Students' Development of Virtual Reality Prototypes for Training in Alcohol-Resistance Skills

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Abstract This paper reports on third-semester engineering students´ development of virtual reality (VR) mini-games, targeted at adolescents, for training in alcohol-resistance skills. Denmark has one of the highest rates of substance abuse in Europe. The mini-games were developed in the game programming environment Unity – and mostly tested in Google cardboard. The mini-games visualized in VR how drinking affected orientation, vision, motor skills, social skills, decision-making and memory. Examples of mini-games were: simulations of house-party situations; balancing and navigating while walking home after a party; driving while drinking; or waking up the morning after a total blackout with strange objects around the bed. The students were experienced programmers but VR was new to them. They spent a lot of time discussing how to prevent cybersickness. Most of the simulations successfully explored decision-making while drinking, but a few of them became games promoting the fun of drinking and making questionable decisions. The gameplay in these mini-games linked drinking to winning the game, which is undesirable. Most of the mini-games showed a potential for developing innovative and creative VR tools for alcohol-resistance skills training.

Keywords: virtual reality, design process, teaching, learning, alcohol

1. Introduction

Denmark has one of the highest rates of adolescent alcohol abuse in Europe (ESPAD, 2016). Drinking patterns leading to elevated blood alcohol levels result in problems associated with acute intoxication, such as accidents, injuries and violence (Barbor et al., 2010). Moreover, alcohol affects the social development of adolescents and young adults. For example, unprotected sex, regretting what they did, falling behind in schoolwork and getting injured are associated with binge drinking amongst adolescents (Wechsler et al., 1995). The odds of alcohol dependence decrease each year drinking onset is delayed (Grant et al., 2001). There are good reasons for delaying onset and shaping adolescents' alcohol habits. In this article, the focus is on enhancing awareness of how alcohol affects vision, motor control and decision-making, for example, and on designing Virtual Reality (VR) prototypes.

Third-semester engineering students developed mini-games on the theme of VR, adolescents and alcohol. The 30 learning and experience technology students were experienced programmers, but VR was new to them (sdu optek, n.d.). The development process was a part of the course entitled Mixed Reality. Mixed Reality comprised both development of VR and augmented reality mini-games (Milgram, 1994; Dunleavy, 2014; Klopfer, 2008; Majgaard, 2017; Majgaard, 2015). The mini-games were developed in Unity and tested using Google cardboard and mobile phones. Since the students were in their early twenties, most of them had their own experiences of alcohol use.

The approach in the class was learning by designing and retrospective reflection. Formally, the learning approach was inspired by concepts like communities of practice and constructionism (Lave & Wenger, 1991; Wenger, 1998; Papert, 1993; Majgaard, 2014; Majgaard, 2015). At the beginning of the semester, the students imitated and copied step-by-step programming video tutorials as part of their acquisition of the basic skills of programming VR and augmented reality. The content of the tutorials and the students' own programming experiences were evaluated in the community of the classroom. Most of the course was spent on iterative development of the VR alcohol resistance mini-games in groups of two or three, which also combined communities of practice and constructionism.

The students' mini-games were a pre-study of a research project titled "Developing and pilot testing a virtual reality-based tool for the training of alcohol & other drug resistance skills" inspired by Blurred Minds (n.d.). The idea of the pre-study was to explore design ideas supporting the forthcoming research project.

This raised the question: how can the students' design of VR mini-games for preventing alcohol abuse inform future designs in this field?

Organisation of the paper: first, related studies of Blurred Minds, a VR alcohol-resistance-training tool. Second, introduction of the case presented in this paper by describing the objectives and requirement of the mini-games as part of the Mixed Reality course. Third, highlights from the students' mini-games presented and evaluated on the themes: cybersickness as a design element; simulating drinking problems; simulating peer pressure; and training-resistance skills. The article ends with reflections on developing content on the Mixed Reality course and the conclusion.

2. Related work

Blurred Minds is a gamified system built to change students' knowledge of, and attitudes to, alcohol and drugs (http://blurredminds.com.au/). Students can experience a simulated house party in VR and decide how their party should unfold, facing real-life scenarios. Their choices determine how and when their night ends. The creator, Dietrich (2016), was experienced in working with co-creation processes, alcohol programmes and adolescents. This inspired the development of Blurred Minds. Some of the games were recorded using 360-degree cameras: see Figure below left (Terzon, 2017). In addition to the 360-degree Unity scenarios, mini-games were also developed: see Figure below right (http://blurredminds.com.au/). The Blurred Minds program was developed by researchers from Social Marketing at Griffith and the University of Queensland supported Queensland Catholic Education Commission.

