THE USE OF GAMIFICATION AND VIRTUAL REALITY IN E-LEARNING TOOLS USED IN PREPARATION FOR DRIVING EXAMS

A COMPARATIVE STUDY

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ABSTRACT

Virtual Reality (VR) is becoming more mainstream and is gaining popularity in the field of education. Nowadays, VR offers great potential for instructional designers mainly when it comes to designing e-learning tools. However, the use of gamification has already been popular for some time and its effectiveness has been the topic of many studies. It is therefore interesting to see what benefits the use of VR has over gamification only in an e-learning tool. The focus of this study is to gain insight into wether the use of VR has a favourable effect on learners' motivation, user experience and learning outcome when compared to the use of only certain game elements.

This study was both exploratory and comparative in its nature. Both quantitative and qualitative data were collected from 40 participants. The quantitative data set mostly focused on already existing validated scales such as the ARCS model and the User Experience Questionnaire. The questions asked during the interviews were formulated in such a manner to gain more insight into the overall (user) experience of the participant. In order to create a fair comparison between a tool using gamification elements and a tool using VR, the same training tool was made using the two different multimedia technologies: One version in VR, playable with a smartphone in combination with VR goggles, and one version using gaming elements, playable on a laptop. The participants were randomly assigned a version to work with during which observations were made.

This study produced a number of findings: There is no statistical evidence for the use of VR being beneficial regarding learners' motivation, user experience and learning outcome. However, the qualitative data shows a strong preference for the VR version. Furthermore, learning outcome is affected by VR when used in the right circumstances. This study found strong evidence in favour of using video, both 360 video and normal video, in an e-learning tool. Finally, several physical issues arose when some participants were working with the VR version due to differing reasons.

The main conclusion that can be drawn from this study is that participants strongly favour the VR version over the gamified only version of the same training tool, mainly due to its realism and it creating an immersive simulation. However, further research is needed due to the small sample size of this study. Regarding practical implications, it is advised to take the costs of implementing VR technologies in e-learning tools into consideration. Additionally, VR should be used only when it is truly beneficial to the learning experience of the users.

Keywords: Instructional design, gamification, virtual reality (VR), motivation, user experience (UX)

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1 INTRODUCTION

Education and the concept of learning has been through a lot of changes over the years. Where traditionally education took place in a classroom, technological advancements created a shift from traditional classroom learning to online learning (Gros & García-Peñalvo, 2016). The term 'e-learning' goes by several definitions and names, and originally emerged in the 1990s. The basic idea of e-learning, with the 'e' standing for electronic, is instruction/education that is delivered by using Information and Communication Technology (ICT) to enhance knowledge (Goyal, 2012; Jamieson et al., 2014; Kakoty, Lal & Sarma, 2011). With the use of e-learning it is possible to learn from distance since the learning is no longer bound to a physical place. However, the concept of distance learning with the use of technology goes further than e-learning. Back in the 1960s, the idea of using radio and television as a way to bring education to a broad audience started to become more popular. A prominent example of this is Open University in the UK, which was based on the principle of 'open education'. It started with a published notice in 1966, but became reality with the acceptance of their first students in 1971 (Gros & García-Peñalvo, 2016; Klement & Dostál, 2016). However, with the creation of the internet a shift took place from more traditional technologies to online technologies of which its effectiveness has already been demonstrated by research in the field of education, government organisations, corporate organisations and military (Gros & García-Peñalvo, 2016; Ruiz et al., 2006), making it a popular tool that is broadly used nowadays.

In the Netherlands, novice drivers often use an e-learning exam training tool to prepare themselves for their theoretical exam which is mandatory to pass during their driving course. However, these e-learning tools tend to be quite traditional. With recent developments in multimedia technologies, instructional designers have the opportunity to implement certain technologies with the goal of enhancing learning and increase motivation. Studies have shown that motivation is a fundamental part of learning (American Psychological Association, 1993) since it has a strong impact on academic performance (Kim & Frick, 2011; Su & Cheng, 2015). A well known and popular example of enhancing motivation is with the use of gamification in a learning environment, of which its effectiveness has been the topic of many studies. The term 'gamification' was formulated in 2002 and started to show up in research on education technologies in 2008. Ever since 2010, the term has been used regularly as the technology gained in popularity (Faiella & Ricciardi, 2015). Seeing as gaming is very popular and the gaming industries is huge, it is logical that certain elements of it are implemented in the learning experience (Muntean, 2011). Gamification is therefore the use of certain game elements in a non-gaming setting (Dichev et al., 2015; Faiella & Ricciardi, 2015; Hamzah et al., 2014; Khan et al., 2017; Muntean, 2011; Su & Cheng, 2015). Overall, studies have proven it to be an effective technology to implement in e-learning since it positively impacts the motivation of the learner (Faiella & Ricciardi, 2015; Hamzah et al., 2014; Khan et al., 2017; Muntean, 2011; Nicholson, 2012; Su & Cheng, 2013; Su & Cheng, 2015).

Another fundamental part of learning is interaction (Noesgaard & Ørngreen, 2015), which is why the use of Virtual Reality (VR) technologies in education is becoming more popular. With the use of VR it is possible to create realistic simulations and lifelike experiences for learners (Martín-Gutiérrez et al., 2017; Tham et al., 2018), which is why it is often used in medical training. VR is a technology that replaces the real world with a simulated realistic virtual world created using computer generated environments (Cruz-Neira, Fernández & Portalés, 2018; Martín-Gutiérrez et al., 2017; Tham et al., 2018). The concept of VR can be traced back as far as the 1920s when it was used for vehicle simulations. Over the years the technology evolved and was used for flight simulations (Ellis, 1994). Nowadays, due to recent technological developments, VR offers great potential for the field of education (Cruz-Neira, Fernández & Portalés, 2018; Greenwald et al., 2017; Martín-Gutiérrez et al., 2017). It is expected that in the next 10 years, it will further grow and develop as a technology and will become more popular and mainstream. Due to these developments the technology will become cheaper to implement due to the use of low cost headsets and software. Realistic immersive experiences are already possible with the use of a smartphone and simple VR goggles (Martín-Gutiérrez et al., 2017).

Studies show the importance of of learners' motivation and learning outcome, and the development of new popular multimedia technologies in a learning environment and its effectiveness. Furthermore, studies have also already shown the benefits of e-learning regarding cost reduction, efficiency, accessibility and flexibility. However, not much research has been done on the attitudes and experiences of the learners working with the e-learning tools (Kakokty, Lal & Sarma, 2011). This together with the literature on learners' motivation and learning outcome, and the use of multimedia technologies form the purpose of this study. Therefore, the purpose of this study is to investigate the effects that gamification and virtual reality have on the motivation, learning outcome, and the overall user experience of new drivers who use an e-learning tool during their driving course as part of exam training. Therefore, the following main research question is proposed: *What effect does the use of gamification and virtual reality in addition to only gamification have on motivation, user experience, and learning outcome of new drivers using an e-learning tool during their course as part of exam training?*. The main goal of this study was to gain insight into wether the use of VR has a favourable effect on these specific components compared to the use of only certain game elements.

In order to conduct the study, two versions of the same e-learning training tool were created in collaboration with with Verkeersschool Boensma (a local driving school). The subject matter of these tools is relevant for those who are currently following a driving course in order to receive their license and who need (extra) practice and preparation for their exams. In collaboration with Warp Industries, one version was created in VR with the use of 360 video and some game elements. The other version was playable on a laptop and was created using gamification, but represented more traditional e-learning tools. The videos used in both training tools were the same with the exception that the VR version used 360 video making it controllable, but the videos in the gamified version do not offer this option since they were looked at on a flat screen.

2 THEORETICAL FRAMEWORK

This section focuses on existing literature on the variables relevant to this study. First, it is necessary to get into existing learning theories and how they apply to modern e-learning. Second, learners' *motivation* is examined and the ARCS model is presented in order to measure motivation in this study. Third, the use of the multimedia technologies *gamification* and *virtual reality* in e-learning and its potential benefits are discussed. Finally, the variable *user experience* is discussed together with technology acceptance.

2.1 FROM LEARNING THEORIES TO E-LEARNING

During the 20th century, several learning theories emerged that are still relevant today when trying to understand how people learn. The first of these theories is the theory of *behaviourism*, which introduced an empirical approach to learning. It was developed in the late 19th century (Harasim, 2012) but was later popularised by American psychologist and social philosopher B.F. Skinner. Skinner based the behaviourist model on his stimulus and response theory (Hung, 2001) meaning that the learner is conditioned to properly respond to an environmental stimulus (Etmer & Newby 2013; Hung, 2001; Klement & Dostál; 2016). With behaviourism the focus is on that which is observable: The main concern is with observing the connection between the stimulus and the response, and the way this connection is shaped, maintained and further enhanced (Ertmer & Newby, 2013; Harasim, 2012). Since the focus is on that which is observable, the mental processes that are necessary and that that the learner uses are not examined. The learner is seen as someone who only reacts to the provided conditions in the environment, not as someone who actively explores the environment themselves (Ertmer & Newby, 2013).

The second of the learning theories is the theory of *cognitivism*. Due to the limitations of the behaviourist model such as being unable to explain social behaviours, a shift was made towards the cognitivist model in the late 1950s (Ertmer & Newby, 2013; Harasim, 2012). Here, the importance of mental processes are recognised (Harasim, 2012; Klement & Dostál, 2016) and, in contrast with behaviourism, the learner is seen as a very active participant in the process. Cognitivism focuses on the transmission and processing of information and how it is received, organised, stored, and retrieved by the mind (Ertmer & Newby, 2013; Hung, 2001). Because mental processes are recognised, the cognitive approach is appropriate for explaining intricate forms of learning. Instead of focusing on what learners do, the focus is on what they do with knowledge and how they gain knowledge. Knowledge has to be made meaningful by connecting new information to existing knowledge in memory. A cognitivist uses feedback to guide and support proper mental connections, where a behaviourist uses feedback to steer behaviour in a desired direction. However, just like with the behaviourism, there is an emphasis on environmental conditions (Ertmer & Newby, 2013).

Finally, the third of the learning theories is the theory of *constructivism*. The constructivist theory was developed partially in reaction to behaviourism and cognitivism (Harasim, 2012), but is considered to fall under cognitivism (Ertmer & Newby, 2013). This theory focuses on the personal discovery of knowledge through creating meaning from experiences and activities, and the importance of the human mind when learning (Ertmer & Newby, 2013; Harasum, 2012; Hung, 2001). Where with cognitivism the learner is seen as someone who actively processes information, with constructivism the learner makes sense of this information and builds upon it (Ertmer & Newby, 2013). According to constructivists, situations determine behaviour thus context is perceived as being important (Ertmer & Newby, 2013; Hung, 2001). A subset of constructivism is *social constructivism*, which focuses on the social aspect of learning: it emphasises interaction with others, both peers and teachers (Harasim, 2012; Hung, 2001).

In continuation of the three major learning theories another theory was developed by Siemens (2004). This fourth theory, c*onnectivism*, is a relatively new theory compared to the three aforementioned theories since these come

from a time where learning was not yet influenced by technologies. Connectivism was developed because of the influence of new technologies. Here, the focus is on the fact that in the digital era knowledge is acquired non-stop. Therefore, it is important to be able to separate relevant information from non-relevant information and to see connections between different fields, concepts and ideas — and to maintain these connections (Siemens, 2004).

E-LEARNING AND INSTRUCTIONAL DESIGN

When looking at instructional design and its application within e-learning, the major learning theories of the 20th century still hold up nowadays. Even though e-learning itself is relatively new, the concept of electronic learning dates back to the 1950s in the form of Computer-Assisted Instruction as a way to teach problem-solving (Aparicio et al., 2016) and in the late 1960s when, according to Klement & Dostál (2016), "new learning machines were experimentally introduced within the framework of the program learning methods development" (p. 3208). However, the term e-learning was not used until 1983 when Mary Alice White coined it in a journal article (Aparicio et al., 2016).

The general idea of e-learning is that of instruction and/or education that is delivered by using information and communication technology (ICT) to enhance knowledge. (Goyal, 2012; Jamieson et al., 2014; Kakoty, Lal & Sarma, 2011). E-learning is sometimes also referred to as online learning, virtual learning, distributed learning, computer based learning, computer-assisted instruction, network and web-based learning (Aparicio et al., 2016; Goyal, 2012) and distance education/learning (Jamieson et al., 2014). E-learning integrates the following functions: Learning, information support and coaching, knowledge management, interaction and collaboration, and finally guidance and tracking, and it can be used either in a classroom setting or from a distance (Aparicio et al., 2016; Karkoty et al., 2011) meaning it overcomes restrictions based on location, distance, time and space.

E-learning is more than just the use of information technology as a device in the learning process. It also includes learning strategies and learning methods (Aparicio et al., 2016), which is why the main learning theories of the previous century are still relevant today (Ertmer & Newby, 2013). The instructional design of e-learning is based on the pedagogical principles of these learning theories in order to uphold the quality of learning (Alonso et al., 2006; Ertmer & Newby, 2013; Gros & García-Peñalvo, 2016). Research has shown that, in accordance with the learning theories, there are certain principles that apply to the design of effective e-learning: (1) The use of authentic tasks to provide learners with real-life contexts, which helps them to see the value of the content (Alonso et al., 2006; Anderson & McCormick, 2006; Ertmer & Newby, 2013; Gedik et al., 2013; Jamieson et al., 2014; Lister, 2014; Merrill, 2002), which relates to (2) The way in which the course materials are presented to the learners (Lister, 2014), (3) Promoting collaboration and interaction (Alonso et al., 2006; Lister, 2014; Noesgaard & Ørngreen, 2015), which relates to (4) A feedback option for learners (Lister, 2014). Furthermore, it is important to use the key concepts of these main learning theories and apply them to current practices in a manner that fits the personal attributes of learners by using new technologies that are at our disposal (Ertmer & Newby, 2013; Gros & García-Peñalvo, 2016; Hung, 2001; Klement & Dostál, 2016).

In addition to the aforementioned principles, Anderson & McCormick (2006) put together a set of ten principles to help instructors choose the right recourses and to help them design teaching and learning activities. Principles such as learner engagement (motivation), innovative approaches (multimedia technologies), effective learning (learning outcome), and ease of use (user experience) add to the effectiveness of the e-learning tool and are relevant for this study. These principles will be further discussed in the following paragraphs of this literature review.

2.2 THE IMPORTANCE OF LEARNERS' MOTIVATION

According to the American Psychological Association (1993), motivation is an essential part of learning. This is further corroborated by multiple research studies that show that learners' motivation has a positive impact on academic

performance (Kim & Frick, 2011; Su & Cheng, 2015). Motivation can generally be defined as one's effort to pursue a goal (Gopalan et al., 2017; Hamzah et al., 2014; Ryan & Deci, 2000). When a student is motivated to learn they will do so without needing any external rewards. However, a student that is not motivated needs external rewards to be convinced to do the learning (Gopalan et al., 2017). Motivation to learn and engage with the e-learning tool is therefore pivotal to its effectiveness (Noesgaard & Ørngreen, 2015).

According to Deci & Ryans 1985's Self-Determination Theory, there are different concepts of motivation that can be distinguished depending on learners' reasons or goals (Deci & Ryan, 2000). One of these concepts is *intrinsic motivation*. When a learner is intrinsically motivated they feel like the reward for learning comes from the learning itself by it being enjoyable and/or for personal satisfaction. However, when a learner needs external rewards in order to feel the incentive to learn, we refer to this as the concept of *extrinsic motivation*. When a learner is extrinsically motivated they will not learn for personal satisfaction but rather for external rewards (Gopalan et al., 2017; Hodges, 2004; Ryan & Deci, 2000). In short, an intrinsically motivated student is self-motivated in pursuing learning while an extrinsically motivated student has been given purpose in order to pursue learning (Gopalan et al., 2017).

ARCS MODEL

Regarding ways to measure learners' motivation, several studies write about the effectiveness of Keller's (1987) ARCS model for instructional design (Gopalan et al., 2017; Hamzah et al., 2014; Hodges, 2004; Kim & Frick, 2011; Su & Cheng, 2015). The model was developed to help instructional designers improve the motivational appeal of their instructional materials (Keller, 1987). The model is based on the belief that, in order to feel motivated, a learner needs to feel like they can succeed and they need to see the value in what they are learning (Hodges, 2004). It also increases the motivation of learners by attracting their attention or interests (Su & Cheng, 2015). Furthermore, it uses a problem-solving approach to motivate learners and stimulate their performance (Hamzah et al., 2014). The letters A, R, C, and S in the name of the model stand for attention, relevance, confidence and satisfaction. As can be seen in figure 1, these four variables together form the variable of motivation, since they are all needed to motivate a person (Keller, 1987; Keller, 2008).

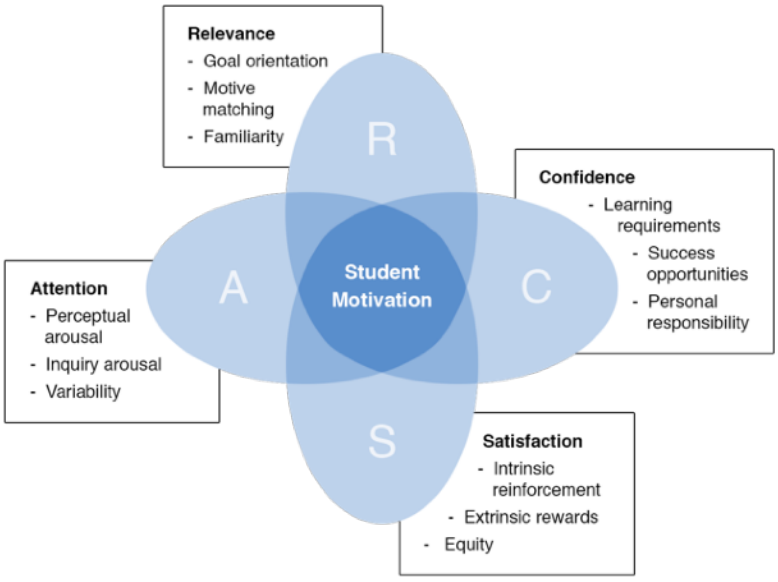

Figure 1. Categories and subcategories of the ARCS model

Attention (A) refers to gaining the learners attention by creating instructional stimuli that will sustain engagement in the learning activity (Keller, 1987). According to Ryan & Deci (2000) a learner will only be intrinsically motivated when the tasks they need to perform "have the appeal of novelty, challenge, or aesthetic value" (Ryan & Deci, 2000, p. 60), therefore it is important to peak student's attention and interest. By using attention grabbing and visually attractive learning material, a student can thus be directly motivated Gopalan et al., 2017).

