, I think it's fine. You know that they're standing in a circle that you have a piece of paper in front of you. As a whole the setup and the song you have to use, the metronome, I think that's realistic.

**You already mentioned some things that were less realistic, did those or anything else take you out of the immersion?**

Well, I mean, it is not that it throws me out of the immersion pre se, because I can understand why it happens. But the double register of the boomwhacker is the only thing that could really pull you out.

**Based on everything you experienced, do you think this simulation can be used to practice and effectively reflect on how you give music lessons?**

Definitely, I think would work for both. Because you really get that, like, you know with kids, they'll be wandering off with minds and looking at different way and that does not really work in a VR environment in my opinion. SO with that you can really tell whether or not what the teacher is doing is like eye-catching. You know, cause a lot of time they'll have like big movements and they really look at you when they they're meant to do it. It is really good to do it in VR because you can really see whether or not you did that as a teacher. I do think it is good because the immersion allows you to slowly get over your nervousness. For me it is not just about the music lesson but with other things as well. You know, nothing really beats the real setting of the thing, right? I can practice as many times as I want, but if I sit down for the exam I will still feel nervous.

## B.3 Participant 3 interview transcribed

**Wat was jouw eerste indruk van de simulatie?**
(Translation: *What was your first impression of the simulation?*

Ik vond het echt heel leuk, omdat het nu tegenwoordig wat morderner is dan de laatste keer dat ik VR heb gebruikt. Hij was veel meer responsief op je handen en op je bewegingen. Wat het ook leuker maakt. Ik was ook heel benieuwd hoe je de muziekles had geïmplementeerd, want ik wist dat het een muziekles zou zijn, maar voor de rest wist ik niks. Het was heel leuk.
(Translation: *I really enjoyed it because it is much more modern now than the last*

*time I used VR. It was much more responsive to your hands and movements, which made it more enjoyable. I was also very curious about how you had implemented the music lesson because I knew it was going to be a music lesson, but I didn't know anything else. It was very fun.*)

**Waren we bepaalde dingen die er voor jou uitsprongen als realistisch?**
(Translation: *Were they are things that you found to be realistic?*)

Ja, mijn eigen bewegingen, zeg maar, hoe die werden vertaald in het systeem waren vrij realistisch. Voor de rest, ja qua visualisaties was het niet heel realistisch natuurlijk, maar de bewegingen en alles, dat voelde vrij goed. // (Translation: *Yes, my own movements, I mean, how they were translated into the system were quite realistic. Otherwise, in terms of visualizations, it was not very realistic, of course, but the movements and everything, that felt pretty good.*)

**En dan de andere kant, waren er dingen die voor nou minder realistisch waren, die je uit de immersion haalde?**
(Translation: *And then the other side, was there anything that was less realistic, that took you out of the immersion?*)

Nee, ja, ik weet niet echt. Ik was super gefocused. Omdat ik echt het gevoel had dat ik het goed wilde doen. Zeg maar, zoals meer dan het daadwerkelijk lesgven, want ik was ook echt geschokt toen ik die surveyvraag zag met, hoe voelde de student, ik had geen idee. Ik was echt in pure focus. Dat als je hier in de muziek bent, dan moet je daar naar toe wijzen. Dat was het enige waar ik aan dacht. En ook bij het laatste stuk, waar ik de les moest volgen, was hetzelfde. Het was dan wel makkelijker, maar ik was heel gefocussed op, als hij naar mij wijst dat ik dan de boomwhacker moet slaan. Maar voor de rest was er niet echt iets dat eruit sprong als, dit werkt niet goed of dit haalt mij echt uit de immersion.
(Translation: *No, well, I don't really know. I was super focused. Because I really felt like I wanted to do it well. Like, more than actually teaching, because I was really shocked when I saw that survey question with, how did the student feel, I had no idea. I was really in pure focus. That if you are here in the music, then you have to point to it. That was the only thing I thought about. And also in the last part, where I had to follow the lesson, it was the same. It was easier then, but I was very focused on, if he points at me, then I have to hit the boomwhacker. But there was not really anything that felt to me like it did not work well or sometime that threw me out of the immersion.*)

Laatste vraag dan. Denk je dat deze simulatie gebruikt kan worden om te oefenen en te reflecteren op hoe je een muziekles geeft?
(Translation: *Last question then. Do you think this simulation can be used to pratice and reflect on how you give a music lesson?*)

Ik vind het lastig om mijzelf te verplaatsen in een muziekdocent of PABO student.
(Translation: *I do not think I can see this from the perspective of a music teacher or PABO student.*)

**Snap ik, maar als je ppur kijkt naar wat jij hebt ervaren. Zou je als je een muziekles zou moeten geven het dan anders doen door wat je nu gedaan hebt?**
(Translation: *I understand, but if you only look at what you have just experienced, if you were asked to give a music lesson, would you do anything different based on what you have just experienced?*)

Ja dat denk ik wel. Nu maakte het niet zoveel uit, want zoals ik ook al heb opgeschreven, some wees ik naar links omdat die moest spelen en dan keek ik naar rechts omdat ik wist dat die daarna iets moest gaan spelen. Maar ik kan mij voorstellen dat het voor kleine kinderen beter werkt als je ze ook echt goed aankijkt. Nu bespeelde ik alleen maar het systeem, in plaats van echt lesgeven. Ja, naar mijn idee, ik denk dat als het aankijken beter was dat je dan beter kan oefenen dan dat ik nu gedaan heb. Maar in principe is het systeem best goed. Ik denk dat een muziekles best wel zo ongeveer gaat. Al is het even gelefen dat ik er een zelf heb gehad. (Translation: *Yes, I think so. Now it didn't matter much, because as I wrote before, sometimes I pointed to the left because they had to play, and then I looked to the right because I knew the next one would have to play. But I can imagine that it works better for young children if you really look at them properly. Now I was only playing the system instead of really teaching. Yeah, in my opinion, I think if the eye contact was better, you could practice better than I did now. But in principle, the system is pretty good. I think that's roughly how a music lesson goes. Although it's been a while since I've had one myself.*)