Figure 1: Screen shots from Blurred Minds. Left: example of 360-degree scenario. Right: mini-game developed in Unity and executed from a browser window

On the Mixed Reality course, the design of the mini-games was inspired by Blurred Minds (n.d.). The students were introduced to the Blurred Minds webpage as part of the kick-off for the design of mini-games: see Figure 2.

Other examples of non-VR mini-game environments for preventing alcohol abuse and inducing responsible behaviour are: Alcohol 101 (n.d.); and Making Smart Choices (Kwan, 2015).

3. Method and case

The method in this case study is inspired by Action Research and Design-Based Research. Experiments and critical reflections are the core of Action Research, allowing learning from and through practice (Lewin, 1946). Lewin describes the Action Research process as being like a spiral staircase, in which each cycle is composed of planning, action, and fact-finding about the result of the action (Lewin, 1946:38). Design-based research is an approach with the intent of producing new theories, artefacts, and practices that account for, and potentially impact, learning and teaching in naturalistic settings. To understand and support learning processes, the research involves the development of technological tools, curriculum, and especially theory (Barab & Squire, 2004; Majgaard et al., 2011).

The case study presented in this paper is the second iteration (second loop in the spiral staircase) of a new engineering course entitled Mixed Reality. In the first iteration, the objective was to explore video tutorials as textbooks (Majgaard, 2017). One of the conclusions was that extending the applications based on the video tutorials facilitated deeper learning for the students. Moreover, increasing use is being made of video tutorials in the teaching of emerging technologies, such as the programming of Mixed Reality prototypes, because there are so few well worked-out textbooks, if any. Unity was new to the students in the first iteration. The students

had to spend a lot of time learning fundamental programming in Unity, C# and understanding the programming environment. This meant that the students had not much time to develop their own ideas from scratch.

The objective of the second iteration documented in this paper was to explore the students' development of content for game-based learning in Mixed Reality. The students in this iteration had had more Unity programming in previous semesters, due to curriculum changes, so we didn't have to introduce Unity as well. We just had to introduce programming for VR and augmented reality (AR), still using video tutorials. What was new was that we had to compose and propose a compelling mini-game idea. This was easy because of the authors' involvement in a grant proposal for alcohol training and VR. The project requirements are listed in the box below.

Mini-project
Teams of a maximum of three students.
Development of educational tool in VR or AR
Theme: "Training of alcohol & other drug resistance skills in Mixed Reality", see more in links below
http://au.educationhq.com/news/40409/blurred-minds-vr-trial-a-sobering-reality/
http://blurredminds.com.au/

Target group: adolescents aged between 15 and 20

Technical requirements.
- Paper prototype
- 5 of Vlambeer's rules of thumb for "game feel" (Vlambeer, 2013).
- More rooms, start screen, final scene, reward system
- VR or AR
- Test of at least 3 persons

Submission 1 (two to three weeks).
- Working title of mini-game
- Brief description of the idea of the game and what makes it interesting
- Examples of interactions and activities in the game
- Photos of the paper prototype

Submission 2 (seven to eight weeks).
- Running game both source file and * .apk files if developed to android (with link from Black Board)
- Two-minute video of running game (may be longer)
- Screenshots from the game
- Five-page report per group of design process including: summary, objective, process description, paper prototype, photos and test results
- Deadline

In the first three weeks (four hours a week), the students were introduced to Mixed Reality and conducted three tutorials. Then they were ready for the design of the mini-game on alcohol-resistance training, for which they had 10 weeks. In parallel with the development of the mini-games, the students had lectures on Hololens (Hololens, n.d.), animation, 360-degree camera and cybersickness.

The involved students were third-semester engineering students from the learning and experience technology programme (sdu optek, n.d.) and they were in their early twenties. The empirical data for this case study consisted of the 30 (24 male and 6 female) students' mini-games, mini-game project reports and video recordings of the mini-games, the curriculum and informal discussion with the students.

The data analysed in this paper are based on student reports and on running mini-games.

4. Highlights from the students' mini-games

Highlights from the students' mini-games are presented thematically below. The themes were: blurred vision and reduced motor control; drinking and driving; anti-social behaviour; balancing while walking; dancing and making choices; forgetting and regretting; and disorientation.