Relevance (R) refers to establishing connections between the instructional environment and the learners' goals, learning styles, and past experiences. The motivation of the learner is more likely to increase when they regard the content to be relevant for them (Hodges, 2004; Kim & Frick, 2011). This is in accordance with one of the principles of

designing effective e-learning, namely providing the learner with authentic tasks. Furthmore, relevance can also come from the way the instructional materials are presented and wether it fits the learner's personal needs (Keller, 1987).

Confidence (C) refers to the learner building positive expectations regarding their performance when performing a task, meaning the motivation of the learner will increase when they believe they will be successful at mentioned task (Gopalan et al., 2017; Hamzah et al, 2014; Keller, 1987; Keller, 2008). Confidence is further stimulated when the learner experiences this success due to their own effort and not due circumstances such as luck or the ease of a task.

Satisfaction (S) is necessary for learners to have positive feelings about the learning experiences and to develop an intrinsic motivation to learn and thus developing a continuing motivation. Satisfaction is achieved when learners have acquired new knowledge or skills (Keller, 2008) and can be stimulated with external rewards (Hamzah et al., 2017) such as prizes and badges. However, the goal is to strengthen the development of intrinsic satisfaction (Keller, 1987).

The existing literature on learning theories and instructional design show that motivation is an essential part of learning and that it generally affects learning outcome. Therefore, the following sub-questions are formulated:

SQ 1 *What influence does the use of virtual reality have on learners' motivation when compared to the gamified e-learning tool?*

SQ 2 *What influence does the use of virtual reality have on the learners' final score when compared to the gamified e-learning tool?*

2.3 THE USE OF MULTIMEDIA TECHNOLOGIES IN LEARNING ENVIRONMENTS

When creating rich learning environments that are visually attractive and grab the learners' attention, the use of multimedia technologies can be beneficial. According to Mayer (2003), deeper learning is promoted within students due to the combination of visuals with words in multimedia learning. This is because content in multimedia learning can be designed in such a way that is consistent with how learners learn, and thus learners will learn more deeply from these well designed instructions. Since humans can synchronously process information from multiple modalities at once, multimedia instruction may also have a positive effect on learning effectiveness (Lau et al., 2014). However, it is important to implement these technologies in such a way it does not have a negative impact on the learner.

2.3.1 GAMIFICATION

One way of implementing a multimedia technology into an e-learning is with the use of gamification. Gamification is the use of game elements such as goals, scores and rewards in non-game applications in order to change the user's behaviour and help them accept the content (Dichev et al., 2015; Faiella & Ricciardi, 2015; Hamzah et al., 2014; Khan et al., 2017; Muntean, 2011; Su & Cheng, 2015). Within an e-learning context, gamification incorporates game dynamics and mechanics to encourage learners to participate (Faiella & Ricciardi, 2015; Hamzah et al., 2014). *Game mechanics* are gaming elements such as scores, badges, levels, leader board, avatars, goals, challenges and achievements. These mechanics enhance the extrinsic motivation of the learner (Muntean, 2011) and are not necessarily seen as 'gaming' when viewed as individual elements. However, when put together they help motivate the learner just like a 'normal' game would (Dichev et al., 2014; Muntean, 2011; Urh et al., 2015). Furthermore, they help the learner understand what the rules are and what is expected of them (Muntean, 2011; Urh et al., 2015). *Game dynamics* refers to the behaviour that emerges from gameplay and comes from the implementation of the game mechanics. For example, levelling up and the

feeling of progressions are game dynamics that ensure the learner will work towards a goal by enhancing intrinsic motivation (Dichev et al., 2014; Muntean, 2011; Urh et al, 2015).

Several studies show that gamification enhances learning engagement, problem-solving skills, learning ability, retention, and other social and cognitive skills (Faiella & Ricciardi, 2015; Hamzah et al., 2014; Khan et al., 2017; Muntean, 2011; Su & Cheng, 2015), but most of all it enhances motivation (Hamzah et al., 2014; Nicholson, 2012; Su & Cheng, 2013) and has a positive impact on learning outcome (Su & Cheng, 2013). The effectiveness of gamification is partly dependent on the use of it being meaningful. When users have a positive, relevant and meaningful learning experience, they will benefit from that in the long term (Nicholson, 2012). Furthermore, with the use of gamification a learner can focus on smaller objectives and get instant feedback after finishing an assignment (Dichev et al., 2014; Su & Cheng, 2013). In turn, instructors can easily track learners' progress thanks to game elements such as badges that learners get for certain achievements (Dichev et al., 2014).

2.3.2 VIRTUAL REALITY (VR)

Another multimedia technology that can be implemented into e-learning is Virtual Reality (VR). As can be seen in figure 2, VR is a technology that replaces the real world with a simulated realistic virtual world created using computer generated environments (Cruz-Neira, Fernández & Portalés, 2018; Martín-Gutiérrez et al., 2017; Tham et al., 2018). This virtual world can be created with either 3D software or with the use of 360 video. Several elements are key to VR, such as immersion, realism and interaction (Martín-Gutiérrez et al., 2017; Tham et al., 2018). A user is fully immersed when contact with the external real world is minimised and the user is surrounded with virtual technologies. VR thus simulates a world in which the user feels physically present (Martín-Gutiérrez et al., 2017). An important factor to this is the real-time interactivity, which makes the simulation feel authentic and real to the user due to instant feedback to their movements, position and sensations (Martín-Gutiérrez et al., 2017; Tham et al., 2018). In order to get fully immersed in the virtual world, certain hardware such as a special headset is needed. However, nowadays smartphones in combination with cheap VR goggles are enough to provide an immersive experience (Martín-Gutiérrez et al., 2017). The immersion works due to the use of simulation techniques that delude user's senses by misleading the brain with certain cues that normally come from the real world. For example with the use of perceptual cues such as visuals, sound, touch, smell, and motion stimuli (Cruz-Neira, Fernández & Portalés, 2018).

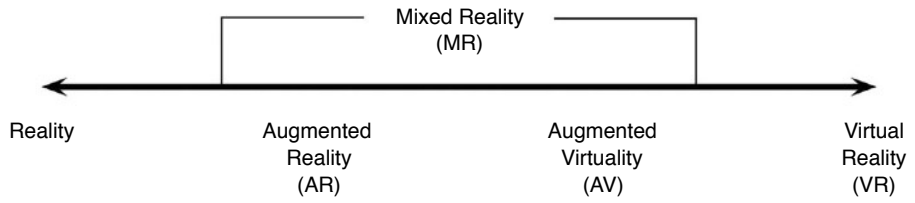

Figure 2. Continuum of mediated reality (Tham et al., 2018)

VR can help learners with collaboration either through interactions with humans in the virtual environment or with a focus on the environment itself. When the focus is on humans, learners can learn how to properly interact with humans in certain situations. When the focus is on the environment, learners can experience a certain physical place (Greenwald et al., 2017) such as an authentic context in a safe environment (Huang & Liaw, 2018). Providing learners with an authentic learning experience is part of the constructivist learning theory since context is an essential part of this theory. Additionally, it helps enhance learners' intrinsic motivation since it can enhance interest in learning and it can increase the effectiveness of the learning outcome since learners can directly apply their knowledge of the real world in the activities in the virtual world (Huang & Liaw, 2018; Martín-Gutiérrez et al., 2017).

2.4 ACCEPTANCE OF TECHNOLOGY AND USER EXPERIENCE

Even though technology acceptance is not one of the main research themes of this present study, it is useful to look into existing theories regarding technology acceptance since the e-learning training tools used in this study are created using newer multimedia technologies, namely virtual reality (VR) and gamification. A well known and widely used model for technology acceptance is David's (1989) Technology Acceptance model (TAM) — often used in e-learning acceptance studies (Huang & Liaw, 2018; Lin, 2011; Šumak, Hericko & Pušnik, 2011) — which focuses on perceived usefulness and perceived ease of use. Previous studies show that perceived usefulness, ease of use and a high level of satisfaction by users indicate wether they accept an e-learning tool or not (Hornbæk & Hertzum, 2017; Lin, 2011; Wang, 2018). Perceived usefulness together with perceived ease of use form the base for user's behavioural intention (Davis, 1989; Hornbæk & Hertzum, 2017; Šumak, Hericko & Pušnik, 2011; Venkatesh, 2000; Venkatesh et al., 2003).

Based on TAM and several other theories and models — Theory of Reasoned Action (TRA), the Motivational Model, the Theory of Planned Behaviour (TPB), a combined TBP/TAM, the Model of PC Utilisation, Innovation Diffusion Theory (IDT), and Social Cognitive Theory (SCT) — Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). UTAUT consists of four constructs (performance expectancy, effort expectancy, social influence and facilitating conditions) that determine behavioural intention. These four constructs are moderated by age, gender, experience, and voluntariness of use. The first construct, *performance expectancy,* is defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh et al., 2003, p. 447). This construct relates to TAM's perceived usefulness. Within TAM, Davis (1989) defines *perceived usefulness* as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). In other words, when a learner perceives the e-learning tool as useful this means that they believe it helps them towards achieving their goal (Lin, 2011).

The second construct, *effort expectancy*, is defined as "the degree of ease associated with the use of the system" (Venkatesh et al., 2003, p.450) which relates to TAM's perceived ease of use. *Perceived ease of use* is best defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). When an e-learning tool is perceived to be easier to work with than another tool, this influence learners' acceptance (Davis, 1989; Hornbæk & Hertzum, 2017). Davis (1989) based the importance of perceived ease of use on Bandura's (1982) research on self-efficacy. Self-efficacy is about one's belief in being able to to achieve a goal in expected situations (Davis, 1989). When a learner perceives an e-learning tool to be easy to work with, this affects their self-efficacy. Self-efficacy also plays a big role in theories on motivation, especially regarding learners' intrinsic motivation (Hodges, 2004; Kim & Frick, 2011; Ryan & Deci, 2000).

The third construct, *social influence*, is defined as "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et al., 2003, p. 451) and the fourth construct, *facilitating conditions*, is defined as "the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system" (Venkatesh et al., 2003, p. 453). These two constructs are less relevant to this present study due to the lack of organisational context and the independent character of the study.

USER EXPERIENCE

Most of the research regarding e-learning and its benefits focus on tools or on the benefits for the organisation using the tool, but not on the experience of the learners themselves (Kakoty, Lal & Sarma, 2011). The learners are the ones who work with the e-learning tools, so it is important to take their user experience into account. User experience (UX) can be described as the perceptions and reactions a person has to using a technological system, product or device. Its focus goes further than just the functional, since it examines how a person experiences said product by looking into what they

feel when it comes to the intuitive, valuable and meaningful aspects. UX is therefore an intrinsically dynamic process since the user's state — both emotionally and internally — is continuously changing before, during and after working with the product (Vermeeren et al., 2010). The user's experience is influenced by their state, the design of the product and its characteristics, and the context of use (Hassenzahl & Tractinsky, 2006). In addition to assessing the user's experience, it is important to look at why and how the user's state changes over time since this creates opportunities both regarding design and experience (Hassenzahl & Tractinsky, 2006; Vermeeren et al., 2010). Since the user's values might influence their experience, it is important to take these already into account during the design process (Nicholson, 2012; Vermeeren et al., 2010). In general, a good design with good content leads to a positive user experience, a bad design with bad content leads to a negative experience (Jamieson et al., 2014).

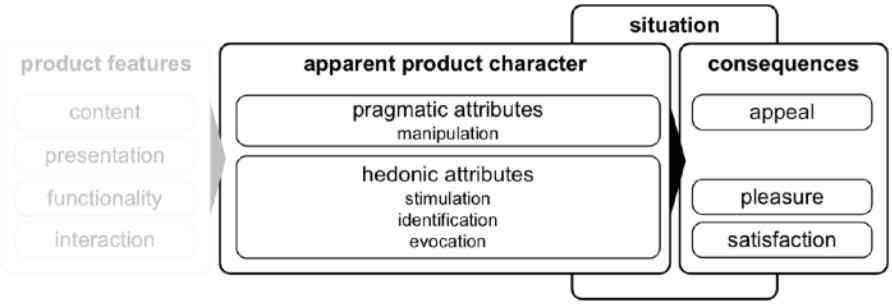

Figure 3. Key elements of the UX model from a user perspective (Hassenzahl, 2003)

As can be seen in figure 3, Hassenzahl (2003) proposed a UX model which focuses on pragmatic goal-oriented and hedonic non-goal oriented characteristics of a technological product that form "the bases for consequences, relative to a situation, including assessments of appeal, pleasure, and satisfaction" (Hornbæk & Hertzum, 2017, p. 8). The pragmatic characteristic in this model is the perceived usability by the user, and the hedonic characteristics focus on stimulation and identification (Hornbæk & Hertzum, 2017). These characteristics also form the base of the User Experience Questionnaire (UEQ) which was constructed by Schrepp, Hinderks & Thomaschewski (2014) (see figure 4). With their questionnaire, they split the concept of UX in separate constructs that can be measured independently. *Attractiveness* is the main overall construct which exists of *pragmatic quality* and *hedonic quality.* With in pragmatic quality, the goal oriented constructs *efficiency*, *perspicuity* and *dependability* are measured. Within hedonic quality, the non-goal oriented constructs *stimulation* and *novelty* are measured. Although the constructs can be measured independently, it is assumed that they influence one another since the user's response to attractiveness is presumably influenced by their response to the five other constructs. (Schrepp, Hinderks & Thomaschewski, 2014; Schrepp, Hinderks & Thomaschewski, 2017).

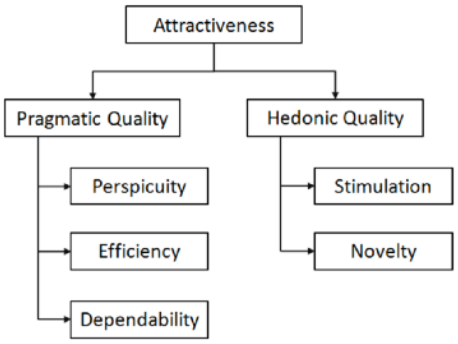

Figure 4. Assumed scale structure of the UEQ (Schrepp, Hinderks & Thomaschewski, 2014)

Based on the literature on technology acceptance and user experience, the following sub-questions are formulated:

SQ 3 *What influence does the use of virtual reality have on the overall user experience when compared to the gamified e-learning tool?*

SQ 4 *What influence does the use of virtual reality have on behavioural intention when compared to the gamified e-learning tool?*

3 RESEARCH METHOD

This section focusses on the methodology of the study based on the findings of the literature review. Here, the research design, the participants, stimulus materials, data collection and data analysis are described. In collaboration with Verkeersschool Boensma (a local driving school), the subject matter of the training tools used in this present study was for learners who were following a driving course in order to receive their license and those who needed (extra) practice and preparation for their driving exams.

3.1 RESEARCH DESIGN

In order to conduct the study, a one phase convergent mixed methods design was chosen but modified for this research. According to Creswell & Creswell (2018), a mixed methods design strengthens the research since it uses both quantitative data and qualitative data. The limitations normally associated with both approaches is limited when they are combined. Normally, the collection of both types of data in the one phase convergent method is done in the same phase, is then compared to one another and/or merged, and then interpreted. However, some adjustments where made to this original model, since the items measured in the quantitative data set (questionnaire) differ from the qualitative data set (interview). The quantitative data set mostly focuses on already existing validated scales such as the ARCS model (Keller, 1987) and the User Experience Questionnaire (Schrepp, Hinderks & Thomaschewski, 2017). The questions asked during the interviews were formulated in such a manner to gain more insight into the overall (user) experience of the participant. However, some elements from both the ARCS model and UEQ were used when formulating the interview questions.

3.2 STIMULUS MATERIALS

In order to create a fair comparison between a tool using gamification elements and a tool using VR, two versions of the same training tool was created using these two different multimedia technologies. The content of both these tools is the same: Both contain the same videos, questions and answer options, and all questions were asked in the same order. The overall goal, and therefore the main goal, for both the gamified e-learning tool and the VR e-learning tool was to prepare new driver's for the CBR exams. Therefore, both tools were performance based.

The participant had to answer ten multiple choice questions related to both practical traffic situations and theoretical knowledge regarding driving theory. The participant had a limited amount of time to answer each question, with an average of around 30 seconds. This left the participant with enough time to watch most of the videos shown per question twice, with the exception of the final two videos which had a longer duration. An example of a question is *"What do you need to take into account in this situation?"* with the video showing a specific traffic situation, e.g. a specific bicycle path that crosses the road. The answer options for this specific question was as follows: (a) cyclists from left, (b) cyclists from right, or (c) cyclists from both sides — with (c) being the correct answer.

Each question was accompanied with a video of the situation. All footage was shot in a car with a GoPro Fusion, a 360 action camera. The GoPro was attached to the headrest of the passengers seat using a magic arm and clamp. When viewed in VR this gives the participant the feeling that they themselves are sitting in this seat, thus sitting next to the driver. This was done for practical and safety reasons, since it was not possible to place the camera in the driver's seat. The GoPro footage was exported two different ways: It was rendered in 360 for the VR version and rendered flat for the gamified version. In the VR version, the 360 footage is controllable since learners can look around them. In the gamified version the footage is viewed on a laptop screen and thus viewed like any normal video.

GAMIFIED VERSION

The gamified version of the tool was created with Articulate Storyline 3 and is accessible on pc, tablet and/or smartphone. A few screenshots of this version can be seen in figure 6. The overall visual style and graphic design was based on the corporate identity of Verkeersschool Boensma, therefore a colour palette existing of solely blue and white colour tones was used.