## B.4 Participant 4 interview transcribed

**Wat was jou indruk van de simulatie?**
(Translation: *What was your impression of the simulation?*)

Toen ik de informatie had gelezen dacht ik van, oke, ik ga dus kinderen met boomwhackers lesgeven. Toen dacht ik al van, oh, dit lijkt me wel leuk zeg, en ook best wel prima te doen. Het was niet meteen leren hoe je een blokfluit moet spelen of wat dan ook. Het was wel gewoon een muziekles waarvan ik dacht van oke, ik denk dat je dit best redelijk snel kan leren en ik vond het ook echt leuk om te doen.
(Translation: *Once I had read the information, I thought, okay, I'm going to teach kids with boomwhackers. Then I thought, oh, this seems fun to me and also quite doable. It wasn't immediately learning how to play the recorder or anything like that. It was just a music lesson which I thought, okay, I think you can learn this quite reasonably quickly, and I also really enjoyed doing it.*)

**Waren er dingen die je realistisch vond?**
(Translation: *Was there anything you found to be realistic*)

Ja, ik vond wel, zeg maar, die handgebaren, zeg maar, die kwamen wel heel realistisch over. Maar soms zat er dan misschien een kleine hapering in, zeg maar. Het was wel in VR, denk dat als het in het echt was dat het dan wel wat directer en net wat duidelijker was, omdat je dan ook echt een persoon aan kan kijken, zeg maar.
(Translation: *Yes, I thought, you know, those hand gestures, you know, they came across very realistically. But sometimes there might have been a small glitch, you know. It was in VR, I think if it were real life, it would be more direct and a bit clearer, because you can actually look at a person, you know.*)

**Waren er ook dingen die je uit de immersion haalde, die ervoor zorgde dat je niet meer voelde dat je deel uitmaakte van de virtuele omgeving?**
(Translation: Was there anything that took you out of the immersion, that caused you to feel like you were no longer part of the virtual environment?)

Nee, eigenlijk niet. Ik zat er best wel gewoon in. Toen ik die headset ook afzette, dacht ik, oh ja, ik ben gewoon in een hokje. Dus ik zat er echt wel in, het voelde wel heel echt. Alleen gewoon het feit dat je met, om het zo maar te zeggen, met getekende poppetjes zat, maakte het wel iets minder echt ja.
(Translation: *No, not really. I was pretty immersed in it. When I took off the headset, I thought, oh yeah, I'm just in a little room. So I was really in it, it felt very real. Just the fact that you were, so to speak, with drawn characters made it a bit less real, yes.*)

**Nu dat je de simulation hebt ervaren, denk je dat het gebruikt kan worden voor het oefenen en reflecteren op hoe je een muziekles geeft?**
(Translation: *After experiencing it, do you think this simulation can be used to practice and reflect on how you give music lessons?*)

Ik denk dat het een goede eerste stap zou zijn tot het leren van, oke, hoe moet ik het überhaupt doen en hoe zou ik het doen? en dat je daarna dus, zeg maar, dat het helpt om het te implementeren voor hoe je het in een echte klas zou doen. Want dan heb je natuurlijk meer indrukken en heel veel emoties bij die kinderen, dat had je nu iets minder. Maar ik denk dat voor de basis voor het begginnen met leren, ik denk dat dit wel heel goed zou kunnen zijn.
(Translation: *I think it would be a good first step for learning, okay, how should I even do it and how would I do it? and that it then helps to implement it for how you would do it in a real class. Because then you naturally have more impressions and a lot of emotions with those children, which you had a bit less of now. But I think that for the basics for starting to learn, I think this could be very good.*)

## B.5 Participant 5 interview transcribed

*Expert*

**Wat was je eerste indruk van de simulatie?**
(Translation: *What was your first impression of the simulation?*)

Nou vooral zeg maar, de docent was echt een stuk beter dan het eerst was, want je ziet nu echt hoe de leerling de docent ziet. Je ziet later ook jezelf en zeg maar als die avatar. Dan zie je ook alle handbewegingen en hoe hij staat en zo. Dat je dat helemaal terug ziet is iets wat wij natuurlijk normaal niet zien als muziekdocenten tijdens een les, dus dat viel me erg op, dat het echt een hele grote verbetering was. Gewoon die reflectie de hele tijd. Voor de rest vond ik de werkvorm ook wel, ja, het was anders dan we eerst een beetje hadden bedacht eerst. Maar het was ook wel gewoon een goede werkvorm om mee te beginnen, dus dat viel me heel goed.
(Translation: *Well, mainly, the teacher was really a lot better than it was at first because you actually see how the student sees the teacher now. You also later see yourself, like, as that avatar. Then you also see all the hand movements and how he stands and so on. Seeing all that back is something we, of course, don't normally see as music teachers during a lesson, so it really struck me that it was a huge improvement. Just that reflection all the time. Otherwise, I also found the format, well,*

*yeah, it was different from what we had originally thought at first. But it was also just a good format to start with, so it worked really well for me.*)