Blurred vision and reduced motor control: In the mini-game entitled "Second Chance", the protagonist played the beer drinking game "beer pong": see the Figure below. The goal was to throw a ball into glasses at the other end of a table. If you missed, then you had to drink; otherwise the opponent had to drink. The more the protagonist drank, the more blurred the vision became: see the Figure below right. It also became more difficult hitting the glasses, due to loss of precise motor skills.

Figure 2: "Second Chance." To the left: beer pong starting point. To the right: beer pong after several beers with blurred vision

Drinking and driving: In the next example entitled "After 10," the students were focusing on teaching the player to balance his/her Blood Alcohol Concentration (BAC) by drinking beer or water: see Figure to the left below. It also became increasingly difficult to drive down the street when the BAC increased. To the right, another group game worked on the same problem with a mini-game entitled "Bad Drink". They combined a high BAC with blurred vision and decreased motor control.

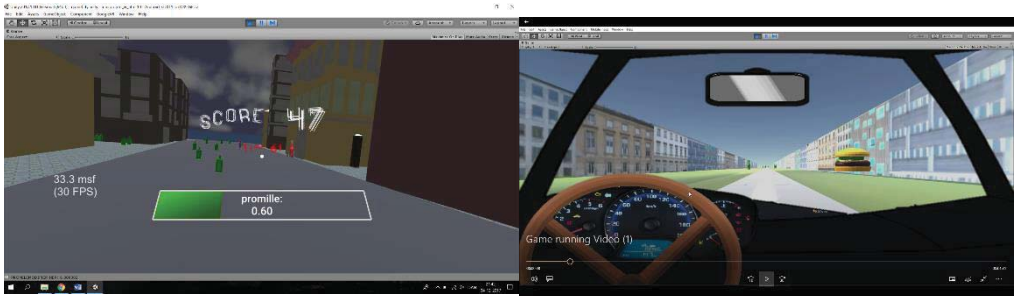

Figure 3: "After 10": To the left, bottles in the street. The player can choose between alcoholic beverages and water. The green bar visualises current BAC. "Bad Drink": to the right, the protagonist is driving a car while drinking and eating burgers

Anti-social behaviour and acute alcohol poisoning. The mini-game entitled "To Drink or Not to Drink" was an action game where the protagonist hit incoming men with bottles. The protagonist aimed (black dot above the bar in the middle) and the bottle was thrown when the blue bar was full: see Figure below left. As BAC increased, it became more difficult to aim.

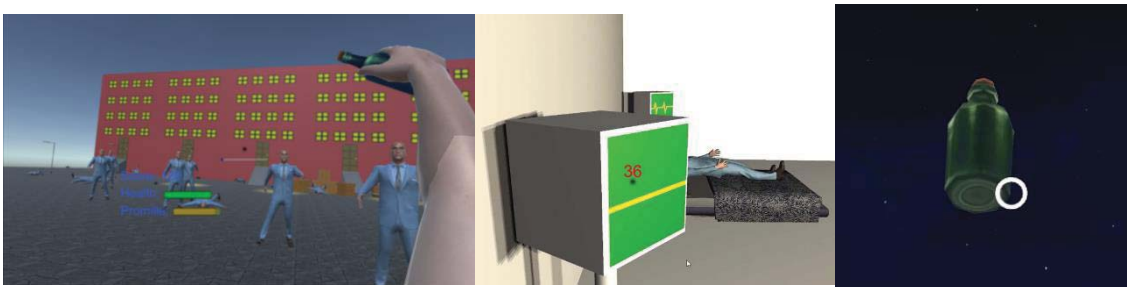

Figure 5: "To Drink or Not to Drink": hitting men with bottles and getting hurt and injured

Balancing while walking. In the game "Rooms of Addiction", the protagonist was meant to avoid beer bottles and earn rewards for drinking water. The more beer was drunk, the more complicated it was to stay on the narrow ramp: see Figure below.

Figure 6: "Rooms of Addiction": balancing while walking

Dancing and making choices. In the game entitled "The Walking Drunk", the protagonist entered a house party and immediately had to decide what to drink. The protagonist received many offers, e.g. half a beer, pills, champagne, water, dance etc., and see the Figure below.