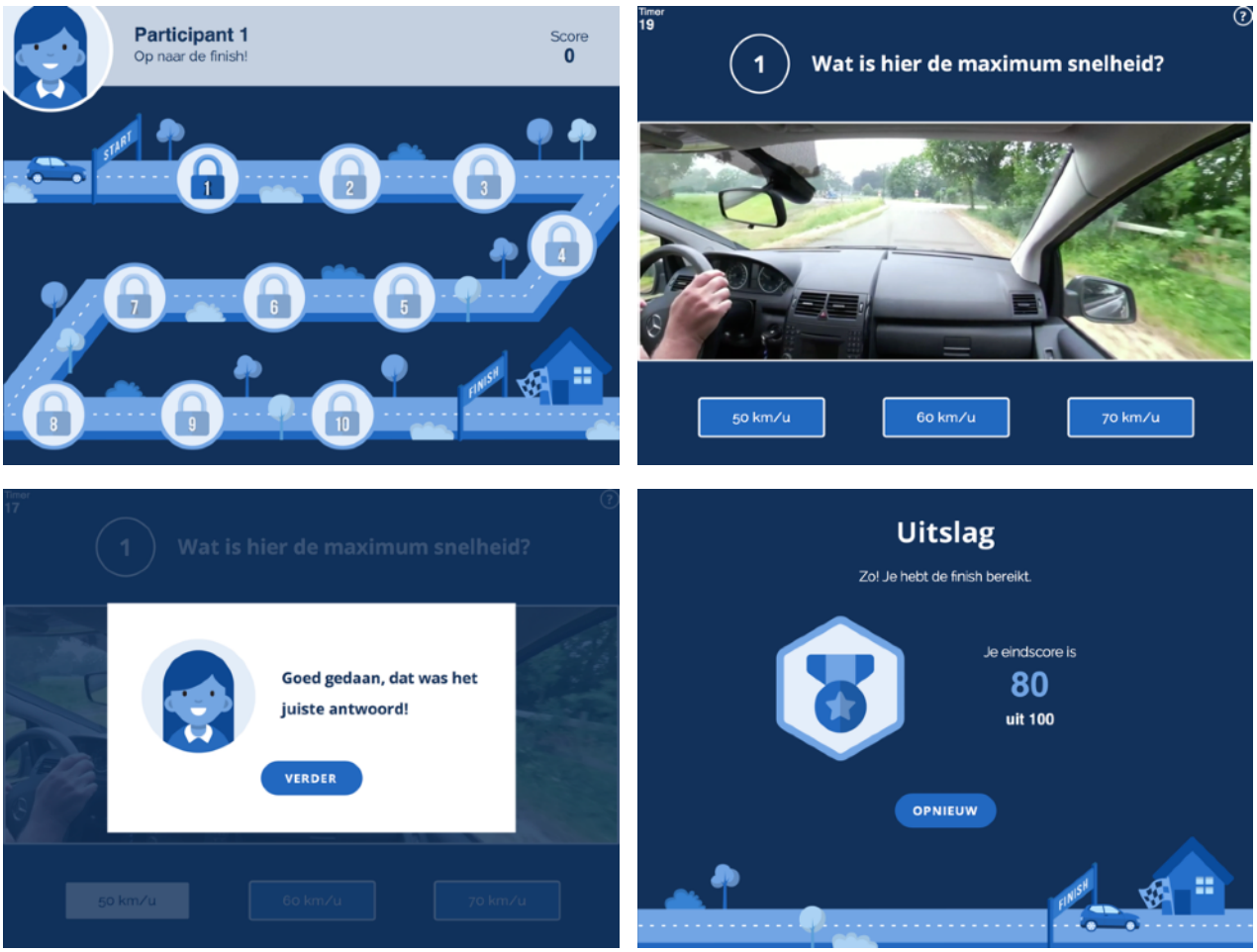

Figure 6. Screenshots of the gamified version of the training tool

In this tool the participant had to unlock multiple challenges in order to unlock the whole 'map'. The goal was to drive the chosen character safely to the finish. The training started with a few introductory screens. The first screen was a welcome screen where the participant filled in their participant code, the second screen contained an explanation of how the 'game' works, on the third screen the prizes/badges and their meaning were explained, and finally on the fourth screen the participant had to pick a character which would be visible throughout the game (see figure 7). After the introductory screens, the main map of the game is visible. In the top left corner the chosen character was shown with a 'neutral' expression, with next to it the participant's name. In the top right corner the participant's current score was visible. This score was updated after every question the participant answered. On the main map the levels of the game were visible, which were recognisable by the number of the question shown in a locked lock. All levels were greyed out in the beginning of the training, but they would become playable one by one once the participant finished a level.

Figure 7. Characters and their various moods

Each level consisted of a screen with the question, the (normal, non-controllable) video and the multiple choice answers. After answering the question the participant was shown a popup with feedback and their character would either smile happily or look shocked: The character would look 'happy' when the answer was correct and 'shocked' when the answer was wrong. The levels that were finished were 'checked off' on the map and this opened up the next level on the map. After each level the car moved further towards the finish. After answering the last question the participant was shown the final screen with their final score and the prize that goes with it. As can be seen in figure 8, there were three possible prizes a participant could 'win': The thumbs up (0-50 points), the medal (60-80 points) or the cup (90-100 points). The thumbs up meant that the participant tried but it was not enough to pass, the medallion meant that they passed but can do better, and the cup meant that they did very well. The meaning of these badges were explained to participants in one of the introduction screens at the beginning of the training tool.

Figure 8. Prizes and the amount of points they are worth

VR VERSION

The VR version of the tool was created using Warp Industries' online Studio application and is accessible on smartphone in combination with simple VR goggles (such as Google Cardboard or VR Box), see figure 9. A few screenshots of this version can be seen in figure 10. Like with the gamified version of the training tool, the same blue and white colours were used from the colour palette.

Figure 9. Overview of the backend of the VR training tool and the used tools for playing

In this tool the participant 'sat' in the passenger seat while the driving instructor was in the driver's seat driving around. In the first scene, the participant was shown some text with instructions and the driver asked wether they are ready or not. The cursor was navigated by looking at the buttons that need to be selected in the 360 VR environment. When the participant looked at 'start', the training starts. Each questions consisted of 360 footage in which the driver asked the question aloud, a text box with the question and the buttons for the multiple answer options. After answering the question the participants was shown a feedback screen. After the final question, the participant was shown a screen in which the driver asked them how it went. After this scene the final score was shown, which based based on a rating of 1 to 5 stars.

Figure 10a. Screenshots of the VR version of the training tool

Figure 10b. Screenshots of the VR version of the training tool

3.3 PROCEDURES AND MEASURES

Data was collected in several different ways and with several different methods. The procedure for data collection was as follows: The participant first filled out the first part of the questionnaire which consisted of several general questions asking about the participants age, gender, education, and some questions regarding how far along they are in the driving course and what their perceived knowledge levels were. The questionnaire then randomly assigned one of the training tool versions, which the participant then worked with. This part of the experiment was filmed for observation, for which the participant filled out the informed consent form (see Appendix A). When the participant was done working with the tool, they filled out the rest of the questionnaire. After this, the interview took place. The interview was recorded by audio for transcribing purposes. Finally, at the end of the interview the participant was asked to work with the other version of the training tool and was asked to make a comparison between the two versions.

3.3.1 QUESTIONNAIRE

When the participant was done testing the tool, they continued to fill out the questionnaire. The first few questions after testing were about the final score, followed by questions regarding motivation, user experience and finally the chances of re-use and recommendation. In table 1 an overview of the constructs and their Cronbach's Alpha scores can be found.

Motivation — Motivation was measured using questions from the ARCS model (Keller, 1987) by using the reduced version of IMMS (Instructional Materials Motivation Survey) namely the RIMMS (Reduced Instructional Materials Motivation Survey). Loorbach et al. (2015) reduced the IMMS to 12 questions without loss of validation or quality. The variable of motivation is normally measured by its four components: *attention* ($\alpha = 0.85$), *relevance* ($\alpha = 0.45$), *confidence* ($\alpha = 0.64$) and *satisfaction* ($\alpha = 0.76$). Each component existed of three questions. An example of one of the questions of the component satisfaction is: *"I really enjoyed working with the training tool."* The participants had to rate the questions from 'not true' to 'very true' with the use of a 5-point Likert scale.

Since the component of relevance has a very low Cronbach's Alpha, the decision was made to remove it from statistical analysis. The questions of this component were the following in the questionnaire: "(1) It is clear to me how the content of this training tool is related to things I already know", "(2) the content and style of writing in this training tool convey the impression that its content is worth knowing" and "(3) the content of this training tool will be useful to me". The

item total statistics of these items shows that the answers to item (2) were most consistent and the answers to items (1) and (3) were least consistent. An explanation for the inconsistent answers to item (1) might be that the participants who were at the beginning of the driving course might not yet have acquired the knowledge to answer some of the questions that were asked in the training tool. Additionally, an explanation for the inconsistent answers to item (3) might be that participants who were nearly done with the course and/or already passed their exams might not see the relevance of the training tools in their current situation. After excluding relevance from the variable motivation, the Cronbach's Alpha is 0.87. In the statistic analysis for this study, the variable motivation contains nine items in total excluding three items.

User Experience — User Experience was measured using the scales from the User Experience Questionnaire (Schrepp, Hinderks & Thomaschewski, 2017). The UEQ exists of six scales which contain a total of 26 items. An example of one of the questions of the scale attractiveness is: *"The exam training is.."* with the participant having to rate the question from 'unpleasant' to 'pleasant' with the use of a 7-point Likert scale. The six scales of the UEQ are divided in three categories: the pure valence dimension *attractiveness* (α = 0.89), the goal-directed *pragmatic quality* (α = 0.79) and the non goal-directed *hedonic quality* (α = 0.85). *Pragmatic quality* includes the following scales: efficiency (α = 0.68, excluding Q9), perspicuity (α = 0.69) and dependability (α = 0.29). Since the reliability score for dependability is very low, this scale was excluded from statistic analysis. The final category, *hedonic quality*, includes the following scales: stimulation (α = 0.83) and novelty (α = 0.72, excluding Q26). After excluding dependability (Q8, Q11, Q17 and Q19), Q9 (efficiency) and Q26 (novelty) from the variable user experience, the Cronbach's Alpha is 0.92. In the statistic analysis for this study, the variable user experience contains 20 items in total excluding six items.

Behavioural intention — At the end of the questionnaire are two questions regarding re-use and recommendation (together α = 0.81). These questions are: *"How big is the chance that you will use the training tool again?"* and *"How big is the chance that you will recommend the training tool to others?"*. Participants had to rate these two questions from 'very small' to 'very big' on a 5-point Likert scale. The first question of the two is a way to measure relevance and the second question is a way to measure satisfaction and potential relevance for others. These questions were formulated based on both existing literature regarding technology acceptance (Davis, 1989; Venkatesh et al., 2003) and online sources on how to conduct a user experience survey (Trista, 2018) in order to get useful feedback, and questions user experience designer should be asking during user research (Kroll, 2017). Kroll (2017) was used because the website UX Collective is known within the field of user experience designers. The article by Trista (2018) was taken from an online platform specialised in prototyping. It offers additional inspiration and insight on which questions should be asked in order to get useful feedback from participants. Multiple other online sources on both user experience and user experience design use the same list of questions as the aforementioned resources.

Table 1. Overview of Cronbach's Alpha scores per construct and item

Construct	Scale	Items	Number of items	Cronbach's Alpha
Motivation	Reduced Instructional Materials Motivation Survey by Loorbach et al. (2015) based on Keller (1987)	Attention	3	.85
		Confidence	3	.64
		Satisfaction	3	.76
		Motivation	9	.87
User Experience	User Experience Questionnaire by Schrepp, Hinderks & Thomaschewski (2017)	Attractiveness	6	.89
		Pragmatic Quality	7	.79
		Efficiency	3	.68
		Perspicuity	4	.69

		Hedonic quality	7	.85
		Stimulation	4	.83
		Novelty	3	.72
		User Experience	20	.92
Behavioural intention	Existing literature on technology acceptance (Davis, 1989; Venkatesh et al., 2003) and online user experience (design) sources by Kroll (2017) and Trista (2018)	Re-use and recommendation	2	.81

3.3.2 INTERVIEWS

After the participant was done filling out the questionnaire, the interview took place. The interviews were recorded to make transcribing easier. The interview questions (Appendix C) were formulated based on themes fitting the study and were partly based on validated models and tools normally used for quantitative research such as the questionnaire in qualtrics. This was done so a proper comparison is possible between the results of the quantitative data from the questionnaire and the extra insight the interviews might offer. The main goal of the questions was to gather extra in-depth information regarding the dependent variables and the following themes: Overall impression, ease of use, compelling elements, learners' motivation, perceived value, further development and comparison of the two versions. There were 25 interview questions in total and after every question the participant was asked to explain further why or why not something was the case and therefore further state their opinion.

The goal of the first few questions was to gather more insight regarding the *pre-knowledge* of participants regarding working with e-learning or online training tools, experience with VR and gaming in general. At the end of the interview the participant had the opportunity to say anything they wanted to say either in addition to what was previously discussed or what they found to be extra important to mention.

The general introduction questions were followed by a set of questions related to *user experience.* These were based on the User Experience Questionnaire (Schrepp, Hinderks & Thomaschewski, 2014) and also online sources on user experience design (Kroll, 2017; Trista, 2018). The goal of these questions was to gather more insight regarding the overall style, the usability, the most compelling and positive but also the most negative aspects (and thus *further development*), and the perceived usefulness of the training tool. An example one of these questions is: *"To what extent do you find the training easy to work with (and why/why not)?"*. Later on during the interview, other more specific questions were asked regarding the *further development* of the tool—such as *"Would you use this training tool or something similar like this again (and why/why not)?"*. These questions were also partly based on the online sources regarding user experience.

The questions regarding *motivation* were partly based on the ARCS model by Keller (1987). The Reduced Instructional Materials Motivation Survey IMMS (RIMMS) was used as inspiration for formulating questions regarding motivation (Loorbach et al., 2015). The questions were based on the attention, relevance and confidence aspect of the ARCS model, for example: *"After working with the training tool did your confidence regarding your skills as a driver get boosted (and why/why not)?"*. The question regarding wether the final score, the *learning outcome*, matched the participant's expectations before starting the training can be linked to satisfaction.

These questions were followed by more specific questions regarding either *VR* or *gamification*, depending on the version of the training tool the participant was assigned to work with. During these questions a more in-depth insight into the value of the gamification element of winning prizes was gathered, and also the final score and the receiving of a score in general (*"At the end of the training you received a final score: What did you think of this and how did this work*

on you?"). Other questions related to the participant's opinion on the use of video in the gamified version and the use of 360 video in the VR version.

Finally, the participant had the chance to work with the other version of the training tool in order to make a *comparison* between the two versions. The participant was asked to compare the second version to the original version they were assigned and how their opinion of the second version differs from the first one. After this they were asked wether they would have preferred the second version over the first one.

3.3.3 OBSERVATIONS

During the testing sessions, all participants were filmed while they were working with the version of the training tool that the questionnaire assigned to them (see figure 11). While the participants were working with the training tool, the researcher acted as an observer and wrote down anything that stood out. After all testing sessions were done, the researcher went through all the footage of the testing sessions to see if anything was missed. By recording all the sessions the playtime, the time it took the participant the see the screen with the final score, of each participant was also recorded. This might offer possible insight into wether one version of the training tools takes noticeably longer to finish than the other.

3.4 PARTICIPANTS

The main target audience for the training tools are people who are currently taking driving lessons or those who can use a refresher course since they, even though they have their license, rarely drive a car. Since it proved difficult to find willing participants who fit these criteria, the criteria for participating was broaden by also letting people participate who received their license less than 3 months ago. In the end, a total of 40 people participated in this study (N=40). The participants were equally distributed over the two versions of the training tool, meaning each version was tested by 20 participants. An overview of the descriptives of the participants can be found in table 2.

Table 2. Descriptives statistics of the participants per version

Gender	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
Male	4 (20%)	6 (30%)	10 (25%)
Female	16 (80%)	14 (70%)	30 (75%)
Age	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
Mean of Age	19.45	20.20	19.82
Education	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
High school	6 (30%)	9 (45%)	15 (37.5%)
HAVO	5 (25%)	5 (25%)	10 (25%)
VWO	1 (5%)	4 (20%)	5 (12.5%)
MBO	8 (40%)	5 (25%)	13 (32.5%)
HBO	3 (15%)	1 (5%)	4 (10%)
WO	3 (15%)	5 (25%)	8 (20%)

Most of the participants were female, the average age of the participants was around 20 years old. Most of the participants were 17 years old and were either in high school or going to a vocational school. Participants were asked at the beginning of the interview about their previous experience with e-learning, virtual reality and gaming in general. An overview of these statistics can be seen in table 3. When looking at their previous experience with e-learning, most participants stated that they already used an e-learning tool previously in the form of online exam training for car driving theory. Regarding virtual reality, most participants had already some experience with VR, ranging from watching 360 videos to actively playing games. Finally, when looking at the participant's experience with gaming, all participants stated that they were familiar with the gamification elements used in both versions of the training tool.

Table 3. Overview of participant's previous experience with e-learning, VR and gaming in general

Experience with e-learning	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
Yes, participant has previous experience	17 (85%)	16 (80%)	33 (82.5%)
No, has no previous experience	3 (15%)	4 (20%)	7 (17.5%)
Experience with VR	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
Yes, participant has previous experience	16 (80%)	14 (70%)	30 (75%)
No, has no previous experience	4 (20%)	6 (30%)	10 (25%)
Experience with gaming	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
Participant used to game	2 (10%)	4 (20%)	6 (15%)
Participant doesn't game much	6 (30%)	8 (40%)	14 (35%)
Participant games on a regular basis	5 (25%)	2 (10%)	7 (17.5%)
Participant games a lot	7 (35%)	6 (30%)	13 (32.5%)

3.4.1 EXPERIENCE WITH DRIVING

In the first 10 questions of the questionnaire participants were asked about how many driving lessons they had taken up until the moment they participated in the study. They were further asked about wether they had already passed the driving theory exam, had already taken the practical exam and wether or not they had already passed the practical exam and thus received their driver's license. An overview of these answers per version of the training tool can be found in table 4. In general, most participants had taken 21 to 30 lessons. A majority already passed the theory exam and thus received the theory certificate, while most participants had not taken the practical exam yet.