**Was er iets dat je realistich over vond komen?**
(Translation: *Was there anything that you found realistic?*)

Ja, vooral het reactie voormogen van de leerlingen op de docent was echt super realistisch, want ja het is gewoon, als de docent een handgebaar geeft dan reageert de leerling ook gelijk door met de boomwhacker te slaan en dat is ook gewoon hoe het in het echt gaat, dus dat vond ik het meest realistisch. Natuurlijk is het niet heel realistisch qua layout qua hoe de poppetjes eruit zien dat soort dingen, maar dat hoeft ook opzich niet, want het is gewoon effectief. Wat ik minder vond, bedacht ik mij, zijn de gezichtsuitdrukkingen en zo, want er waren ook vragen zoals ”wat zou de leerling denken?”, maar het natuurlijk allemaal geprogrameerd, dus dat kan helemaal niet. Het was echt een beetje te clean ofzo, want leerlingen hebben soms echt een reactievermogen en dan je echt van, hoe kan dat? Zeg maar het kan echt zijn dat een leerling gewoon twee seconden later reageert. Dat is gewoon soms zo en dan gaan dus de ene boomwhacker door de ander heen. Dan moet je als docent gewoon zeggen van nee, deze noot komt eerst en die die noot. Dat is een gedeelte wat niet wordt geofend. Het is allemaal gewoon alsof je een super goede klas hebt die het toch al kan. Alleen jij als docent kan het fout doen, maar de leerlingen maken dat geen fout. Een kinderliedje instuderen is heel makkelijk voor ons, dat doen wij in 5 minuten en dat staat het er. Dat is dus niet een vaardigheid die wij hoeven te oefenen.
(Translation: *Yes, especially the reaction capability of the students to the teacher was really super realistic, because yes, it's just like, when the teacher makes a hand gesture, then the student also immediately reacts by hitting with the boomwhacker, and that's just how it actually goes, so I found that the most realistic. Of course, it's not very realistic in terms of layout like how the figures look, those kinds of things, but that doesn't have to be, because it's just effective. What I found less realistic, I realized, are the facial expressions and such, because there were also questions like, 'What would the student think?', but naturally it's all programmed, so that can't be done at all. It was really a bit too clean or something, because students sometimes have a reaction capability and then you're really like, how is that possible? It really can be that a student just reacts two seconds later. That's just sometimes how it is, and then one boomwhacker goes through the other. Then, as a teacher, you just have to say, no, this note comes first and then that note. That's a part that isn't practiced. It's all just like you have a super good class that can already do it. Only you as a teacher can make a mistake, but the students don't make mistakes.*

*Practicing a children's song is very easy for us, we do that in 5 minutes and then it's done. So that's not a skill we need to practice.*)

**Gebeurde er iets waardoor je echt uit de ervaring gehaald werdt? Dat je jezelf niet meer deel voelde uitmaken van de virtuele omgeving?**
(Translation: *Did something happen that took you out of the experience? Something that made you feel like you were no longer part of the virtual environment?*)

Wat ik vooral lastig vond, is dat je opeen een metronoom hoort, en ik snap het opzich wel, want je hebt natuurlijk een tempo et cetera. En dat is hartstikke goed als je eerst zeg maar het liedje hoort en dat ermee doe aftikken, dan weet je wanneer het liedje begint. Maar als jij als docent begint, je staat voor de klas, je druk op start, dan begint de metronoom te tikken. Ik denk dat als muzikant, 1 2 3 4 spelen, en geef het dan gelijk door aan de leerlingen. Terwijl normaal als jij als docent voor een klas staat, jij komt daar binnen en ze een boomwhacker in handen, dan moet je nog uitleggen hoe het werkt. Dan moet je zeggen, dit is het nummer dat we gaan spelen, deze noten horen daarbij, willen julie het lied eventueel meezingen? Dan nog uitleggen hoe de handgebaren zitten. Dat hebben we allemaal niet gedaan. Ik heb ook de les niet afgesloten. Ik heb alleen maar aangegeven wanneer wie moest spelen. Daarna was ik zelfs vergeten om de les af te sluiten, het was gewoon van zo, en nu is het klaar. Dat is niet hoe het gaat, want dat gedeelte van het alleen maar aangeven dat kunnen wij. Dat is niet moeilijk. Maar we struggelen gewoon met de uitleg met als er iets fout gaat. Of wat als de leerlingen bijvoorbeeld al lang kunnen zoals deze klas, wat ga je dan doen? Je kan het niet nog 3 kwartier herhalen, want daar hebben ze geen zin in. Of stel je hebt een suprt slechte klas die er wel misschien 3 kwartier voor nodig heeft, hoe ga je zorgen dat ze het in die 3 kwartier ook wel echt kunnen? En, dat zij gewoon dingen die je, in zo'n wereld niet kan, dat trok mij gewoon heel erg eruit. Het is eigenlijk een spelletje waarbij ik het toch allang kon en alle andere dingen, ja, daar heb ik gewoon niet op gelet. Ik heb zelfs nauwelijks gelt op de leerlingen, ik dacht ,die spelen toch gewoon? Maar echte leerlingen doen dat niet, zeg maar.
(Translation: *What I found especially difficult is that you suddenly hear a metronome, and I understand it to some extent because you naturally have a tempo, etc. And that's very good if you first hear the song and tap along with it, then you know when the song starts. But if you, as a teacher, start and stand in front of the class, you press start, and then the metronome starts ticking. I think that as a musician, 1 2 3 4 play, and then immediately pass it on to the students. Whereas normally, if you, as a teacher, stand in front of a class, you enter and they have a boomwhacker in hand, then you still need to explain how it works. Then you have to say, this is the*