Figure 7: "The Walking Drunk": to the left, the dance floor. To the right, an example of choice in Danish, where the protagonist is offered half a beer. The protagonist chooses by gazing at no, thanks (Nej tak)

Forgetting and regretting. In the mini-game entitled "Total Blackout", the protagonist woke up the next day and was trying to reconstruct what happened the previous night, based on clues such as a tooth, a gun and unknown underwear: see the Figure below. The protagonist texted with friends about the party the previous night: see the Figure below in the middle. To the right, there were indications of unplanned sexual activity. To the left, a tooth suggested a violent argument.

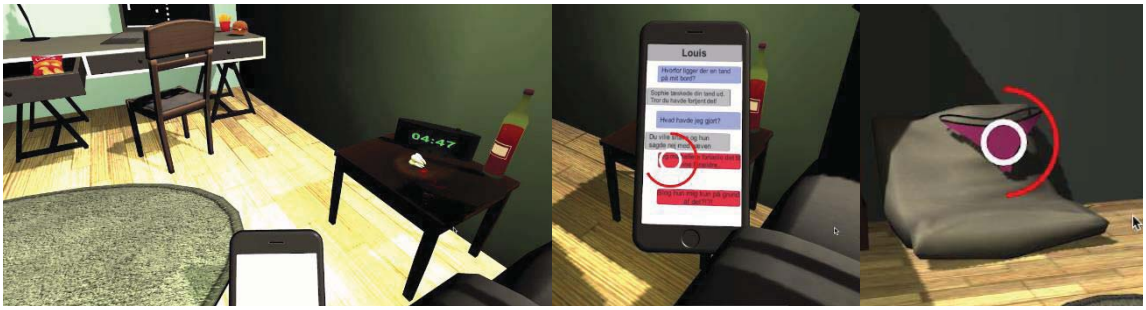

Figure 8: "Total Blackout"

Disorientation. In the game entitled "Walk of Shame", the protagonist was walking home from an unfamiliar part of town using a mobile map. The protagonist had to stay on the sidewalk and look out for fast driving vehicles. The game was played at different levels. In a drunken state, the vision was blurred, and it was harder to control walking in the right direction.

Figure 9: "Walk of Shame": To the left, walking home using a mobile map. Centre and right, the protagonist is taking a close look at the map

5. Reflections on the mini-games

Cybersickness as a design element

A troublesome problem with VR is the tendency for some users to exhibit symptoms similar to classic motion sickness, both during and after a VR experience. This type of sickness, cybersickness, is distinct from motion sickness, in that the user is often stationary in the physical world and the visual imagery is moving (LaViola, 2000). Some symptoms of cybersickness are. dizziness, disorientation, nausea and vomiting. These symptoms are similar to short-term effects of alcohol.

For example, Off-Peak Games (2015) introduced five ways of reducing cybersickness in the design process: reduce non-forward movements; reduce vection; reduce accelerations; reduce camera vertical movements; and add a static reference frame.

The students extensively discussed cybersickness and whether they should exploit or avoid its symptoms as part of the training of the adolescents. The mini-games both utilized the tendency to induce and reduce cybersickness symptoms in the player. For example, in the mini-game "After 10", see Figure 4 left, the player moved forward in the virtual world and was stationary in the physical world, which increased the risk of cybersickness symptoms (La Viola, 2000). In the mini-game "Bad Drink", see Figure 4 right, the player also moved forward in the virtual world but the frames of a car window and steering wheel provided a static reference frame which, according to Off-Peak Games (2015), should reduce the symptoms of cybersickness. Other mini-games such as "Total Blackout" reduced the tendency to cybersickness (LaViola, 2000) by keeping the player stationary both in the physical and virtual worlds, with the possibility of moving the head in both worlds, see Figure 8. In the mini-game "The Walking Drunk", the player teleported to the various places in the house in order to avoid moving forward, which also reduced symptoms of cybersickness (Off-Peak Games, 2015), see Figure 7.

In summary, some games utilized the similarity between cybersickness and short-term effects of drinking alcohol. Others chose to design a more pleasant and longer- lasting VR experience.

Simulating binge-drinking problems

According to Wechsler (1994), binge drinking among high-school students causes many problems. For example, having a hangover, doing something you regret, arguing with friends, engaging in unplanned sexual activity, getting hurt or injured, requiring medical treatment for alcohol overdose, getting into trouble with local police, forgetting where you are and what you did, vandalism, drinking and driving. The most frequent problem is having a hangover, doing something you regret and being involved in drinking and driving.