Table 4a. Overview of participant's current experience with driving

Amount of driving lessons	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
1 to 10 lessons	4 (20%)	5 (25%)	9 (22.5%)
11 to 20 lessons	4 (20%)	5 (25%)	9 (22.5%)
21 to 30 lessons	7 (35%)	4 (20%)	11 (27.5%)
31 to 40 lessons	3 (15%)	4 (20%)	7 (17.5%)
More than 40 lessons	2 (10%)	2 (10%)	4 (10%)

Table 4b. Overview of participant's current experience with driving

Already passed the driving theory exam?	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
Yes, passed the theory exam	13 (65%)	13 (65%)	26 (65%)
No, did not take or pass the theory exam	7 (35%)	7 (35%)	14 (35%)
Already taken the practical exam?	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
Yes, one time	3 (15%)	1 (5%)	4 (10%)
Yes, two times	1 (5%)	3 (15%)	4 (10%)
Yes, more than three times	0 (0%)	1 (5%)	1 (2.5%)
No	16 (80%)	15 (75%)	31 (77.5%)
Already passed the practical exam?	**VR (N=20)**	**Gamified (N=20)**	**Total (N=40)**
Yes, received their driver's license	4 (20%)	5 (25%)	9 (22.5%)
No, did not take it yet or pass it	16 (80%)	15 (75%)	31 (77.5%)

3.4.2 PERCEIVED KNOWLEDGE AND CONFIDENCE LEVELS

In the first part of the questionnaire participants where asked to estimate their knowledge level regarding both driving theory and driving in practice. These questions were asked to get insight into the confidence levels of the participants, since confidence is part of the ARCS model. During the interview part of the experiment the participants were further asked about wether their confidence was boosted or not after working with the training tool.

A 5-point Likert scale was used to measure these items, where 1 = low and 5 = high. These questions were followed by a question where participants had to estimate how well they think the exam training will go regarding final score. This item was also measured by a 5-point Likert scale, where 1 = bad and 5 = very good. The mean scores and standard deviations of these items per training tool version can be found in table 5.

Table 5. Participant's perceived knowledge level of driving theory, driving in practice and perceived confidence level

	VR (N=20)		**Gamified (N=20)**		**Total (N=40)**		
	M	**SD**	**M**	**SD**	**M**	**SD**	**T-test**
Perceived knowledge level of driving theory	3.20	0.52	3.65	0.67	3.43	0.64	t (38) = -2.37, p = 0.01
Perceived knowledge level of driving in practice	3.40	0.68	3.35	0.67	3.38	0.67	t (38) = 0.23, p = 0.41
Perceived confidence level / expectations final score	3.45	0.76	3.60	0.75	3.53	0.75	t (38) = -0.63, p = 0.27

In general, the scores regarding perceived knowledge level of driving theory and driving in practice, and perceived confidence level and expectations shows that these levels are perceived as slightly above average. This is more or less equally distributed among the two versions of the training tool, with the the knowledge level of driving theory being perceived slightly higher among the participants of the gamified version. However, independent samples t-tests were performed to see if there is statistical evidence of there being a significant difference between the scores of the VR version and the gamified version. A significance level of $\alpha = 0.05$ and Confidence Interval of 95% is used for all analysis.

The independent samples t-test shows a significant difference in the scores of the VR version and the gamified version regarding *perceived knowledge level of driving theory*. Since $p < 0.05$, there is statistical evidence that participants using the gamified version felt significantly more confident regarding their perceived knowledge level of driving theory prior to using the training tool than participants using the VR version. This needs to be taken into account when looking at wether the participant's final score matches their expectations. However, the independent samples t-test shows no significant difference in the scores of the VR version and the gamified version regarding *perceived knowledge level of driving in practice* and *perceived confidence level and expectations.*

3.5 DATA ANALYSIS

On most of the gathered data several different statistical analysis were performed, depending on the type of data and the type of statistical test fitting the data. A significance level of $\alpha=0.05$ and Confidence Interval of 95% is used for all statistical analysis. For most the quantitative data gathered from the qualtrics questionnaire an independent samples t-test was used and performed in SPSS. This was done to test if there are significant differences between the mean scores of the two different versions of the training tool regarding the following dependent variables of motivation, user experiences, chances of re-use and chances of recommendation, and the final scores.

The final scores of the participants were also gathered and recorded. To test if there was a significant difference between the final scores gathered from the VR version of the training tool compared to final scores of the gamified version, a chi-square test of independence was performed in SPSS. Furthermore, the same statistical analysis was used for certain questions and the difference between the scores on those questions between versions.

The qualitative data gathered from the interviews was coded in atlas.ti. Because the interview questions were formulated based on certain themes, the categories of the codes were already partly known before the coding process. Within these themes, an open approach was used which resulted in axial coding due to certain patterns that emerged. The coding process was therefore both theory-driven and data-driven (Decuir-Gunby, Marshall & Mcculloch, 2011). A codebook was created based on these patterns.

A second coder was asked to code a sample (10%) of the qualitative interview data. The second coder is a graduate of the Educational Masters Program within the field of Social Sciences at Radboud University. She was given two Excel files, one including interview data of the VR version and one including interview data of the gamified version. Each file included a sheet with the codebook and two sheets with fragments from interviews. The coder was asked to place the correct code after the given interview fragments. Afterwards, the Cohen's Kappa (κ) was calculated in SPSS to determine the interrater reliability. Since Kappa (κ) score is .869, the strength of the interrater agreement can be considered to be very strong (Landis & Koch, 1977).

Table 6. Cohen's Kappa

	Value
Measurement of Agreement	.896
Number of valid segments	98

4 RESULTS

In this section, the results and other findings of the study will be presented. First, the quantitative data is presented which was acquired through the questionnaire followed by the qualitative data from the interviews is presented and, finally, the observations made the participants working with the training tools. The qualitative data and observations will be illustrated with the use of quotes from the participants. An overview of the coded interview data can be found in Appendix E and Appendix F, which also includes quotations. The same codebook was used for all interview data.

4.1 QUESTIONNAIRE

To test if there are significant differences between the mean scores of the two different versions of the training tool, an independent samples t-test was performed on all dependable variables. A significance level of α = 0.05 and Confidence Interval of 95% is used for all analysis. Both versions of the training tool have a population of N = 20, the total population is therefore N = 40. The descriptives and findings of the t-tests can be found in table 7.

Table 7. Statistical findings from the independent samples t-tests regarding motivation, user experience and behavioural intention (α = 0.05)

	VR (N=20)		Gamified (N=20)		
	M	**SD**	**M**	**SD**	**T-test**
Motivation	***4.05***	***0.64***	***3.90***	***0.61***	***t (38) = 0.76, p = 0.23***
Attention	4.00	0.85	3.87	1.00	t (38) = 0.45, p = 0.33
Confidence	3.73	0.63	3.62	0.77	t (38) = 0.53, p = 0.30
Satisfaction	4.42	0.70	4.22	0.41	t (38) = 1.10, p = 0.14
Note: 5-point Likert scales were used to measure the items above, where 1 = not true and 5 = very true.					
User Experience	***5.86***	***0.77***	***5.86***	***0.50***	***t (38)= -0.01, p = 0.49***
Attractiveness	5.97	0.82	6.12	0.51	t (38) = -0.65, p = 0.26
Pragmatic quality	5.44	0.86	5.58	0.73	t (38) = -0.54, p = 0.30
Efficiency	5.58	0.88	5.78	0.73	t (38) = -0.78, p = 0.22
Perspicuity	5.34	0.97	5.42	0.89	t (38) = -0.30, p = 0.38
Hedonic quality	6.19	0.76	5.94	0.57	t (38) = 1.18, p = 0.12
Stimulation	6.10	0.71	5.90	0.71	t (38) = 0.89, p = 0.19
Novelty	6.30	0.88	5.99	0.73	t (38) = 1.24, p = 0.11
Note: 7-point Likert scales were used to measure the items above, where 1 = negative, 4 = neutral and 7 = positive.					
Chances of re-use	***3.95***	***0.94***	***4.15***	***0.93***	***t (38) = -0.67, p = 0.25***
Chances of recommendation	***4.40***	***0.68***	***4.05***	***0.76***	***t (38) = 1.53, p = 0.07***
Note: 5-point Likert scales were used to measure the items above, where 1 = low and 5 = high.					

4.1.1 MOTIVATION (ARCS MODEL)

The independent samples t-test for the variable *motivation* resulted in there being no significant difference in the scores of the VR version (M = 4.05, SD = 0.64) and the gamified version (M = 3.90, SD = 0.61) conditions; t (38) = 0.76, p = 0.23. As can be seen in table 7, statistical analysis was performed on the three components used to measure motivation: *attention*, *confidence* and *satisfaction.* This statistical analysis also shows no significant difference between the scores of the VR version and the gamified version. These results suggest that VR does not enhance motivation in a training tool compared to when only gamification is used.

4.1.2 USER EXPERIENCE (UEQ)

The independent samples t-test for the variable *user experience* also resulted in there being no significant difference in the scores of the VR version (M = 5.86, SD = 0.77) and the gamified version (M = 5.86, SD = 0.50) conditions; t (38) = -0.01, p = 0.49. As can be seen in table 7, statistical analysis was performed on the scales used to measure user experience that are divided in three categories: *attractiveness*, *pragmatic quality* and *hedonic quality*. Pragmatic quality was measured with the scales *efficiency* and *perspicuity.* Hedonic quality was measured with the scales *stimulation* and *novelty.* The aforementioned categories and scales all show that there is no statistical evidence in the VR version scoring higher than the gamified version. These results suggest that VR does not enhance the user experience compared to when only gamification is used in a training tool.

4.1.3 RE-USE AND RECOMMENDATION

The independent samples t-test for the variable *re-use*, which looks at the chance the participant would re-use the training tool (behavioural intention), shows no significant difference in the scores of the VR version (M = 3.95, SD = 0.94) and the gamified version (M = 4.15, SD = 0.93) conditions; t (38) = -0.67, p = 0.25. This is also the case for the variable *recommendation*, the statistical analysis shows no significant difference in the scores of the VR version (M = 4.40, SD = 0.68) and the gamified version (M = 4.05, SD = 0.76) conditions; t (38) = 1.53, p=0.07. These results suggest that VR does not enhance the chances of re-use and recommendation of a training tool compared to when only gamification is used.

4.1.4 FINAL SCORES

The final scores of the gamified version were calculated based on a score out of 100 points. Participants received 10 points for every question they answered correctly, and there were 10 questions in total. Wrong answers were worth zero points. With the VR version the same principle applied. However, with the VR version the final score was calculated based on receiving stars, with 5 being the highest score and 1 the lowest. The scores of the VR version were recalculated using the same system as the gamified version. The learning outcome per question and final scores of both versions can be found in Appendix D.

The average (mean) final scores of both versions is around 60, with that of the VR version being 60.5 and that of the gamified version being 59.5. The lowest score of the VR version is 40 and that of the gamified version is 30. The highest score on the VR version is 90, with 80 being the highest score of the gamified version. The median of the score of both versions is 60. The data of the VR version is bimodal with modes of 50 and 60, however, the mode of scores of the gamified version is 70.

An independent samples t-test with a significance level of $\alpha = 0.05$ was performed to examine the relation between the final score outcome of the training tool and the version of the tool used. As can be seen in table 8, the

relation between these variables was not significant. There is no statistical evidence of there being a significant difference between the final score outcome when comparing both versions of the training tool to one another.

Table 8. Descriptives and statistical findings regarding the final scores and certain questions of the training tools (with a significance level of α = 0.05)

	VR (N=20)				Gamified (N=20)				T-test
	M	SD	Min	Max	M	SD	Min	Max	
Final score	60.5	14.7	40	90	59.5	15.4	30	80	t (38) = 0.21, p = 0.42
	Correct		Total points		Correct		Total points		
Scores Q1	12 out of 20		120		18 out of 20		180		t (38) = -2.28, p = 0.01
Scores Q4	7 out of 20		70		2 out of 20		20		t (38) = 1.93, p = 0.03
Scores Q8	19 out of 20		190		13 out of 20		130		t (38) = 2.49, p = 0.01

Since a few of the questions that were asked in the training tools were different from the others, the scores of these questions were further examined. The first of these questions is the opening question, question 1. Participants were shown a situation where the car was driving on a road going from outside city limits to entering city limits and were asked what the maximum allowed speed limit was in this situation. An independent samples t-test revealed that the scores of the gamified version were significantly higher when compared to the scores of the VR version. The gamified version is more comparable to other conventional training tools the participants have previously worked with and a practice question was therefore not needed. However, a practice question in the VR version would have been beneficial so the participants had a chance to first get used to the training tool before immediately having to work with it. It is therefore recommended to put a practice question at the beginning of a training tool.

Another question that stands out due to its different nature is question 4. Participants were shown a situation where the car was driving behind another car on the highway and were asked wether the distance between the cars was safe enough. For this example it was very important for the participants to properly look at the situation. An independent samples t-test revealed that the scores of the VR version were significantly higher when compared to the scores of the gamified version. In the gamified version the distance seemed further away than in the VR version due to the video being displayed on a flat screen instead of in 360 video. Therefore, with the VR version participants were more likely to experience what it is like to drive too close behind a car.

Finally, question 8 differs from the other questions due to the need for participants to look properly around in and at the situation that was shown. Participants were shown a situation where the car is turning into a road where a specific lane for cyclists to cross over is located, and they were asked about what they had to take into account in this situation. An independent samples t-test revealed that the scores of the VR version were significantly higher when compared to the scores of the gamified version. Because for this question it was preferred for participants to look around in 360 degrees and thus seeing more of the situation, it explains why the participants testing the VR version scored better on this question than those testing the gamified version.

Even though the sample size is small, the results and scores of questions 4 and 8 suggest that the use of VR is beneficial in a training tool when it is used in situations where the 360 experience adds something to the learning experience. This means that virtual reality should not be used just because it is an option, but because the virtual reality aspect actually makes the study material more clear to the learner. In the questions where the VR version scored better when compared to the gamified version, it was beneficial for the learner to ‘fully’ experience the situation that was shown to them. This was achieved with the use of VR.

Table 9. Descriptives and statistical findings from the independent samples t-tests (α = 0.05)

	VR (N=20)		Gamified (N=20)		
	M	**SD**	**M**	**SD**	**T-test**
Perceived confidence level / Expectations final score	3.45	0.76	3.60	0.75	t (38) = -0.63, p = 0.27
Note: 5-point Likert scales were used to measure the items above, where 1 = bad and 5 = very good.					
	Yes	**No**	**Yes**	**No**	**Chi-square test**
Were expectations matched?	12	8	14	6	X^2 (1) = 0.44, p = 0.51

At the end of the questionnaires participants were asked if their final score matched the expectations they had before using the training tool. The outcome of their *perceived confidence level* before using the training tool are also discussed in paragraph 3.4.2 and shows there is statistical evidence that participants using the gamified version felt significantly more confident regarding their perceived knowledge level of driving theory prior to using the training tool than participants using the VR version. As can be seen in table 9, regarding the question wether their final score matched their expectations — after testing the training tool — a bit more than half of the participants stated that, yes, the final score they received matched their expectations.

4.1.5 SUMMARY OF RESULTS

Overall, there is no statistical evidence for there being a significant difference between the scores of the versions of the training when measuring learners' motivation, user experience, chances of re-use and recommendation, and final scores. However, the results and scores of certain questions that were asked in the training tools suggest that the use of VR is beneficial when it is used in situations where the 360 experience adds something to the learning experience. This suggests that VR should only be used when it makes the study material more clear to the learner and thus has a positive impact on how the learner interacts with the study material.

4.2 INTERVIEWS

During the interviews, all participants (N = 40) were asked the same set of questions with either a focus on VR (N = 20) and the use of 360 video or a focus on the use of gamification (N = 20) and normal video. For the qualitative data an axial coding approach was used in atlas.ti. An overview of these codes grouped by code group can be found in Appendix E (VR version) and Appendix F (gamified version) which also includes quotations. The same codebook was used for the interview data of both versions of the training tool. To keep a clear overview of the qualitative data, only constructs with at least four (20%) mentions will be discussed. Comments and mentions regarding use for others, final score, confidence and behavioural intention all exist of 20 mentions since the answer of every participant regarding these constructs is taken into account. An overview of the themes, constructs and mentioned per version can be found in table 10. The findings of the interviews will be presented per theme with the use of quotations by participants per version of the training tool.