*song we are going to play, these notes belong to it, do you want to possibly sing along with the song? Then still explain how the hand gestures work. We didn't do all that. I also didn't close the lesson. I only indicated when who should play. After that, I even forgot to close the lesson, it was just like, and now it's done. That's not how it goes because that part of just indicating we can do. That's not difficult. But we struggle with explaining when something goes wrong. Or what if the students might already be able to like this class, what are you going to do then? You can't repeat it for another 45 minutes because they don't feel like that. Or suppose you have a really poor class that might need 45 minutes, how do you ensure they can really do it within those 45 minutes? And those are just things you can't do in such a world, that really pulled me out of it. It's actually a game that I could already do for a long time and all the other things, yes, I just didn't pay attention to them. I barely paid attention to the students, I thought, they just play, don't they? But real students don't do that, you know.*)

**Zie je wel of en hoe dit gebruikt kan worden voor reflectie en het oefenen van muziekles geven?**
(Translation: *Do you see how this can be used for relfection and for practicing how to give music lessons?*)

Ja, sowieso, want we hebben nu op dit moment IOS Connect en daarmee kan je jezelf filmen tijdens dat je les geeft. Dat kun je daarna terug kijken. Wat vervelend is, is dat je de hele les moet opnemen, waardoor je dus, zeg maar, alle wisselingen bijvoorbeeld, dan je de eerste 5 minuten wachten tot alle kinderen op hun plek zitten. Bij zo'n VR kun gelijk zien welke werkvorm je moet oefenen, dus alleen het gedeelte waar jij als docent je vaardigheden moet laten zien. Daar kan je dan gelijk op terug reflecteren, in plaats van dat je bijvoorbeeld 3 kwartier een les moet afkijken. Dus wat er nu stiekum gebeurd is dat we door de video heen scrollen, want het is zo lang. 9 van de 10 keer zijn de kinderen ook hartstikke afgeleid als je zo'n mobiel ergens in de ruimte neerzet, dat het geeft ook niet helemaal een eerlijk beeld van hoe je lesgeeft. En nu kan ik wel zien wat ik doe qua lichaamstaal, al mis ik dan nog wel bijvoorbeeld nog gewoon de gezichtsuitdrukkingen. En dat het geen nut heeft als je gaat praten in de VR wereld. Ik kan nu wel een mooie uitleg gaan geven, maar die kinderen zullen daar nu niet op anticiperen. Dat is wel wat er in het echt gebeurd. Dat mis je gewoon. I vond het ook raar dat je eerst als leerling in een les zit en het lijkt alsof de docent een uitleg geeft, maar je hoort niks.
(Translation: *Yes, definitely, because we currently have IOS Connect and with that you can film yourself while teaching. You can watch it back afterward. What's annoying is that you have to record the whole lesson, which means you have to, say, wait*

*the first 5 minutes for all the children to be seated. With VR you can immediately see which aspect you need to practice, so only the part where you, as a teacher, need to demonstrate your skills. You can then immediately reflect on that, instead of having to watch a 45-minute lesson. So what we secretly do now is scroll through the video because it's so long. 9 out of 10 times the children are also very distracted when you place a mobile somewhere in the room, so it doesn't completely give a fair picture of how you teach. And now I can see what I do in terms of body language, although I still miss, for example, the facial expressions. And it's useless to talk in the VR world. I can give a nice explanation now, but the children will not anticipate it. That is what happens in real life. You just miss that. I also found it strange that you first sit in a class as a student and it seems like the teacher is giving an explanation, but you don't hear anything.*)

**Wat zou er toegevoegd moeten worden zodat de simulation voor jou echt nut heeft?**
(Translation: *What would need to be added before the simulation is useful to you?*)

Dat je een instructie moet geven. Nu oefen je vooral je lichaamstaal en het aangeven. Nu kan je natuurlijk de instructie uit je hoofd leren, dus wat het nog beter zou maken is als leerlingen erop gaan anticiperen. Dan kan je verschillende levels hebben, want je hebt ook verschillende klassen en leerlingen. Dat er bepaalde dingen mis gaan, zodat je daarop kan oefenen. Wat moet je dan zeggen? Wat moet je doen? Ook in lichaamstaal, maar ook in instructies pratent. Wat als het heel goed gaat, wat voor extra dingen kan je dan bedenken? Dat er nog gewoon niet in deze werkvorm. Als het echte leerlingen waren zouden zij letterlijk alleen met de boomwhacker slaan, maar geen idee hebben van wat ze nou echt hebben geleerd. Er mist een duidelijk leerdoel. Wij hebben altijd iets dat we met de leerlingen moeten behalen, iets dat ze moeten weten aan het einde van de les. Ze weten niet welke noot erbij welk kleurtje wordt. Ze weten niet wat voor liedje. Het is allemaal dat soort dingen, dat zou het veel beter maken, want dan heb je in ieder geval leerdoelen, is echt het aller allerbelangrijkste wat ze nu bij de scholen aanbieden als ze dat niet behaald worden, dan is het gewoon, ja, dat heb ik gedaan. Ja, ja, was gewoon een beetje tijdverspilling.
(Translation: *That you should give an instruction. Now you mainly practice your body language and indicating. You can naturally memorize the instruction, so what would make it even better is if students start to anticipate it. Then you can have different levels, because you also have different classes and students. That certain things go wrong, so you can practice that. What should you say then? What should you do? Also in body language, but also in giving instructions. What if it goes very well, what extra things can you think of then? That's just not part of this format yet. If they*

*were real students, they would literally only hit with the boomwhacker, but have no idea what they've really learned. There is a lack of a clear learning goal. We always have something that we need to achieve with the students, something they should know by the end of the lesson. They don't know which note corresponds to which color. They don't know which song. It's all those kinds of things, that would make it much better, because then you at least have learning goals, which is really the most important thing they offer in schools now, if they're not achieved, then it's just, yeah, what I've done. Yeah, yeah, was just a bit of a waste of time.*)

## B.6 Participant 6 interview transcribed

**What was your first impression of the VR simulation?**

I thought it was quite nice. I thought actually the animations and stuff was more advanced than I would have assumed actually, so that looked really nice. I also said in the questionnaire that I like th controls like the gestures and like with the sick and the dot, it made sense. Like of course it's not something you immediately figure out like, a small thing maybe. Later on, it would be easier if the children look a bit different, because with remembering like which one had which color, sometimes was a bit difficult. Also with like the keeping an overview of like the sheet music and the children was a bit tough. I'm not sure how the scale is in real life, but it felt like the paper was like small and maybe I was too high or something. I could not look at everything at once, so it was sometimes like, looking around a bit. And during the lesson I was giving, initially I thought like, I guess also because in the song the first few notes are the smae, I thought for a moment that that was like the metronome, but, and then I realized, oh, wait, those were the notes they were already playing. I don't know if you have different versions of this, but I would have preferred if they would just follow what I do. Now they knew the song already, so if I made the mistake they were already too far and I could not catch up.

**Were there any particular aspects of the simulation that you found to be particular realistic?**

Realistic, yeah, the classroom and I think, yeah, also as a student, when I bit the boomwhacker on the table and stuff like it, it felt natural that it would make the sound when it did and stuff like that. I also thought, yeah, like also my shadow or how I look as the teacher, it was quite realistic. Yeah, the fact that some people look the same, maybe not so realistic, but that's fine. What else? Also the tasks seemed like something you would have in a primary school setting.

**Did something like the pupils looking the same or anything else that you experienced as less realistic take you out of the immersion?**

Not necessarily out of the immersion. I mean it depends what you want to do anyway, like with the VR. So for this I think it was fine, but like in real life, of course, you have added problems probably like someone might just get up and leave, or like yell or something. So those things you do not have in this version, which is fine for what it is. No, it did not take me out of it, I was quite immersed. It just was quite quick, I guess also for the research, but yeah.

**Do you see this being used to practice giving music lessons and help with reflecting?**

I quite liked it because, I mean, I also watched the video of me teaching, but to be honest it felt different to be in the students spot following the lessons. So I thought that was actually quite nice. Also in this case like you could a bit more clearly see when maybe you point to this side, but then, like you, you can see that sometimes it's less clear from the student point of view who you are pointing at from that angle. So I thought that was helpful. I don't know how they normally teach things, but yeah, this seems pretty straightforward and I can imagine that, yeah, having such simulations would make people feel more confident before going into a more chaotic environment.So, and one thing I already put in the questionnaire, but if someone in color blinds this would not work as well. That is one thing. I thought it was pretty promising and you can have that with different activities I guess, like you could have maybe a database or something. Like a database of different activities they could do in their music classes so they can just learn. I think it is helpful that you start learning one way of doing it. but I don't know if that would make people only do it that way, like if it would kill creativity. But I don't think so, if they are primary school teacher, they will come up with different ways. So maybe you could also show different ways of teaching so they can get more ideas. Like this could also look this way. Because just looking and pointing was kind of, too clear if you ask me.

## B.7 Participant 7 interview transcribed

**Wat was jouw eerste indruk van de simulatie?**
(Translation: *What was your first impression of the simulation?*)

Nou, het VR gedeelte werkt allemaal erg goed. De controls ook duidelijk. Van tevoren had ik niet echt een idee wat we allemaal gingen doen. Ik zal ene beetje doorheen gaan wat ik allemaal dacht toen ik daar eerst als leerling zat. Ik vond het snel duidelijk wat de docent aan het doen was, en daarna wilde ik eigenlijk die docent zo veel mogelijk na doen. Ja, de controls waren wel duidelijk, dus ik wist snel hoe je alles kon doen met de handbewegingen en de controller.
(Translation: *Well, the VR part works really well. The controls are also clear. Beforehand, I didn't really have an idea of what we were going to do. I'll go through a bit of what I thought when I first sat there as a student. I found it quickly clear what the teacher was doing, and then I actually wanted to imitate the teacher as much as possible. Yes, the controls were clear, so I quickly knew how to do everything with the hand movements and the controller.*)

**Waren er bepaalde aspecten die je als realistisch hebt ervaren?**
(Translation:*Were there any aspects you experienced as being realistic?*)

Nou, zoals ik al zie, de VR werke goed, dus ik had wel echt zeg maar, ik eigenlik het hele gedeelte in het geheel best wel realistisch. Ik kon mij best goed inleven met wat er gebeurde.
(Translation:*Well, as I mentioned, the VR worked well, so I really felt like the whole part was quite realistic. I could empathize well with what was happening.*)

**Waren er ook dingen die je minder realistich vond, die je misschien zelfs uit de ervaring haalde?**
(Translation:*Were there also things you found less realistic, that perhaps even took you out of the experience?*)

Nou, er zat een leerling, die was gekopieerd en geplakt rechts. Dat onder andere, verder, nou ja, het was duidelijk niet fotorealistisch, maar nee, verder niks.
(Translation: *Well, there was a student, who was copied and pasted on the right. That among other things, well, yeah, it was clearly not photorealistic, but no, nothing else.*)