Table 10a. Statements regarding the themes with at least 4 (20%) individual mentions per construct per version

Theme	VR		Gamified	
Overall impression	**Construct**	**Mentions**	**Mentions**	**Construct**
First reaction	Fun and realistic	7	6	Fun and interesting
	Fun and innovative	6	6	Fun and different
	Fun and different	4		
Style	Good and clear	9	7	Good and clear
	VR: Nice and fun	8	6	Fun and pleasant
	Very realistic	6	6	Use of gamification is nice and fun
Use of VR / video	VR: Useful due to realism	16	11	Video: Makes the situation(s) (more) clear
	VR: Good way to get used to real life experiences	6	10	Video: Makes it realistic
	VR: You see more of the situation	4	6	Video: Holds attention
Ease of use				
Easy and clear	Gameplay and goal	16	14	Gameplay and goal
	Questions and answers	8	12	User Interface (UI)
			8	Questions and answers
Difficult and unclear	Getting used to the User Interface (UI)	9	12	Knowing when question applies to the situation/video
	Content / needed knowledge	4	6	The video quality (sometimes)
	Knowing when question applies to the situation/video	4	5	Content / needed knowledge
Use for others	Those new to VR have to get used to it	6	14	Easy in use for everyone
	Easy in use for everyone	5	6	Logical and intuitive in use
	Easy for young people, difficult for old(er) peopler	5		
	Easy in use with proper instructions	4		
Compelling elements				
Most positive aspect	Realism	8	8	Use of video
	Informative	6	5	Ease of use
Most interesting aspect	VR/360 experience	17	11	Use of video
			6	Gamification elements
Surprising and/or unexpected aspect	Realistic feel	4	4	Use of video
	Gameplay	4	4	Gameplay

Table 10b. Statements regarding the themes with at least 4 (20%) individual mentions per construct per version

Theme	VR			Gamified
Motivation	**Construct**	**Mentions**	**Mentions**	**Construct**
Attention	Could focus/pay attention due to VR	19	17	Could focus/pay attention due to video
Final score	Score matched expectations	8	11	Score matched expectations
	Score did not match expectations	8	6	Score did not match expectations
	Score exceeded expectations	4	3	Score exceeded expectations
	The score works motivating	12	—	—
Winning of prizes			13	Motivating
			7	Not motivating
Confidence	Not boosted	12	10	Not boosted
	Boosted	8	10	Boosted
Perceived value				
Usefulness	Realism	15	11	Knowledge check
	Informative	8	9	Extra practice
	Knowledge check	7	7	Informative
			7	Use of video
Behavioural intention	Re-use: (Extra) practice	15	11	Re-use: (Extra) practice
	Re-use: Miscellaneous	5	5	Re-use: Miscellaneous
			4	Re-use: Informative
Further development				
Main missing element	Being the driver / have more influence	5	9	More extensive feedback
Feedback	Add a practice question	7	12	Add more extensive feedback
	Better video quality	6	6	Better video quality
	Have more influence as player / more interactivity	5	6	Make clear when the question applies to the video

OVERALL IMPRESSION

Overall, the first reaction to both versions of the training tool is about the same. All participants stated they found the version they were working with to be fun. However, the VR version being perceived as more innovative and realistic. Regarding the realism of the VR version, multiple participants commented that it felt like being in the situation themselves. However, the gamified version is also seen as different from more traditional (e-)learning tools that participants have previously worked with.

> *"It felt like I was in there myself."*
>
> — Participant 8 (VR version)

> *"It is totally different than normal training tools because of the use of moving images."*
>
> — Participant 20 (gamified version)

The style of both versions is seen as good and clear, and nice and fun. The style of the VR version is seen as very realistic by most participants. The gamified version being perceived as fun is due to the clear use of gamification elements (choosing character, use of badges). However, according to half of the participants, the use video in the gamified version makes this version also quite realistic but as can be seen by the number of mentions (see table 10), the VR version is commented on more often as being realistic. Many participants who tested the gamified version stated they did not expect video to be used in the training tool and were pleasantly surprised that this was the case. As can be seen regarding the use of videos, all statements are positive and suggest the use of videos is beneficial in a training tool. However, the VR versions stands out due to the use of video being extra realistic and it is perceived as a good way to get used to real life experiences for those who are still a bit wary of driving a car in real life.

> *"Thanks to VR, novice driver's who are still a bit scared can get some experience driving in a safe way."*
>
> — Participant 2 (VR version)

> *"The use of video adds a lot to the experience because it makes it more realistic. It lets you see more of the situation compared to still images."*
>
> — Participant 6 (gamified version)

Regarding overall first impression, the interview data suggests that the participants who tested the VR version were positively impressed by the realism of this version. All participants mentioned realism in some way and most stated that it felt like they were 'in' the simulation. However, participants also responded overwhelmingly positive to the use of video in the gamified version. These findings suggest that the use of video positively impacts the learner wether it is 360 video or normal video.

EASE OF USE

Regarding the ease of use of the training tools, the gameplay and goal of both versions was seen as most clear. Aside from that, the way the questions were asked and the way the participants had to answer the questions was also clear to most participants. However, when it comes to the user interface, only the UI of the gamified version is mentioned as being easy and clear in use. Almost half of the participants of the VR version mentioned that the user interface of this version was difficult and unclear to them in the beginning since they had to get used to it. Participant 7, who is on the autism spectrum, specifically mentioned taking a long time to figure out how to work with the UI as they kept looking straight ahead and answering questions by accidentally selecting answers.

> *"In the beginning, the controls were the least clear to me."*
>
> — Participant 7 (VR version)

> *"To me, he user interface and the controls were most clear."*
>
> — Participant 20 (gamified version)

Multiple participants of both versions mentioned that having the needed knowledge to correctly answer the questions was one of the most difficult aspects of the training tools. Furthermore, according to several participants another difficult/ unclear aspect was knowing when the question applied to the situation shown in the video. However, a few participants said this regarding the VR version while more than half of the participants said this regarding the gamified version. When looking at how easy the training tool are in use for others, most participants who tested the gamified version said this version was easy to use while others mentioned it being logical and intuitive in use. However, the answers regarding the ease of use for others when using the VR version are a bit more divided.

> *"If people are not familiar with VR they really have to get used to it at first."*
>
> — Participant 2 (VR version)

> *"The least clear aspect was when the question applied to the situation shown in the video."*
>
> — Participant 15 (gamified version)

Half of the participants thought that the VR version will be difficult to use in the beginning. Furthermore, they thought that people unfamiliar with VR will have to get used to it, or that the tool will only be easy to use with the right user instructions. A quarter of the participants who tested the VR version think it is easier for younger people to work with this version and/or that it might not be suitable at all for older people. This is interesting, because the gamified version was perceived to be very easy to use by all participants. They did not foresee issues for older people to work with this version. This suggests that technology acceptance of the VR version might be more of an issue when compared to technology acceptance of the gamified version. The gamified version felt more familiar to the participants and was therefore easy to use, while the VR version was new and was therefore something they had yet to get used to.

COMPELLING ELEMENTS

When it comes to the compelling elements of both e-learning tools, the answers are somewhat similar between the two versions. The most positive aspect of the VR version is that it is realistic and informative. The use of video and the ease of use of the gamified version are perceived as being the most positive aspects of this version.

> *"It is very realistic because you follow the same procedures as you would in real life."*
>
> — Participant 2 (VR version)

> *"The use of moving images, so the use of video, is the most positive aspect."*
>
> — Participant 18 (gamified version)

The most interesting aspect of the VR version is, according to most participants, the fact that it's in VR — so the 360 experience in combination with the gamification elements. For the gamified version this is the use of video together with the use of gamification elements. The realistic feeling and gameplay of the VR version is regarded as most surprising and/or unexpected. When looking at gamified version, it is the use of video that is perceived as most interesting and surprising together with the gameplay. However, opinions differ regarding this sub-theme since not all participants found aspects to be specifically surprising or unexpected.

> *“I did not expect that it would feel like I was really inside a car.”*
>
> — Participant 18 (VR version)

> *"The most interesting aspect is that it gives you the feeling that you can really watch the situation as if sitting next to the driver, so the fact that the images were moving.”*
>
> — Participant 4 (gamified version)

The statements regarding compelling elements suggest that, again, the fact that the VR version feels realistic made a big impression on the participants. For the gamified version this is the use of video in the gamified version. Interestingly enough, the use of video made more of an impact on participants who tested the gamified version than the use of gamification elements. These findings suggest that, in general, participants find the realistic feeling of the VR version to be the most compelling element, but when the 360 experience is not available the use of video would be the most compelling element. This might be due to the use video offering some kind of realism as stated under ‘overall impression’.

MOTIVATION

When it comes to motivation, almost all participants stated that the use of 360 video in the VR version and the use of video in the gamified version helped them pay attention and it captured their attention. Over half of the participants who tested the VR version answered to question 15 (“were you able to keep your attention on the training?”) that this was also because they were not able to look away, since the video was all around them due to it being 360. These findings suggest that the use of video, both 360 and normal, has a positive impact on attention.

> *“Because the video of the situation was all around me, I could not look at anything else because it is all in 360 video.”*
>
> — Participant 6 (VR version)

> *“It was easy to stay focused because the videos made sure that I had to pay attention.”*
>
> — Participant 1 (gamified version)

Overall, when comparing the answers regarding final score and wether the score matched the participants expectations, the answers between the versions do not differ much. The participants who tested the VR version were slightly more disappointed in their final score compared to the participants of the gamified version. Overall, the scores of the gamified version lined up more with their expectations than those testing the VR version. This is in accordance with the answers given regarding final score and expectations in the questionnaire. However, there were a few participants surprised by their score exceeding their expectations.

> *“The final score works motivating since you will try to get a higher score each time.”*
>
> — Participant 20 (VR version)

> *“Of course I wanted to win the main prize, so this motivated me to do my best.”*
>
> — Participant 12 (gamified version)

According to over half of the VR participants, seeing their score at the end worked motivating for them since it motivates them to try again and get a higher final score. This also applies to the winning of prizes in the gamified version, since over half of these participants answered that the use of badges worked motivating for them because it made them try harder to win the ‘best’ prize. However, it did not work motivating for everyone. Several participants mentioned that they were not very competitive in their nature so the winning of prizes does not give them any extra motivation. However, all

participants in both versions wanted to do well and receive a high score. These findings suggest that the game element of 'scores' and/or 'final scores' works motivating, but that winning badges or prizes might not always be necessary.

> *"My confidence was not completely boosted because of my final score."*
>
> — Participant 10 (VR version)

> *"I did not have much confidence in my skills and knowledge beforehand, but now I do a little bit."*
>
> — Participant 13 (gamified version)

Over half of the participants said that their confidence was not boosted after working with VR version, while half of the participants of the gamified version said the same thing. This is interesting because according to the results of the questionnaire, the final scores of the participants seem to mostly match the expectations they had beforehand. This might be because participants had some time to let their scores sink in and talk more about the tool. They might have felt good about their score right after finishing the training, but after a while their confidence might have decreased.

PERCEIVED VALUE

When it comes to the perceived value of training tools, all participants found the tool they worked with to be useful. Most participants found the version they tested to be useful due to it being a good way to perform a knowledge check or due to it being informative. However, three quarter of the participants testing the VR version found this version to be useful due to its realism. For the gamified version it was mentioned that the use of video made it useful.

> *"It is useful because it is realistic. It feels like you're really in the situation and you see and do what you would do in real life."*
>
> — Participant 8 (VR version)

> *"Because of the mistakes I made during the training I now know to what I have to pay extra attention."*
>
> — Participant 10 (gamified version)

> *"It is a nice additional and extra way to prepare for the exams."*
>
> — Participant 8 (VR version)

> *"This is a nice addition to driving lessons, something I can do at home."*
>
> — Participant 8 (gamified version)

All participants stated they would use their version of the tool again if they had the chance. Most of them stated this was because it would be useful for extra practice. Aside from using the training tools again for extra practice, other miscellaneous reasons were given by the participants. For example, the training tool made it easier for them to concentrate or it was done in a more interesting way than more traditional training tools. These participants stated that normally they have issues with concentration and some had learning disabilities. For them the VR version provided a lot of value because it made it easier for them to concentrate.

> *"I would use it again because it makes it easier for me to concentrate."*
>
> — Participant 7 (VR version)

> *"The way this was done makes it more interesting to me to learn and it helps me with learning new information."*
>
> — Participant 3 (gamified version)

These findings suggest that, regarding perceived value, the use of video plays a big role. For the VR version this is the use of 360 video which gave it its realistic feeling. For the gamified video this is the use of normal video. The fact all

participants stating that they would use the training tool again shows behavioural intention. These findings show, again, that the realism of the VR version made a big impact on the participants who worked with this version. Especially on those who stated that the VR version helped them with their learning process.

FURTHER DEVELOPMENT

Regarding the further development of both training tools, the main missing element in the VR version was to have more influence on the driving route by being the driver. However, regarding the gamified version, the main missing element was more extensive feedback after answering a question.

> *"..that I was not behind the steering wheel myself, because now you're sitting next to the driver."*
>
> — Participant 20 (VR version)

> *"I miss more specific and extensive feedback after answering the questions, so you know exactly what you did wrong."*
>
> — Participant 8 (gamified version)

When further asked if they had any feedback regarding the development of the tool they tested, the participants who tested the VR version mentioned that adding a practice question at the beginning would be favourable. Some participants further mentioned that they would like have more influence on the route which would add more interactivity. Over half of the participants who tested the gamified version said that the addition of more extensive feedback would be beneficial. So would making it more clear when the question applies to the situation that is shown in the video.

> *"The training tool can be improved by adding a practice question at the beginning."*
>
> — Participant 1 (VR version)

> *"It would be nice if you get more concrete feedback, so you know what you did wrong."*
>
> — Participant 7 (gamified version)

It is interesting that the feedback of adding more extensive feedback after answering a question was only mentioned for the gamified version and not for the VR version. Participants might lack this need with the VR version because they were already more immersed in the situations they were asked questions about when compared to the gamified version. The same can be said regarding making it more clear when the question applies the video. Only the participants who tested the gamified version stated this. The participants who tested the VR version were fully immersed in the videos from the moment the videos started playing meaning they immediately started to pay attention. Those working with the gamified version were visibly more apprehensive about when to answer the question, because they were waiting to see if there would happen more in the video. These findings suggest that VR provides a more immersive experience than just the use of (normal, flat) video can. When provided with a more immersive experience, participants needed less context afterwards — hence there was no need for extra additional extensive feedback.

PERCEIVED TARGET AUDIENCE

The goal of one of the questions regarding further development was to gather insight on who the participants thought was the target audience for the training tool when taking required knowledge level into account. Participants found the VR version a bit more fitting for beginners compared to the gamified version, which was perceived as a bit less fitting for beginners. These findings are interesting since the content of both training tools were exactly the same. This suggests that participants perceived the use of VR more fitting for those who had to get used to everything involved with driving.

Multiple participants stated they they thought the VR version would be beneficial for those who are a bit unsure about driving in real life because it offers a safe experience in a real life setting.

> *"This is for people who don't have much experience with driving and are just starting learning to drive. This is a safe way for them to get familiar with the practice of driving."*
>
> — Participant 11 (VR version)

> *" [The gamified version] is for people who already started working on their theory exam and have had some driving lessons already because you need some level of knowledge and experience already."*
>
> — Participant 17 (gamified version)

Furthermore, both training tools have the same amount of mentions saying the tools are most fitting for students who are in the middle to end of the driving course, implying that a certain level of knowledge is needed to be able to correctly answer the questions asked in the training tools. This is in accordance with multiple participants of both versions stating that having the needed knowledge to correctly answer the questions was one of the most difficult aspects of the training tools. This also lines up with the confidence of a bit over half of the participants not being boosted due to their possible lack of knowledge on certain things asked in the training tools.

4.2.1 COMPARISON AND PREFERENCES

At the end of every interview the participant was shown the other version of the training tool. This meant that the participants who worked with the VR version had the chance to work with the gamified version and vice versa. They were asked to make a comparison between the two versions. Overall, 29 out of 40 participants mentioned that they found the VR version more realistic than the gamified version, and 10 participants stated that you see more of the situation in this version compared to the other. Six participants found the VR version more fun and four participants mentioned they found it more interactive than the gamified version. Finally, three participants mentioned they found it easier to focus and keep their attention on the training with the VR version than they did with the gamified version. However, six participants said they found the gamified version more practical in use than the VR version since it needs less preparation such as VR goggles and a special smart phone application. Furthermore, five participants said that the gamified version was less innovative than the VR version, but four participants said this version is more clear in use and has a more clear structure. One participant said it was easier for them to focus and keep their attention on the training with this version because in VR they were not able to look away from the screen.

PREFERENCES

Out of the total of 40 participants, 34 participants ended up favouring the VR version over the gamified version. Many of the participants said this is because the VR version is more realistic, more interactive and more fun to play. Overall they found the experience to be better with the VR version. One participant said the following:

> *"I prefer the VR version. I think VR is amazing and it really feels like you are in the car yourself. It makes is easier to estimate the situations around you and for some things it is better to have more in depth vision of the situation."*
>
> — Participant 16 (VR version)

This quote strongly implies that the use of VR was beneficial for them because it let them see more of the situations that were shown, something they seemed to value. Throughout the interviews this was mentioned by many participants. In

the end, only three participants favoured the gamified version over the VR version. These participants explained this was mostly due to them feeling physically ill when using the VR version, and them finding the gamified version more practical in use. One participant said the following:

> *"I prefer the gamified version over the VR version because it is physically less demanding. The VR version is currently to tiring for me, it is overstimulating for me. This is why I prefer the gamified version."*
>
> — Participant 20 (gamified version)

However, three participants had no preference for either version specifically. These participants explained that they found both versions of the tool to be useful depending on practicalities. One participants said the following:

> *"I don't have a preference. I think you can learn a lot from the VR version because of the VR aspect but the gamified version on the laptop is also fun because it is also a game."*
>
> — Participant 4 (VR version)

The quote above is also in line with what many participants who ended up favouring the VR version stated. They all found the gamified version to be quite fun due to its game elements. However, most of the participants who initially tested the gamified version and were very pleasantly surprised by it ended up favouring the VR version due to its realism. One of the participants with a personal preference for the VR version had the following to say regarding the practical use of the VR version:

> *"The gamified version is physically more comfortable, but the VR version is more interactive. With the VR version you can really look around you and you see more of the situation which makes it more effective. I would personally choose the VR version. However, if I would want to do a quick practice session at home I would probably play the gamified version before the VR version because with the VR version you need quite some preparation before you can play it."*
>
> — Participant 12 (gamified version)

This is in accordance with what five other participants said. Participant 17 of the gamified version mentioned another interesting aspect regarding their preference for the VR version, namely:

> *"Both training tools are fun, but I think that the VR version will make the most difference. This version is good for people who are dyslectic and have a bit more difficulty with studying and learning things. The VR version will work better for people who are better in dealing with practical situations."*
>
> — Participant 17 (gamified version)

This is interesting since this was not taken into account when developing and testing the training tools, but might offer an interesting insight for future research topics. However, for now these findings suggest that participants find the realistic aspect of the VR version to be of great value mainly because it lets them see and experience more of the training and its situations. However, the VR version is more suitable for short periods of time, but for longer practice sessions the gamified version is preferred.