**Denk jij dat deze simulaite nuttig kan zijn voor PABO studenten die beter willen leren hoe ze muziekles op een basisschool kunnen geven?**
(Translation: *Do you think this simulation can be useful for teacher training students who want to learn better how to teach music lessons in primary school?*)

Ja, wat ik vooral denk is dat hetgene was het meest nut heeft, denk ik, is dat je zelf dus kan kijken naar hoe je daar hebt gestaan en wat je dan met je lichaamstaal doet. Ik denk dat dat bestwel nuttig is. Kon er gewoon van mezelf zien hoe ik gewoon stond en hoe ik allerhande bewegingen maakte en dergelijke.
(Translate: *Yes, what I mainly think is that what is most useful, I think, is that you can look at how you stood there yourself and what you do with your body language. I think that is quite useful. I could just see from myself how I stood and how I made various movements and the like.*)

## B.8 Participant 8 interview transcribed

**What was you first overall impression of the VR simulation?**

Yeah, I thought it, like, the whole classroom and the students looked very, like, cute. Like the setting and the background. Yeah, I think it was fun to practice with this. Hitting with the boomwhacker and as a teacher. I guess the first thing that stood out was, yeah, I don't know. I was struggling a bit like other students were set so far apart. Like by the time I had, like, realized where they were sitting and where I'm supposed to point at. Usually the nest note was already playing, so I felt like I was a bit lagging behind.

**Did anything in particular feel realistic?**

Yeah, I mean, the student kind of did their own thing. I guess that felt rather realistic. I think the main thing that stood out was the student reacting to whatever I was doing.

**Did anything happen that took you out of the immersion?**

Ummm, yeah, I felt like as a student, like, I sometimes accidentally wrecked the thing, especially when I was trying to hit it, and up it did it like twice. But I think that is just the thing with VR, probably that you struggle a bit with motion.

**And from the teacher side?**

I don't know, like, I was struggling with like pointing at the student, but they played the song regardless of it, right? Like, they just went on. So I was trying to catch up to them, but maybe that is also good, because otherwise you can get completely lost. Like if you stop pointing they stop playing. Maybe that is more realistic, but maybe

for learning how to teach, it is nice if they're a bit more responsive.

**The goal of the simulation is to help pre-service teacher help with practicing giving music lessons and relfect on how they give a lesson. Do you think this simulation can be used for that purpose?**

Yeah, I think it's definitely, like, useful. I mean, I have not really any experience with teaching, but I would imagine it is useful to at least, yeah, make this test run and like see how the students react and then also see your own actions. Especially I think watching the video, I could really see myself, like, lagging behind and like the body language seemed a bit unsure like i was a bit confused. I guess you don't notice that if just give a lesson and get some feedback from other people, maybe it is more clear if you actually see yourself doing it.

## B.9 Participant 9 interview transcribed

**Wat was jouw eerste indruk van de VR simulatie?**
(Translation:*What was your first impression of the VR simulation?*)

Ja, grappig, het voelt wel echt alsof je die kinderen iets probeert door te geven, dus de omgeving voelt wel heel realistisch aan, zeg maar. Dus ik had wel echt het idee dat ik voor een groep kinderen stond. Op een gegeven moment was ik het kwijt soort van, ik had gewoon niet meer door waar ik op papier was en toen speelde het gewoon door en dat voelde wel verwarrend. Dan verwacht je eigenlijk dat ze dan ook stilvallen en dat de meest je soort van twijfelachtig naar je gaan kijken. Maar dat gebeurd niet. Maar voor de rest, ja, je had wel het gevoeldat ze heel erg geconcentreerd naar je zaten te kijken. En op basis van de reflectie? Ja, ik weet niet hoeveel van dat soort vragen komen, maar op basis van de reflectie zat ik soort van, ik was wel echt met mijn eigen ding bezig. Ik probeerde wel echt een soort van dat dirigeren goed te doen, en als er dan vragen komen van, hoe staat de leerling erbij, dan dacht ik van: "Oh, daar heb ik eigenlijk helemaal niet op gelet." (Translation: *Yes, funny, it really feels like you're trying to convey something to those children, so the environment feels very realistic, so to speak. So I really had the feeling that I was standing in front of a group of children. At one point, I kind of lost track, I just didn't realize where I was on paper anymore, and then it just went on, and that felt quite confusing. Then you actually expect them to fall silent and kind of look at you questioningly. But that doesn't happen. But otherwise, yes, you did feel like they were very focused on looking at you. And based on the reflection? Yes, I don't know how many of those kinds of questions are coming, but based on the reflection I was*

*kind of just doing my own thing. I really tried to do a kind of conducting well, and if questions then come up like, how is the student doing, then I thought, 'Oh, I actually didn't pay attention to that at all.'*)

**Wat waren de aspecten die je realistisch over vond komen?**
(Translation: *What were the aspects that you found to be realistic?*)

Nou ja, soweiso natuurlijk dat je in een klaslokaal staat. Je hoort gewoon geluid en dat matched met wat ze doen, dus dat zorgt wel voor dat je denkt van ja. En dat je handen gewoon je handen zijn, dat zorgt er echt voor dat je dus ook met je vingers gaat bewegen. Ja, dat zijn denk ik wel de sterkste. Dat zorgt voor mij wel dat ik het gevoel had dat ik er echt stond.
(Translation: *Well yes, of course, you're standing in a classroom. You just hear sound and it matches with what they're doing, so that makes you think, yes. And that your hands are just your hands, that really causes you to also move your fingers. Yes, I think those are indeed the strongest aspects. That made me feel like I was really standing there.*)