4.2.2 SUMMARY OF RESULTS

Overall, all participants stated they perceived the version of the training tool they worked with to be fun. Those who tested the VR version were impressed by its realism, stating it felt like they were 'in' the situations that were shown to them. However, the use of video in the gamified version also made a positive impression on participants. Multiple participants stated that the use of video made in this version also made the experience more realistic. These findings suggest that the use of video positively impacts the learner wether it is 360 video or normal video.

Regarding ease of use, the gamified version is perceived to be easier to work with than the VR version. This might be due to the gamified version and its user interface resembling more traditional e-learning tools. The user interface of the VR version caused some issues with multiple participants, since they stated that they had to get used to the UI in the beginning. However, this issue might be solved by adding user instructions. This findings suggests that technology acceptance of the VR version might be more of an issue when compared to technology acceptance of the gamified version due the perceived ease of use.

The compelling elements of both training tools were the use of (360) video. For the VR version this was the use of 360 video, which gave it is realistic feeling. For the gamified version, this was the use of normal video. Interestingly enough, the use of video in the gamified version made more of an impact than the use of gamification elements. These findings suggest that, in general, participants find the realistic feeling of the VR version to be the most compelling element, but when the 360 experience is not available the use of video would be the most compelling element. This might be due to the use video offering some kind of realism as stated under 'overall impression'.

Regarding motivation, almost all participants stated that the use of 360 video in the VR version and the use of video in the gamified version helped them pay attention and it captured their attention. Furthermore, the use of scores motivated the participants. Many participants stated that seeing their score at the end motivated them to try again and get a higher final score. These findings suggest that the game element of 'scores' and/or 'final scores' works motivating, however, the use of badges or prizes might not always be necessary.

When it comes to the perceived value of training tools, all participants found the tool they worked with to be useful and all of them would use the training tool again if given the chance. Both versions were perceived to be a good way to perform a knowledge check or to be informative. Overall, most participants testing the VR version found this version to be useful due to its realism, and for the gamified version it is because of the use of video. These findings show, again, that the realism of the VR version made a big impact on the participants who worked with this version.

Regarding further development, the main missing element in the VR version was to have more influence on the driving route by being the driver. However, regarding the gamified version, the main missing element was more extensive feedback after answering a question. Since this feedback was not suggested for the VR version, these findings suggest that VR provides a more immersive experience than just the use of (normal, flat) video can. When provided with a more immersive 360 experience, participants needed less context afterwards — hence there was no need for extra additional extensive feedback.

The perceived target audience for both training tools differs a bit. Participants found the VR version a bit more fitting for beginners compared to the gamified version, which was perceived as a bit less fitting for beginners. These findings are interesting since the content of both training tools were exactly the same. This suggests that participants perceived the use of VR more fitting for those who had to get used to everything involved with driving. Multiple participants stated they they thought the VR version would be beneficial for those who are a bit unsure about driving in real life because it offers a safe experience in a real life setting.

Finally, regarding the preferences for a specific version of the training tool, most participants stated they preferred the VR version. This was mainly because the VR version was much more realistic than the gamified version, and it let the participants see more of the situations that were shown to them. However, multiple participants did state

that they thought the gamified version was more suitable for longer practice sessions since it is physically more comfortable and more practical in use. This implies the VR version is not suitable for everyone regarding physical comfort.

4.3 OBSERVATIONS

During the time that participants tested the assigned version of the training tool and — at the end of the session — when they got to work with the other version, several observations were made. When the participants worked with the tools the time it took them to finish the training was recorded. The average time it took a participant to finish the VR version is 3 minutes and 37 seconds, for the gamified version this is 3 minutes and 23 seconds. This means that participants of either version took about the same amount time to finish answering the questions and see the final screen with their final score.

It took some time for the participants who had no previous experience with VR to get used to working with the VR version of the training tool. This was not the case with the gamified version, since all participants immediately recognised how it worked. Because the gamified version resembled more traditional e-learning tools, participants were instantly familiar with the user interface. However, for most of the participants who worked with the VR version it also took some time to realise they could look 360 degrees around them. The further in the training they were the more they made use of this aspect of the technology.

However, some of the participants working with the gamified version (#4, #5 and #6) had a tendency to not finish watching the videos and thus answering the questions too quickly. This was not the case with the VR version, since all participants fully watched the video and sometimes even more than once — something none of the participants working with the gamified version did. Interestingly, overall, the participants who worked with the VR version felt more of the time pressure compared to the other participants. This might be because these participant felt more immersed into the situations due to the use of VR. Due to the feeling of immersion the experience felt real to them, which might explain why the pressure of the situations felt real to them too.

Table 11. Responses that mentioned physical issues regarding VR

Description	**N = 40**
Vision issues (eyes had to adjust or issues with VR box lenses)	13 (32.5%)
VR box leans too heavy on the nose	4 (10%)
VR caused motion sickness	3 (7.5%)
VR caused overall physical discomfort	1 (2.5%)
Total	21 (52.5%)

As can be seen in table 11, several physical issues emerged when several participants worked with the VR version. These issues consist of vision issues due to their eyes having to adjust to the VR goggles, the VR goggles leaning very heavily on their noses and causing discomfort, getting motion sick due to the use of VR and overall physical discomfort by getting overstimulated. Regarding motion sickness one of the participants who tested the gamified version had the following to say:

> *"Because I got motion sickness from the VR version I prefer the gamified version. However, if I didn't have to endure physical discomfort I would pick the VR version because it is more realistic and you see more of the situations shown in the videos."*

— Participant 8 (gamified version)

Other participants who felt physical discomfort due to working with the VR version voiced the same sentiment. Another participant who tested the gamified version mentioned that they think that the gamified version is more fitting for longer practice sessions whereas the VR version is more fitting for shorter practice sessions, as can be concluded from the following quote:

> *"The gamified version is more fitting for longer practice sessions because the VR version causes too much physical discomfort when used for longer periods of time. However, for short practice sessions it works fine because it gives you a realistic and authentic feeling of driving a car and is useful for people who are new at driving."*

— Participant 15 (gamified version)

Overall, both versions of the training tool were received with enthusiasm by the participants. Even though almost all participants prefer the VR version over the gamified version, these results suggest that the gamified version is more practical in use in several ways: Due to being more physically comfortable and due to it being more practical in use since less is needed in order to use the training tool. The findings of the these observations are in line with the findings regarding preferences. These findings, again, suggest that the VR version is comfortable to work with for only short amount of times, but the gamified version is more suitable for longer practice sessions. Furthermore, the VR version is not suitable for everyone due to physical discomfort some might experience.

5 DISCUSSION

This study investigated the effect that gamification and virtual reality in addition to gamification has on motivation, user experience, and learning outcome of new drivers using an e-learning tool during their course as part of exam training. Overall, the results of the quantitative part of this study indicate that there is no significant difference in scores between the VR version and the gamified version, and when looking at learning outcome. However, the results of the qualitative part of this study indicate there is a difference between the two versions of the training tool regarding some specific aspects. There were some noticeable findings in the qualitative data and when looking and regarding the scores of certain questions asked in the training tool.

One of the focuses of this study is motivation. It is clear that the use of both 360 video and normal video grabbed the attention. For both versions of the tool it was said that the use of 360 video and normal video was the most compelling element. This is in accordance with literature on the use of video in instruction based training, which implies that video has a positive impact on learners' motivation (van der Meij & van der Meij, 2016). Interestingly, the use of normal video also provided a realistic experience according to participants. The videos provided participants with more context regarding the questions they were asked which is in line with the constructivist approach to learning, since learners have to experience situations in order to gain knowledge (Ertmer & Newby, 2013; Harasum, 2012; Hung, 2001). That said, there was an overwhelmingly positive response to the use of 360 video in the VR version due to it being realistic and immersive. This is in accordance with existing literature on VR, since VR offers realistic simulations to learners (Huang & Liaw, 2018; Martín-Gutiérrez et al., 2017). Either way, the use of video in training tools is beneficial. However, when given the chance, the learner will pick 360 video over normal video.

There are some noticeable differences in the answers between the participants and the two versions when looking at relevance. Participants found the VR version more fitting for learners who are at the beginning/middle of the driving course. VR provides a realistic but safe way for beginners to get used to the basics of driving, such as the need to properly look around and assess situations and also offers the option for learners to practice the same situation under the same conditions repeatedly (Cruz-Neira, Fernández & Portalés, 2018). The gamified version is perceived to be more fitting for those in the middle of the course and/or everyone in the course. Participants said that for the gamified version a certain level of knowledge is needed even though the contents of both training tools were the same.

The knowledge levels of the participants regarding the subject matter varied, since some were beginners and some were (almost) done with the course. When looking at confidence, there are no significant differences between the two versions. The learning outcome of both versions is also about the same, except for specific questions where participants were asked to about situations where having the ability to look around was beneficial. The main conclusion regarding learning outcome is therefore that VR only has added value in instructional design when the 360 aspect comes in useful and is needed in the authentic task the learner needs to perform. This is in accordance with literature on VR, which show that VR is to be used in situations where the use of simulation is useful (Pantelidis, 2009).

Interestingly, even though confidence was not boosted partly due to final score, almost all participants stated that the use of scores motivated them. There is an overwhelming support for the implementation of game elements such as scores, badges and levels in order to increase learners' motivation in literature on gamification (Dichev et al., 2014; Faiella & Ricciardi, 2015; Hamzah et al., 2014; Muntean, 2011; Urh et al., 2015). In Kyewski & Krämer's (2018) study, they researched wether badges have an impact on intrinsic motivation and their findings showed that the use of badges neither increased nor decreased it. The findings of this present study partly support these findings. Most of those who worked with the gamified version of the training tool stated that the winning of prizes motivated them, however, a considerable amount of participant stated it had no effect on their motivation.

The participants were satisfied with either version of the training tool. This is in accordance with the chances of re-use and recommending the training tool to others which in turn is in accordance with online sources on conducting user experience surveys (Kroll, 2017 & Trista, 2018), as this implies behavioural intention. Perceived usefulness and perceived ease of use are key when it comes to behavioural intention (Davis, 1989; Venkatesh et al., 2003). All participants stated that both training tools were perceived by them as being useful. However, regarding perceived ease of use there is a bit of the difference between the two versions. The gamified version is perceived as being very easy to work with because the UI felt natural to them. However, almost half of the participants had issues with the UI of the VR version in the beginning and stated they had to get used to it.

The VR version is perceived to be more difficult in use for older people or those who have no previous experience with VR. This implies that a bit of technological knowledge or experience is needed to work with VR. When looking at technology acceptance, this further implies that learners will accept the gamified version over the VR version since ease of use influences self-efficacy (Davis, 1989; Ryan & Deci, 2000). However, Bertrand & Bouchard (2008) and Šumak, Polancic, & Hericko's (2010) found that learners do not necessarily use an e-learning tool because it is easy to use, but because they find it helpful for their education. This is supported by the findings of this present study, since all participants perceived the learning tools to be useful. Regarding difficulties with the gamified version, participants had issues recognising when the question applied to the situation shown in the video whereas in the VR version this was more clear. According to Mayer (2009), the signalling principle applies here since people learn better when given cues that highlight the essential material (Mayer, 2009). These cues were missing in both versions, however, the VR version offered a more full immersion with participants feeling more fully inserted in the situation and thus seeing more of the situation (Huang & Liaw, 2018; Martín-Gutiérrez et al., 2017).

Participants had a positive user experience with both versions, as they were both perceived to be attractive, and both pragmatic and hedonic qualities had positive scores. The use of VR is definitely the stand out element regarding the experience. The VR provided participants with extra context since this was apparently missing in the gamified version. When asked to give feedback for further development, those who worked with the gamified version stated that the main missing element was extensive feedback after answering a question. This did not come up with the VR version. Again, this can be explained by the more immersive experience the VR version provided (Huang & Liaw, 2018; Martín-Gutiérrez et al., 2017). However, with the VR version participants mentioned they would like the training to have been more interactive with them being able to drive the car in the simulation themselves. Adding more interactivity would also provide an even more immersive experience (Cruz-Neira, Fernández & Portalés, 2018). Many participants also stated they had to get used to the VR experience and thus needed a practice question before starting the training. Mayer's (2009) pre-training principle applies here, which states that pre-training leads to people learning more deeply from a multimedia message.

The findings of the observations give some insight into advantages and disadvantages of the VR version. First, the feeling of time pressure was more noticeable for those working with the VR version. Again, this can be explained due to the realistic feeling and immersion of this version of the training tool (Huang & Liaw, 2018; Martín-Gutiérrez et al., 2017). Secondly, a participant who deals with dyslexia mentioned the VR version being more fitting for those who normally have learning difficulties and would therefore profit from a more practical approach, which the VR version provides. Thirdly, a participant on the autism spectrum mentioned they preferred the VR version due to the full immersion since it left less room for other distractions. Lastly, with multiple participants difficulties arose regarding physical discomfort. Many participants had issues with their eyes having to adjust in the VR goggles and to the VR training and multiple participants complained about the VR goggles being very heavy on the nose. This can be explained due to the low cost of the simulation, since more expensive hardware provides an even more immersive and seamless simulation and might be more comfortable in use (Cruz-Neira, Fernández & Portalés, 2018). Other participants felt physically sick when working with the VR version due to getting motion sickness or feeling overall physical discomfort, which is not

uncommon when using a VR training. Research has shown that some individuals are more perceptive to physical discomfort when working with VR than others (Hutton, Ziccardi, Medina & Rosenberg, 2018; Munafo, Diedrick & Stoffregen, 2017).

In the end, even though the quantitative data does not imply that the use of VR in addition to gamification in a training tool has a significant effect on motivation, user experience and learning outcome, a significant amount of participants in this study stated their preference for the VR version. This was mainly due to its realistic aspect and the 360 experience it offered, but some also stated that they preferred the this version due to a novelty effect. Many participants said they want to work with the VR version again 'because it is new' or 'different' since they were not yet that familiar with 360 video and the VR gameplay. Research has shown that novelty plays a role when people evaluate stimuli (Hopp & Gangadharbatla, 2016). This explains why the VR version created this novelty effect with many of the participants. Even though many of them had already some experience with VR, these experiences were in a different setting than the one provided in this study. The novelty effect is the strongest at the beginning of the interaction with the stimuli but decreases with repeated or prolonged interaction (Hopp & Gangadharbatla, 2016). This explains why this effect was missing with the gamified version, since all participants were exposed to both versions. When learners are unfamiliar with gamification, the novelty affect might still occur.

Now that the findings are explained based on existing literature, what can be said about the effect of VR over the use of only game elements? There is an overwhelming support by participants in this study in favour of the VR version even though this is not backed up by the quantitative data. The qualitative data ended up giving more insight and a deeper look into the interaction of the participants with the training tools beyond the insights the quantitative data provided. Because of this, the focus is on the findings of the qualitative results. These results imply that, even though there is no statistical evidence of VR being beneficial, the learners themselves seem to think that there are many benefits to VR over the use of only game elements.

5.1 PRACTICAL IMPLICATIONS

The findings of this study can contribute to both the academic and research field, but can also provide insight for those developing e-learning tools for practical purposes. However, the generalisability of this study should be taken into account due to its small and exploratory character. The context of this study was based on a very practical setting with a practical subject matter. The participants in this study were all young, they grew up with newer technologies and were familiar with the multimedia technologies used in the stimulus material.

When implementing VR in an e-learning tool, the subject matter should be fitting for VR simulations (Pantelidis, 2009). A good use of VR would be for vehicle simulations since it provides learners with a real life simulation in a safe setting (Huang & Liaw, 2018; Martín-Gutiérrez et al., 2017). In this setting the use of the 360 aspect would be beneficial, since learners need to look around in the virtual world in order to completely assess the situation. As this present study has shown, VR has an impact on learning outcome only when it is used in a simulation where the 360 aspect of VR is needed in order for the learner to get a proper understanding of the situation. Otherwise, the use of normal video might achieve the same result.

When VR is used in an e-learning tool, a practice question should be added at the beginning of the training so learners can get used to the gameplay en user interface (Mayer, 2009). A practice question might also influence the perceived ease of use since learners have the chance to get to know the system before starting with the subject matter at hand. This might have an influence of technology acceptance since learners are quicker to adapt to technology when they perceive it as being easy to use (Davis, 1989; Venkatesh et al., 2003).

The physical comfort of the learner is important. The duration of the training should be limited when using VR. According to Hutton, Ziccardi, Medina & Rosenberg (2018), learners who experience physical discomfort should be

encouraged to take breaks during sessions so they can assess their various levels of physical discomfort. Furthermore, testing should be done with a 'fast motion sickness score' (FMS score) as a way to gain insight into potential levels of motion sickness of learners.

Regarding the use of certain game elements, the findings of this study imply that working with a scoring system does have a positive impact on learners' motivation. However, the use of external awards is not necessary for every learner. Some learners are already intrinsically motivated and do not need external rewards. For some learners external rewards are needed in order to get extrinsically motivated, which might in turn help with intrinsic motivation (Hamzah et al., 2014; Nicholson, 2012; Su & Cheng, 2013). As the literature review revealed, gamification needs to be meaningful just like the use of VR needs to fit the subject matter.

Finally, companies and instructional designers need to take the costs of implementing VR technologies in their e-learning tool into consideration. They also have to decide wether the use of VR would be truly beneficial to the learning experience of the users. In the end, when it comes to learning, the learners and their experiences play a considerable part in the learning progress. This can also be concluded from the qualitative data from this study, since this presents advantages and disadvantages of the use of VR as experienced by the learners.

5.2 LIMITATIONS AND FUTURE RESEARCH

There are some limitations that should be taken into consideration when interpreting results and providing suggestions for the future research on this topic. Firstly, this study was a small scale exploratory study. Both versions of the training tool were created by the researcher and not by professional e-learning companies. This might have influenced the quality of the training tools used in this study. The VR version of the training tool was therefore not as fully immersive and interactive as would have been possible with more developed hardware. The user interface in a more fully immersed VR experience might feel more natural to the learner, which can affect ease of use and physical comfort (Cruz-Neira, Fernández & Portalés, 2018). Furthermore, the quality of the videos was affected due to limited financial resources.

For future research it is recommended to use a bigger pool of participants. Furthermore, the participants who participated in this study were all young and grew up with newer technologies. It is therefore recommended to conduct the same study with a different set of participants to see how that influences motivation, user experience, technology acceptance and learning outcome. Using Venkatesh et al.'s (2003) UTAUT model for technology acceptance might give more insight in the effect the age, gender, experience, and voluntariness of use the participant has on the use of VR in an e-learning tool.

Due to the lack of a post-test a month or so after participants having worked with the training tools, it is unknown what the long term effects are of either training tool regarding the learning outcome. Future research is needed to gain insight in the long lasting impact VR might have on learning outcome. It is also recommended to look further into the effect it has on learners' confidence, since this present study does not have any conclusive results on that. Due to the lack of a consistent knowledge level between the participants it was difficult to distinguish between the effect the technology had or the effect the study material had on their confidence. It is therefore recommended that participants in future research are all on the same knowledge level regarding the subject matter and study material used in the study.

It is also recommended to look into the effect VR has on the cognitive load of the learner. A potential issue with multimedia learning is that it might lead to cognitive overload, which happens when the learner's processing capacity of their cognitive system is exceeded by what the learning task demands of them (Mayer & Moreno, 2003). Cognitive load was not a focus of this study, but research implies that VR has the ability to reduce cognitive load since the simulation resembles real life meaning learners are left with more mental capacity to focus on the learning concepts themselves instead of extraneous factors (Huang, Rauch & Liaw, 2010). If VR reduces cognitive load significantly when compared to only the use of game elements, this would be a considerable for advantage.

Furthermore, it will be useful to look into the novelty effect that VR has on learners. This effect might even be affected by the age, gender and experiences of the users since it occurs when a technology is new or different to learners. This study has shown that the novelty effect made participants pick the VR version over the gamified version. For now, all participants seemed to be positively impressed by the newness of the use of 360 video and VR gameplay in a training tool. However, it is unclear how this novelty effect would influence their preference in the future or when they would have been more or overly familiar with the technology.

Finally, more qualitative research into the use of VR in a learning environment is needed. Even though qualitative research has its disadvantages, this study has shown that the qualitative data generated much more insights than the quantitative data were able to. Since user experience was one of the central themes, the qualitative approach made it easier to focus on specific experiences of participants. This way it was possible to get more insight into attitudes. Because of the subjective character of qualitative data, more research on this subject and in this field is still needed in order to come up with generalisable insights for the industry.

5.3 CONCLUSION

All in all, the participants in this study reacted very positively to the use of VR in a training tool to help them prepare for their driving exams. Even though the participants also reacted positively to the gamified version, almost all most of them showed a clear preference for the VR version. The gamified version was perceived to be fun and already different from the more traditional training tools, but the VR version was by far perceived to be the most realistic, interactive and innovative. Even though the quantitative results do not imply that the use of VR is necessarily beneficial over the use of only gamification, the qualitative results provide some useful insights into what made the most impact on the learners. That is why the qualitative results are the focus of the findings of this study. Due to the small size of this study, the results can not be generalised. However, due to the exploratory nature of this study, the results might offer a framework for future research.

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APPENDICES

APPENDIX A
INFORMED CONSENT FORM

Introductie

Bedankt voor de tijd die je wilt vrijmaken voor het deelnemen aan dit onderzoek. Mijn naam is Evelien Boensma en ik studeer Communication Studies met de specialisatie Technical Communication aan Universiteit Twente. Voor mijn master thesis doe ik kwalitatief onderzoek naar de toegevoegde waarde van virtual reality binnen e-learning tools met betrekking tot de user experience, motivatie en (leer)resultaat. Hiervoor heb ik twee e-learning trainingen ontwikkeld voor Verkeersschool Boensma.

Onderwerp

De ontwikkelde trainingen dienen als examentraining voor het behalen van het rijbewijs. De virtual reality training maakt gebruik van 360 graden video en is speelbaar via een smartphone in combinatie met een VR box. Voor deze training is het nodig de 'Warp VR' app te downloaden in de app store. De gamified training is speelbaar op de computer, tablet en smartphone en heeft verder geen extern materiaal nodig. Allebei de trainingen bevatten spel elementen.

Opmerkingen

In het onderzoek zullen vragen worden gesteld over jouw ervaring met de examentraining. Bij de antwoorden op de vragen zijn er geen goede of foute antwoorden mogelijk, al jouw ervaringen, gedachten, meningen en opmerkingen zullen worden meegenomen in de resultaten. Het interview zal maximaal een uur in beslag nemen. Om de analyse van de resultaten zo goed mogelijk te kunnen uitvoeren en om niets van je antwoorden verloren te laten gaan zal het testen en het interview worden opgenomen.

Het testen van de examentraining wordt gefilmd. Hierbij wordt je zoveel mogelijk onherkenbaar in beeld gebracht. Het interview wordt opgenomen door middel van geluidsopname. Alle antwoorden die je geeft worden volledig anoniem verwerkt. Ik hoop dat je hier geen bezwaar tegen hebt. Mocht je toch besluiten niet meer te willen deelnemen dan kan het interview op elk moment beëindigd worden en zullen je antwoorden niet worden meegenomen in de resultaten. Als je verder nog vragen hebt kan je die die nu alsnog stellen.

Procedure

1. Voordat we met het testen zelf gaan beginnen wil ik je vragen of je de online enquête wilt invullen tot je de tekst in beeld krijgt waarin je wordt verzocht om met het testen te beginnen.
2. Na het invullen van het eerste gedeelte van de enquête is het tijd om de examentraining te doen. Hierbij zal ik observaties maken.
3. Na het testen van de examentraining wil ik je verzoeken om de enquête verder in te vullen.
4. Wanneer je klaar bent met het invullen van de enquête is het tijd voor het interview waarbij ik verdere vragen stel over je ervaring de training.
5. Na het interview zal ik je kort de andere versie van de training laten zien ter vergelijking.

In totaal zal het ongeveer 30 tot 45 minuten duren.

Algemene informatie

Titel van het onderzoek:	The use of gamification and virtual reality in e-learning tools used for driving test preparation: A comparative study
Verantwoordelijke onderzoeker:	E.C.M. (Evelien) Boensma
Bereikbaar op:	e.c.m.boensma@student.utwente.nl

Contactgegevens Commissie Ethiek

Naam:	Commissie Ethiek Faculteit Gedragswetenschappen Universiteit Twente
Adres:	Postbus 217, 7500 AE Enschede
Telefoon:	053-4894591
E-mail:	j.rademaker@utwente.nl (secretaris)

Verklaring

"Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode, doel en de risico's en belasting van het onderzoek. Ik weet dat de gegevens en resultaten van het onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden. Mijn vragen zijn naar tevredenheid beantwoord. Als ik nog verdere informatie over het onderzoek zou willen krijgen, nu of in de toekomst, kan ik me wenden tot Evelien Boensma.

Ik begrijp dat film-, foto, en videomateriaal of bewerking daarvan uitsluitend voor analyse en/of wetenschappelijke presentaties zal worden gebruikt.

Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen."

Voor eventuele klachten over dit onderzoek kunt u zich wenden tot de secretarisv an de Commissie Ethiek van de faculteit Gedragswetenschappen van de Universiteit Twente.

Aldus in tweevoud getekend:

Naam deelnemer: ……

Datum: …… Handtekening deelnemer: ……

"Ik heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden. De deelnemer zal van een eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden. Ik verklaar mij bereid om nog opkomende vragen over het onderzoek naar vermogen te beantwoorden."

Naam onderzoeker: ……

Datum: …… Handtekening onderzoeker: ……

APPENDIX B
QUESTIONNAIRE (QUALTRICS)

Introduction

Nogmaals bedankt voor de tijd die je wilt vrijmaken voor het deelnemen aan dit onderzoek.

Je hebt net al zowel mondeling als geschreven uitleg ontvangen over het onderzoek en daarna heb je meteen de toestemmingsverklaring getekend. Als dit nog niet is gebeurd wil ik je verzoeken dit eerst te doen voordat je verder gaat met het invullen van deze enquête.

Deze testsessie bestaat uit verschillende onderdelen:

- Voordat we met het testen zelf gaan beginnen wil ik je vragen of je de online enquête wilt invullen tot je de tekst in beeld krijgt waarin je wordt verzocht om de examentraining te doen.
- Wanneer je de examentraining doet zal ik observaties maken.
- Wanneer je klaar bent met de training wil ik je verzoeken om de enquête verder in te vullen.
- Na het volledig invullen van de enquête is het tijd voor het interview waarbij ik verdere vragen stel over je ervaring met de training.
- Na het interview zal ik je kort de andere versie van de training laten zien ter vergelijking.

In totaal duurt het zo'n 60 minuten.

Wanneer het afnemen van het onderzoek is afgerond zal er onder de deelnemers een waardebon van bol.com worden verloot ter waarde van 15 euro.

Veel plezier tijdens het testen van de examentraining,

Evelien Boensma
e.c.m.boensma@student.utwente.nl

General information

Gelieve de volgende vragen in te vullen alvorens het testen van de examentraining.

Wat is je leeftijd?

Wat is je geslacht?

- ○ Man
- ○ Vrouw

Wat is je hoogst genoten of huidige opleiding?

- ○ Middelbare school, namelijk
- ○ MBO
- ○ HBO
- ○ WO

Hoeveel rijlessen heb je (tot nu) gehad?

- ○ 1 tot 10
- ○

11 tot 20
21 tot 30
31 tot 40
meer dan 40

Heb je het theorie-examen al gehaald?

Ja
Nee

Heb je al eens het praktijkexamen gedaan?

Ja, één keer
Ja, twee keer
Ja, drie keer
Ja, vaker dan drie keer
Nee

Heb je het praktijkrijexamen al gehaald?

Ja
Nee

Hoe hoog schat je jouw kennisniveau in met betrekking tot autotheorie?

Zeer laag	Laag	Niet laag, niet hoog	Hoog	Zeer hoog
○	○	○	○	○

Hoe hoog schat je jouw kennisniveau in met betrekking tot het autorijden in de praktijk?

Zeer laag	Laag	Niet laag, niet hoog	Hoog	Zeer hoog
○	○	○	○	○

Hoe verwacht je dat de examentraining straks zal gaan?

Zeer slecht	Slecht	Niet slecht, niet goed	Goed	Zeer goed
○	○	○	○	○

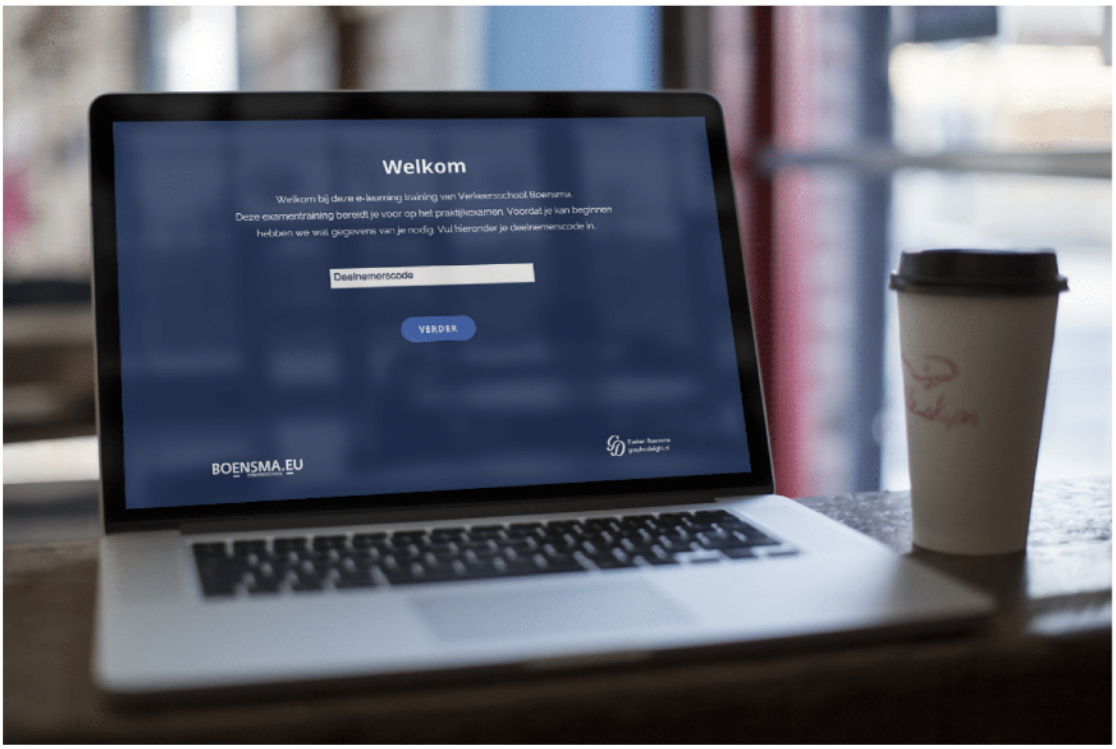
Testing (VR version)

Het is nu tijd om de *virtual reality* examentraining te testen. Daarna word je verzocht om de enqûete verder in te vullen.

○ Ik heb de VR examentraining gedaan

Testing (gamified version)

Het is nu tijd om de *gamified* examentraining te testen. Daarna word je verzocht om de enqûete verder in te vullen.



- [ ] Ik heb de gamified examentraining gedaan

Learning outcome

De volgende twee vragen gaan over de zojuist behaalde score.

Welke score heb je zojuist behaald aan het eind van de examentraining?

- [ ] 1 tot 5 sterren, namelijk _____
- [ ] Uit een score van 100, namelijk _____

Komt deze score overeen met je verwachting?

- [ ] Ja
- [ ] Nee

Motivation (ARCS)

De volgende 12 vragen hebben betrekking tot motivatie.

Kies voor hetgeen dat het meest aansluit op jouw mening.

Ik begrijp hoe de inhoud van deze training gerelateerd is aan dingen die ik al weet.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

De kwaliteit van de inhoud hielp om mijn aandacht vast te houden.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

Toen ik de training deed had ik er vertrouwen in dat ik van de inhoud kon leren.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

Het werken met de training was zo plezierig dat het me stimuleerde om verder te werken.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

De manier waarop de informatie/content in de training is gestructureerd hielp om mijn aandacht vast te houden.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

Ik vond het erg leuk om de training te doen.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

De inhoud en stijl van de training geven de indruk dat het de moeite waard is om de inhoud te weten.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

Na een tijdje de training te hebben gedaan, had ik er vertrouwen in dat ik het praktijkexamen wel kan halen.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

De variatie aan videobeelden hielp om mijn aandacht bij de training te houden.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

De inhoud van de training zal bruikbaar voor me zijn.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens

De structuur van de training hielp me er vertrouwen in te hebben dat ik het praktijkexamen zou kunnen halen.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

Het was een genoegen om met zo'n goed ontworpen training te werken.

Niet mee eens	Enigszins mee eens	Redelijk mee eens	Grotendeels mee eens	Helemaal mee eens
○	○	○	○	○

User Experience

De volgende 26 vragen hebben betrekking tot user experience.

De vragen bestaan uit paren van tegengestelde eigenschappen die van toepassing zijn op de examentraining. De bolletjes tussen de twee eigenschappen symboliseren de verschillende gradaties tussen de twee tegenstellingen. Kies wat het meest overeenkomt met de indruk die de examentraining op je heeft nagelaten.

De examentraining is..	onplezierig	○ ○ ○ ○ ○ ○ ○	plezierig
De examentraining is..	onbegrijpelijk	○ ○ ○ ○ ○ ○ ○	begrijpelijk
De examentraining is..	creatief	○ ○ ○ ○ ○ ○ ○	fantasieloos
De examentraining is..	makkelijk te leren	○ ○ ○ ○ ○ ○ ○	moeilijk te leren
De examentraining is..	waardevol	○ ○ ○ ○ ○ ○ ○	waardeloos
De examentraining is..	saai	○ ○ ○ ○ ○ ○ ○	prikkelend
De examentraining is..	oninteressant	○ ○ ○ ○ ○ ○ ○	interessant
De examentraining is..			

onvoorspelbaar ○ ○ ○ ○ ○ ○ ○ voorspelbaar

De examentraining is..

snel ○ ○ ○ ○ ○ ○ ○ langzaam

De examentraining is..

origineel ○ ○ ○ ○ ○ ○ ○ standaard

De examentraining is..

belemmerend ○ ○ ○ ○ ○ ○ ○ ondersteunend

De examentraining is..

goed ○ ○ ○ ○ ○ ○ ○ slecht

De examentraining is..

ingewikkeld ○ ○ ○ ○ ○ ○ ○ eenvoudig

De examentraining is..

afstotend ○ ○ ○ ○ ○ ○ ○ pakkend

De examentraining is..

gebruikelijk ○ ○ ○ ○ ○ ○ ○ vernieuwend

De examentraining is..

onaangenaam ○ ○ ○ ○ ○ ○ ○ aangenaam

De examentraining is..

vertrouwd ○ ○ ○ ○ ○ ○ ○ niet vertrouwd

De examentraining is..

motiverend ○ ○ ○ ○ ○ ○ ○ demotiverend

De examentraining is..

volgens verwachtingen ○ ○ ○ ○ ○ ○ ○ niet volgens verwachtingen

De examentraining is..

inefficiënt ○ ○ ○ ○ ○ ○ ○ efficiënt

De examentraining is..

overzichtelijk ○ ○ ○ ○ ○ ○ ○ verwarrend

De examentraining is..

onpragmatisch ○ ○ ○ ○ ○ ○ ○ pragmatisch

De examentraining is..

ordelijk ○ ○ ○ ○ ○ ○ ○ rommelig

De examentraining is..

aantrekkelijk ○ ○ ○ ○ ○ ○ ○ onaantrekkelijk

De examentraining is..

vriendelijk ○ ○ ○ ○ ○ ○ ○ onvriendelijk

De examentraining is..

conservatief ○ ○ ○ ○ ○ ○ ○ innovatief

Final questions

We zijn er bijna! Tot slot de laatste twee vragen.