**Je had al benoemd dat je het soms even kwijt was en dat de kinderen dan wel doorspeelde waren er ook andere dingen die je minder realistisch vond? Was dat ook iets dat jou uit de ervaring haalde?**
(Translation: *You already mentioned that you sometimes lost track and the children continued playing; were there any other things you found less realistic? Was that also something that took you out of the experience?*)

Ja, nou ja, dat maakt wel de beleving, soort van, dan krijg je wel minder het gevoel dat het aan jou te doen doen is, weet je wel?Jij moet natuurlijk wel het gevoel van de regie houden en als je dat verliest dan zou je dat wel willen zien in de realiteit, maar dat gebeurt niet. Dat zorgt wel dat je dan denkt van, oh ja, ik zit gewoon in een simulatie. Dat het toch een beetje de immersion breekt voor mij.
(Translation:*Yes, well, that does affect the experience, kind of like, you get less of the feeling that it's up to you, you know? You naturally have to keep the feeling of control and if you lose that, you'd want to see that in reality, but that doesn't happen. That does make you think, oh yes, I'm just in a simulation. It kind of breaks the immersion for me.*)

**Denk jij dat deze simulatie effectief zou zijn om mense die muziekles op basisscholen willen geven met helpen hoe je dat moet doen, en ze laten reflecteren op hoe ze het doen?**

(Translation: *Do you think this simulation would be effective in helping people who want to teach music lessons in primary schools learn how to do it, and have them reflect on how they are doing it?*)

Nou ja, ik denk het wel, een soort van. De vragen achteraf hielpen mij heel erg bij het bedenken van, waar gaat het eigenlijk om? Want ik was heel erg doelgericht met het muziek overbrengen. Als ik dan een vraag gesteld wordt van, hoe zaten de kinderen erbij? Dat ik dan eigenlijk denk van, oh, dat ik eigenlijk niet. Dat is dan interessant en wat ik dan zou meenemen als ik ooit echt een les zou geven. Dat je op deze manier echt ervaart, niet persé leert, maar echt ervaart van, oh ja, daar let ik helemaal niet op. Dus ik denk dat dat heel effectief is. En toch, dat zij dus niet echt reageren op wat je doet, dat maakt het wel soort van dat, als ik in een chaos zit, dan wordt het bij mij ook chaotisch, maar het moet nog wel goed gaan. Dat is natuurlijk wel, dat is denk ik wel iets wat je echt moet leren in de praktijk, of als de simulatie beter is. Maar ik denk dat het wel nuttig kan zijn, helemala omdat je gewoon eens door hebt van, oke, nu sta ik onder een soort van stress voor een klas waar iets van mij verwacht wordt. Hoe kun je dan nog steeds goed de kinderen in de gaten houden? ik denk dat dat wel heel effectief is zonder dat je meteen voor een echt klas staat. Ja oké ja, en nog even, want je had nu natuurlijk ook de vergelijking met video. Ik zat nog wel te denken, misscien zou het nog fijner zijn als ik achteraf in plaats avn had mee kunnen doen, gewoon in het klaslokaal kon zitten. Want dan heb je omdat je nu ook de taak kreeg om weer met die boomwhacker to gaan slaan, dus was je daar vooral mee bezig, en minder met hoe breng ik het over als ik iets deed. Misschien had ik dat nog wel interessanter gevonden om gewoon achterin de klas te gaan zitten in VR om te kijken hoe dat eruit ziet.
(Translation: *Well, yes, I think so, sort of. The questions afterward really helped me think about what it's actually about. Because I was very goal-oriented about conveying the music. When a question is then asked, how were the children doing? That I actually think, oh, that I actually didn't. That is interesting and something I would take with me if I ever really gave a lesson. That you really experience, not necessarily learn, but really experience like, oh yeah, I completely didn't pay attention to that. So I think it's very effective. And still, since they don't really respond to what you do, it kind of becomes that when I'm in chaos, it also gets chaotic for me, but it still has to go well. That is something that you really have to learn in practice, or if the simulation improves. But I think it can be useful, especially because you just realize, okay, now I'm under some stress for a class that expects something from me. How can you still keep a good eye on the children? I think that is very effective without immediately standing in a real class. Yes, okay, and just to add, because you now also had the comparison with video. I was still thinking, maybe it would be even nicer*

*if afterward, instead of participating, I could just sit in the classroom. Because then, since you also had the task to hit with that boomwhacker again, you were mainly busy with that, and less with how I convey it when I did something. Perhaps I would have found it more interesting to just sit in the back of the classroom in VR to see what it looks like.*)

## B.10 Participant 10 interview transcribed

**Wat was je eerst indruk van de VR simulatie?**
(Translation: *What was your first impression of the VR simulation?*)

Hele ervaring, ja, leuk, is iets niews. Leuke manier om ermee bezig te zijn. Veel dingen waarvan ik dacht, hé, dit maakt het echt wel realistisch, die kwamen op mij over als wat ik in een echt lokaal zou verwachten. Dat viel mij niks tegen. Je hebt het gevoel dat je echt interactie hebt met de kinderen en ze kijken je aan. Ik denk dat het oogcontact voor mij heel belangrijk was. Het zijn niet alleen maar bewegende objecten maar je hebt echt een connectie met ze.
(Translation: *The whole experience, yes, fun, is something new. A nice way to be engaged with it. Many things that I thought, hey, this really makes it realistic, came across to me as what I would expect in a real classroom. That didn't disappoint me. You have the feeling that you really interact with the children and they look at you. I think eye contact was very important to me. They are not just moving objects but you really have a connection with them.*)