Hoe groot is de kans dat je de examentraining opnieuw zal gebruiken?

Zeer klein	Klein	Niet klein, niet groot	Groot	Zeer groot
○	○	○	○	○

Hoe groot is de kans dat je de examentraining aanbeveelt aan anderen?

Zeer klein	Klein	Niet klein, niet groot	Groot	Zeer groot
○	○	○	○	○

End

APPENDIX C
INTERVIEW QUESTIONS

Pre-knowledge

1. Heb je eerder met een e-learning of online training gewerkt?
   (Have you worked with an e-learning tool or an online training before?)
2. Had je al ervaring met virtual reality?
   (Did you already have experience with virtual reality?)
3. Wat is je ervaring met games?
   (What is your experience with games and gaming in general?)

User Experience

4. Hoe vond je het om de training te doen?
   (What was it like to work with the training tool?)
5. Wat vind je van de stijl van de training?
   (What do you think of the style of the training tool?)
6. In hoeverre vind je de training duidelijk?
   (To what extent do you think the training tool to be clear?)
7. In hoeverre vind je de training makkelijk te gebruiken?
   (To what extent do you find the training tool easy to work with?)
8. Wat vind je dat er mist aan de training?
   (Is there anything you missed in the training tool?)
9. Was er iets verrassends of onverwachts aan de training?
   (Was there anything that surprised you or was unexpected about the training tool?)
10. Welk gedeelte en/of aspect van de training vond je het meest interessant?
    (Which part and/or aspect of the training tool was the most interesting to you?)
11. Wat vind je positief aan de training?
    (What do you like about the training tool (positive aspects)?)
12. Wat vind je negatief aan de training?
    (What do you dislike about the training tool (negative aspects)?)
    i. Wat zou er gedaan kunnen worden het te verbeteren?
       (What could be done to improve it?)
13. In hoeverre vind je de training van toegevoegde waarde?
    (To what extent do you find the training tool to be of added value?)
    i. Vind je de training nuttig?
       (Do you think the training tool is useful?)

Motivation

14. Denk je dat de training je heeft geholpen?
    (Do you think the training tool helped you?)
15. Kon je tijdens het maken van de training de aandacht erbij houden?
    (Were you able to keep your attention to the training tool while working with it?)
16. Kreeg je door het doen van de training vertrouwen in je vaardigheden als autorijder?
    (Did you gain confidence in your skills as a driver by working with the training tool?)

Gamification or VR

17. Gamified — Aan het begin van de training werd al het winnen van prijzen genoemd.
    (At the start of the training, the winning prizes was mentioned.)
17. VR — Aan het eind van de training kreeg je een score op basis van 5 sterren te zien.
    (At the end of the training you were given a score out of 5 stars.)
    i. Wat vond je hiervan?
       (What is your opinion on this?)
    ii. Hoe werkte dit op jou?
       (Translation here)
18. Gamified — Wat vond je van het gebruik van video?
    (How do you feel about the use of video?)
19. VR — In hoeverre is het gebruik van VR video van toegevoegde waarde voor jou?
    (To what extent is the use of VR (360) video of added value to you?)

Learning outcome

19. Aan het eind van de training kreeg je je (eind)score te zien. Kwam deze score overeen met je verwachtingen?
    (At the end of the training you were shown your final score. Did this score match your expectations?)

Further development

20. Zou je deze training of iets vergelijkbaars weer gebruiken?
    (Would you use this training tool or something similar again?)
21. Denk je dat andere mensen makkelijk met deze training om kunnen gaan?
    (Do you think it will be easy for other people to work with this training tool?)
22. Voor wie vind jij deze training het meest geschikt, en waarom?
    (Who do you think this training tool is most suited for, and why?)

Comparison

23. Vergeleken met de training die je net hebt gedaan, wat vind je van de tweede training?
    (Compared to the first training tool you worked with, what do you think of the second training tool?)
24. Achteraf gezien als je mocht kiezen, had je dan liever de tweede training gedaan (waarom wel/niet)?
    (In retrospect, if you had the choice, would you have preferred the second training tool (why/why not?)

Final question

25. Zijn er nog opmerkingen die je graag kwijt wilt?
    (Is there anything else you want to comment on or want me to know?)

APPENDIX D
OVERVIEW OF LEARNING OUTCOMES

Q1. Wat is hier de maximum (toegestane) snelheid?

- **A. 50 km/u (10 pt)**
- B. 60 km/u (0 pt)
- C. 70 km/u (0 pt)

Participants were shown a situation where the car was driving on a road going from outside city limits to entering city limits and were asked what the maximum allowed speed limit was in this situation. They 30 seconds to answer.

Q1.	Correct answers	Incorrect answers
VR version	12	8
Gamified version	18	2

Q2. Waar moet je hier specifiek rekening mee houden?

- A. Motorrijders (0 pt)
- B. Auto's (0 pt)
- **C. Vrachtwagens (10 pt)**

Participants were shown a situation where the car was driving around a parking lot where many big trucks were parked and were asked what they had to specifically take into account in this situation. They 30 seconds to answer.

Q2.	Correct answers	Incorrect answers
VR version	20	0
Gamified version	18	2

Q3. Waar moet je hier rekening mee houden?

- A. Zijn snelheid (0 pt)
- B. Vrachtverkeer (0 pt)
- **C. Twee rijbanen die erbij komen (10 pt)**

Participants were shown a situation where the car was about to enter the highway and were asked what they had to take into account in this situation. They had 30 seconds to answer.

Q3.	Correct answers	Incorrect answers
VR version	16	4
Gamified version	14	6

Q4. Is er zo voldoende volgafstand?

- **A. Nee (10 pt)**
- B. Ja (0 pt)
- C. Volgafstand is onbelangrijk (0 pt)

Participants were shown a situation where the car was driving behind another car on the highway and were asked wether the distance between the cars was safe enough. They had 24 seconds to answer.

Q4.	Correct answers	Incorrect answers
VR version	7	13
Gamified version	2	18

Q5. Wanneer moet je hier je richtingaanwijzer aan doen?

- A. 200 meter van te voren
- **B. 300 meter van te voren**
- C. 600 meter van te voren

Participants were shown a situation where they will need to take a specific exit from the highway and were asked at what distance from the exit you have to put the blinkers on. They had 30 seconds to answer.

Q5.	Correct answers	Incorrect answers
VR version	12	8
Gamified version	15	5

Q6. Wat moet je hier doen bij de dubbele belijning?

A. Links over de schouder kijken (0 pt)

B. Rechts over de schouder kijken (10 pt)

C. Zo snel mogelijk invoegen (0 pt)

Participants were shown a situation where the car was about to switch to the lane used to exit the highway and were asked about what you need to do when you see a double stroke on the road right before switching lanes. They had 30 seconds to answer.

Q6.	Correct answers	Incorrect answers
VR version	9	11
Gamified version	10	10

Q7. Welke rijstrook moet je hier kiezen?

A. De meest linkse v/d twee (0 pt)

B. Altijd de meest rechtse (0 pt)

C. De snelste (10 pt)

Participants were shown a situation where the car is off the highway and a section with traffic lights while they want to go right and were asked which lane to pick in order to properly do so. They had 30 seconds to answer.

Q7.	Correct answers	Incorrect answers
VR version	0	20
Gamified version	0	20

Q8. Waar moet je hier rekening mee houden?

A. Fietsers van links (0 pt)

B. Fietsers van rechts (0 pt)

C. Fietsers van twee kanten (10 pt)

Participants were shown a situation where the car is turning into a road where there's a specific lane for cyclists to cross over and were asked about what they had to take into account in this situation. They had 30 seconds to answer.

Q8.	Correct answers	Incorrect answers
VR version	19	1
Gamified version	13	7

Q9. Waar moet je hier rekening mee houden?

A. Verkeer van links

B. Conflictverkeer

C. Onverwachte fietsers

Participants were shown a situation where the car is driving towards a cross section with multiple traffic lights and were asked about wha they had to take into account in this situation. They had 35 seconds to answer.

Q9.	Correct answers	Incorrect answers
VR version	12	8
Gamified version	12	8

Q10. Waar moet je hier rekening mee houden?

A. Auto's die uitsteken (0 pt)

B. Fiets -en loopverkeer (0 pt)

C. Al het bovenstaande (10 pt)

Participants were shown a situation where the car was driving around a parking lot near shopping centres and were asked about what they had to take into account in this situation. They had 40 seconds to answer.

Q10.	Correct answers	Incorrect answers
VR version	14	6
Gamified version	17	3

FINAL SCORES PER VERSION OF THE TRAINING TOOL

	Total score	Average score
VR version	1.190	59,5
Gamified version	1.210	60,5

FINAL SCORES PER PARTICIPANT AND PER TRAINING TOOL VERSION

	VR version	Gamified version
Participant 1	40	70
Participant 2	80	50
Participant 3	60	40
Participant 4	50	40
Participant 5	50	30
Participant 6	40	40
Participant 7	60	60
Participant 8	50	80
Participant 9	70	70
Participant 10	60	80
Participant 11	80	60
Participant 12	90	70
Participant 13	70	70
Participant 14	60	50
Participant 15	60	80
Participant 16	40	60
Participant 17	80	70
Participant 18	50	70
Participant 19	50	60
Participant 20	70	40

APPENDIX E

OVERVIEW CODED OF INTERVIEW DATA (VR VERSION)

Overview of responses to the VR version (N=20), with at least 4 (20%) individual mentions per code

	Description	N	Example
Overall impression			
First reaction	Fun and realistic	7	"It felt like I was in there myself." (P8)
	Fun and innovative	6	"It was innovative and fun." (P10)
	Fun and different	4	"It [the exam training] was done in a completely different way than normal [exam trainings]." (P11)
Style	Good and clear	9	"The style was good, it was clear to me." (P13)
	VR is nice and fun	8	"The fact that it was all VR makes it good." (P3)
	Very realistic	6	"I like that it is so realistic." (P9)
Use of VR	Useful due to realism	16	"The use of VR makes it realistic and it really holds your attention." (P15)
	Good way to get used to real life experiences	6	"Thanks to VR, novice driver's who are still a bit scared can get some experience driving in a safe way." (P2)
	You see more of the situation	4	"Thanks to VR you can really see the whole situation." (P14)
Ease of use			
Easy and clear	How to play and what to do	16	"I thought it was clear, and I knew what was expected of me." (P9)
	Questions and answers	8	"To me, the way the questions were asked and the options for answering were most clear." (P15)
Difficult and unclear	Getting used to how it works	9	"At first, the controls were the least clear to me." (P7)
	Content / needed knowledge	4	"The contents and needed knowledge can be most difficult at times." (P8)
	When question applies to video	4	"The most difficult and unclear thing was to know at what point of the situation the question was applicable." (P6)
Use for others	Those new to VR have to get used to it	6	"If people are not familiar with VR, they really have to get used to it at first." (P2)
	Easy in use for everyone	5	"It is easy in use, so everyone can use and handle it." (P19)
	Easy for young people, difficult for old(er) peopler	5	"Older people will probably not onderstaand how it works." (P5)
	Easy in use with instructions	4	"With the right user instructions everyone will be able to understand it and use it." (P4)
Compelling elements			
Most positive aspect	It's realistic	8	"It's very realistic because you follow the same procedures as you would in real life." (P2)

	It's informative	6	"The information really gets through to me this way, and now I know what I have to work on." (P3)
Most interesting aspect	The whole VR/360 realistic experience	17	"The fact it felt like I was really in the car and that I could look around." (P13)
Surprising or unexpected	How real it is and feels	4	"I did not expect that it would feel like I was really inside a car." (P18)
	The way it is done	4	"I found it surprising that it was possible to do it like this, with VR." (P5)
Further development			
Main missing element	Being the driver / have more influence	5	"That I was not behind the steering wheel myself, because now you're sitting next to the driver." (P20)
Feedback	Add a practice question	7	"The training tool can be improved by adding a practice question at the beginning." (P1)
	Better video quality	6	"With some videos of the situations the image quality was not as sharp, so this could be improved." (P8)
	Have more influence as player/more interactivity	5	"It would be cool if you as a player can have influence on the driving route, for example with a steering wheel controller." (P11)
Learners' motivation			
Attention	Could focus/pay attention due to VR	19	"Because the video of the situation was all around you, you could not look at anything else because it is all 360." (P6)
Final score	The score works motivating	12	"It [score] works motivating since you will try to get a higher score each time." (P20)
	Score matched expectations	8	"It did match my expectations, I feel secure regarding my knowledge level." (P11)
	Score did not match expectations	8	"The score did not match my expectations, but it was not bad either." (P3)
	Score exceeded expectations	4	"I expected it to be lower, but unconsciously I might know more than I thought." (P9)
Confidence	Not boosted	12	"Not completely because of my final score." (P10)
	Boosted	8	"My final score gives me confidence since I did well." (P12)
Perceived value			
Usefulness	Because it's realistic	15	"It is useful because it's realistic, it feels like you're really in the situation and you see and do what you would do in real life." (P8)
	Because it's informative	8	"I learned to take my time for certain things." (P15)
	Because it's a knowledge check	7	"I now understand what I did wrong and this is something I can now pay extra attention to my driving lessons." (P3)
Re-use	Would use again for (extra) practice	15	"It is a nice additional and extra way to prepare for the exams." (P8)
	Would use again (miscellaneous)	5	"Because it makes it easy for me to concentrate." (P7)

APPENDIX F

OVERVIEW CODED OF INTERVIEW DATA (GAMIFIED VERSION)

Overview of responses to the gamified version (N=20) with at least 4 (20%) individual mentions per code

	Description	N	Example
Overall impression			
First impression	Fun and different	6	“It is totally different than normal training tools because of the use of moving images.” (P20)
	Fun and interesting	6	“I thought it was fun and interesting, because you are really working with it.” (P6)
Style	Good and clear	7	“The style is clear, I knew what was expected of me.” (P10)
	Fun and pleasant	6	“The style is pleasant: it is not too childish but also not too old-fashioned.” (P3)
	Use of gamification is nice and fun	6	“It’s nice that it’s a game because I’m very competitive.” (P12)
Use of video	Makes the situations (more) clear	11	"It gave a clear view of the situation which makes it easier to estimate what to do.” (P2)
	Makes it realistic	10	“It made it more realistic because it shows how things really go [like in real life].” (P7)
	Holds attention	6	“It ensures that it holds my attention.” (P9)
Ease of use			
Easy and clear	How to play and what to do	14	“I think it speaks for itself because I knew immediately what I had to do.” (P7)
	User Interface	12	“The user interface and the controls were most clear to me.” (P20)
	Questions and answers	8	“The way you can answer the questions, so the three answer options and that you had to pick one.” (P3)
Difficult and unclear	When question applies to video	12	"The least clear was when the question applied to the situation in the video.” (P15)
	The video quality sometimes	6	“The videos themselves were sometimes not entirely clear due to overexposure.” (P12)
	Content / needed knowledge	5	“The hardest part was that I did not know what to answer on some of the questions.” (P3)
Use for others	Easy in use for everyone	14	“The controls and the user interfase are easy in use so others can work with this also.” (P20)
	Logical and intuitive in use	6	“The user interfase very logical and is easy in use.” (P6)
Compelling elements			
Most positive aspect	Use of video	8	"The use of moving images, so the use of video, is the most positive aspect.” (P18)
	It’s easy in use	5	“It is very user friendly.” (P16)
Most interesting aspect	Use of video	11	"The most interesting aspect is that it gives you the feeling that you can really watch the situation as if sitting next to the driver, so the fact that the images were moving.” (P4)

	Gamification elements	6	“The most interesting aspect to me is the whole gamification aspect such as picking a charackter and unlocking levels on the map.” (P17)
Surprising or unexpected	Use of gamification	4	“I found it surprising how much fun it was to play and that you had to unlock those levels on the map.” (P11)
	Use of video	4	“I did not expect the use of moving images, so the use of video.” (P9)
Further development			
Main missing element	More extensive feedback	9	“I miss more specific and extensive feedback after answering the questions, so you know exactly what you did wrong.” (P8)
Feedback	Add more extensive feedback	12	"It would be nice if you get more concrete feedback, so you know what you did wrong.” (P7)
	Make clear when question applies to video	6	“It can be made more clear when the question applies to the situation shown in the video.” (P15)
	Better video quality	6	“The video quality can be a bit better, it can be more clear.” (P14)
Learners' motivation			
Attention	Could focus/pay attention due to video	17	“It was easy to stay focused because the videos ensured that you had to pay attention.” (P1)
Final score	Score matched expectations	11	“I expected this outcome, I still have some work to do.” (P7)
	Score did not match expectations	6	“My final score was a bit of a let down, this is probably because of a lack of knowledge and experience.” (P6)
	Score exceeded expectations	3	“I expected the final score to be lower.” (P13)
Winning of prizes	Worked motivating	13	“Of course I wanted to win the main prize, so this motivated me to do my best.” (P12)
	Did not work motivating	7	“The winning of prizes did not really have an affect on me.“ (P18)
Confidence	Boosted	10	“I did not have much confidence in my skills and knowledge beforehand but now I do a little bit.” (P13)
	Not boosted	10	"I did not really do well so I did not really gain any confidence.” (P4)
Perceived value			
Usefulness	Because it’s a knowledge check	11	“Because of the mistakes I made during the training I now know what I have to pay extra attention to.” (P10)
	Because it’s extra practice	9	“It is something extra aside from driving lessons and it is a way to practice the driving theory from the book, even when you have not had any driving lessons.” (P6)
	Because it’s informative	7	“I have seen new situations that I had not seen before.” (P18)
	Because of use of video	7	“The use of moving images, so the use of video, really helps because it makes it more realistic.” (P7)
	Because it’s stimulating and motivating	4	“Working towards a goal motivates me.” (P11)
Re-use	Would use again for (extra) practice	11	“This is a nice addition to driving lessons, something I can do at home.” (P8)

Would use because it's informative	4	"You learn from it, you now know what you need to improve." (P2)
Would use again (miscellaneous)	5	"The way this was done makes it more interesting to me to learn and it helps me with learning new information." (P3)

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