**Welke aspecten kwamen op jou over als realistich?**
(Translation: *What aspects did you find to be realistic?*)

Ik hoef nu geen rekening te houden met onverwachts gedrag van de kinderen. Ik omcht ervan uitgaan dat de kinderen gewoon mij aankeken en niks geks deden eigenlijk. Dat het aspect van lesgeven dat je niet alleen maar de kennisoverdracht doet, maar ook het gedrag in de gaten houd, ik weet niet of dat volledig realistisch is. Misschien moet je ook met andere dingen rekening houden.
(Translation: *I don't have to take into account unexpected behavior from the children now. I could assume that the children just looked at me and didn't do anything strange, actually. The aspect of teaching where you not only convey knowledge but also keep an eye on behavior, I don't know if that's completely realistic. Maybe you also need to take other things into account.*)

**Heb je ook een voorbeeld van iets dat je uit de immersion haalde?**
(Translation: *Do you have an example of something that took you out of the immersion?*)

Nee, nee, de immersion was erg goed voor mij.
(Translation: *No, no, the immersion was very good for me.*)

**Nu dat jij dit hebt meegemaakt, denk jij dat deze simulatie gebruikt kan worden door iemand die net begint met leren over hoe je een muziekles geeft om te oefenen en te reflecteren?**
(Translation: *Now that you have experienced this, do you think that this simulation can be used by someone who is just starting to learn how to give a music lesson to practice and reflect?*)

Als het gaat over het reflecteren met een video of in VR vanuit een outsider perspectief, dan denk ik dat je er heel veel van kan leren. Een deel van de feedback die ik scheef, had ik niet kunnen schijven vanuit mijn eigen perspectief als docent. Toen focussesde ik vooral op de subjectieve ervaring van mij als docent. Als outsider als je het bekijt dan denk je, oké, maar qua lichaamstaal dit of dat en hoe is de interactie. In die zin is het een hele goede feedback tool. Maar om te bekijken en zien of er dan een groot verschil in zit tussen de video en hoe de studenten dat meemaken, ik weet niet of er dan een groot verschil zit tussen de video of het als student meemaken.
(Translation: *When it comes to reflecting with a video or in VR from an outsider perspective, then I think you can learn a lot from it. Part of the feedback I wrote, I couldn't have written from my own perspective as a teacher. Then I focused mainly on my subjective experience as a teacher. As an outsider when you look at it, then you think, okay, but in terms of body language or interaction. In that sense, it's a really good feedback tool. But to review and see if there's a big difference between the video and how the students experience it, I don't know if there's a big difference between the video or experiencing it as a student.*)

## B.11 Participant 11 interview transcribed

**Wat was jouw eerste indruk van de simulatie?**
(Translation: *What was your first impression of the simulation?*)

Nou ik vond het echt wel geinig om te doen. Ja, ik dacht eerst van, oh het is wel

lastig om dat ritme goed vast te houden, zeker als je dat liedje niet kent. Maar dan keek je noet de video terug en het leek om zich wel mee te vallen met hoe ik het deed. Het ging best prima. Ja, verder, ik heb ook allemaal vragen moeten beantwoorden over wat de kinderen allemaal vonden, maar volgens mij waren ze niet geprogrammeerd om heel veel verschillende dingen te doen. Dus daar heb ik op zich niet heel veel inzicht over of ze wel of niet op letten, of ze wel of niet meededen. Volgens mij raakte iedereen wel alle noten, dus, prima.
(Translation: *Well, I found it quite fun to do. At first, I thought, oh, it's quite difficult to keep that rhythm, especially if you don't know the song. But then you watched the video back and it seemed to be fine with how I did it. It went pretty well. Yes, further, I also had to answer all kinds of questions about what the children thought, but I don't think they were programmed to do many different things. So I don't have much insight into whether they paid attention or whether they participated. I think everyone hit all the notes, so, fine.*)

**Waren er dingen die je minder realistisch vond?**
(Translation: *Were there things you found less realistic?*)

Nou, ik denk dat als je echt voor de klas staat, ten eerste heb je dan nog wel wat meer kinderen en ik denk dat die wel gewoon heel veel drukker aan het zij met ofwel praten of schreeuwen of met dat ding gaan slaan. Dat soort dingen. Het is misschien wel representatief, maar het is denk ik nog niet echt te vergelijken met voor een echte klas staan.
(Translation:*Well, I think when you're actually standing in front of a class, first of all, you have a few more children and I think they are much busier with either talking or shouting or hitting that thing. That kind of stuff. It may be representative, but I don't think it's really comparable to standing in front of a real class.*)

**Wat kwam wel realistisch over?**
(Translation: *What did come across as realistic?*)

Ja, op zich het hele idee van VR voelt echt, geeft wel het idee dat ik voor de klas sta. Dus wat dat betreft werkt het wel echt goed. Ik denk zeker als er nog meer kinderen zouden staan en ze misscihen wel bewegen ofzo, dan denk ik dat het echt wel realistisch zou voelen.
(Translation: *Yes, in itself the whole idea of VR feels real, it gives the impression that I am standing in front of the class. So in that respect, it really works well. I think especially if there would be more children and if they maybe moved or something, then I think it would feel really realistic.*)

**Denk je dat deze simulatie een effectieve manier is om te reflecteren op hoe je een muziekles geeft?**
(Translation: *Do you think this simulation provides a good way to reflect on how you give a music lesson?*)

Ja, ik denk eigenlijk wel zeker. Omdat ik ook zelf van mijn eigenlijk ging kijken. Dat had ik nu ook niet speciaal verwacht, dus dat vind ik echt wel leuk om te zien.