In the mini-games above, many of these problems are in play. The idea of the mini-game "Total Blackout" is simulation based on regretting and not remembering what happened, see Figure 8. In addition, it covers most problems such as arguing with friends, engaging in unplanned sexual activity, forgetting where you were and what you did, and risky behaviour with a gun. Drinking and driving is also one of the core problems. It is covered in the mini-game "Bad Drink", where the drinking protagonist drives along the streets: see Figure 4. In "Walk of Shame" the drunken protagonist is having trouble both finding home and avoiding cars: see Figure 9.

Training skills of resistance to peer pressure.

Flory et al (2004) demonstrated strong associations between early onset of drinking alcohol, peer pressure, lack of resistance skills and sensation-seeking. Adolescents who start to drink early seem have more anti-social behaviour and are more likely to use other drugs later.

The mini-game "Second Chance" plays on peer pressure and offers only negative choices – the protagonist is only a part of the group if she participates in the game: see Figure 3. The mini-game "Walking Drunk" also addresses peer pressure resistance skills. In this game, the protagonist can choose dancing as a social activity which, over time, also reduces BAC: see Figure 7. In "Total Blackout", the protagonist is a part of a virtual community that helps the player to fill in the blanks: see Figure 8. The mini-game "To Drink or Not to Drink" addresses anti-social behaviour by making the player throw bottles one after another see Figure 5.

To go forward, we suggest more options in training peer pressure resistance skills and more choices to reduce BAC in future mini-games.

6. Reflection on developing content in the Mixed Reality course

For me as a teacher, it was very satisfying combining both future research and teaching in class. A few of the students found it very demanding to develop the mini-games with the programming knowledge they had in C#. Especially the mini-games on throwing bottles were very similar to the one of the tutorials. Most of the others' mini-games were amazingly creative and complicated.

The students were asked to implement game-feel elements for 2D action games inspired by Vlambeer (2013), which was about exaggeration and permanence. Enlarged and exaggerated elements lead the protagonist into the intended direction. For example, in "Total Blackout" the size of the tooth exaggerated and there was more blood shown than to be expected, see Figure 8. The protagonist was supposed to take a closer look at the tooth, which would initiate the intended interaction. Other exaggerated elements in this game were the gun and underwear. The mobile phone was also enlarged in order to enable the player to see the text. In "To drink or not to drink", the men stayed permanently in the scene after being hit with bottles, see Figure 5 – this made the scene more intriguing. It was a good challenge for the students to balance the mini-games in a game-feel perspective.

The part about teaching adolescents strategies to drink less alcohol in social contexts (Grant, 2001) came within the focus of another example "The walking drunk", see Figure 7. In some of the other games, e.g. "To drink or not to drink", the player dies in the end, which is a rather scaring element in training of adolescents´ resistance skills: see Figure 5. This is in contrast to Grant (2001) who suggests the training of new skills rather than scaring the audience. Therefore, in the next iteration, we plan to describe explicitly the resistance training elements in the requirements for the project.

7. Summary and conclusion

The case study presented in the paper explores the potential of using VR in game-based learning on the theme: alcohol-resistance training. Moreover, the case study illuminated the potential of using VR to simulate alcohol symptoms and train alcohol-resistance skills.

How can the students' design of VR mini-games for preventing alcohol abuse inform future designs in this field?

The students' design of interacting by gazing was working well – especially the exaggerated feedback given to the user, e.g. the red circle in "Total Blackout".

The similarities between short-term effects of alcohol and cybersickness, and simulation of short-term effects of alcohol in VR, are also promising for future designs in this field.

Additionally, the young engineering students presented plenty of activities related to binge drinking which also inform future research in the field. Regretfully, they presented fewer varied examples of activities to balance the BAC. Below is a list of how the mini-games can inform future design and research in the field:

Activities about making the right choices

- Educational and informative activities
- Activities to balance the BAC such as passing time, dancing, eating and drinking water
- Simulating peer pressure and training resistance skills

Activities related to heavy drinking

- Scary consequences of alcohol poisoning
- Anti-social behaviour
- Risky behaviour
- Drinking and driving
- Engaging in unplanned sexual activity
- Forgetting and regretting
- Balancing while walking

Simulation of short-term effect of alcohol in VR

- Blurred vision
- Reduced motor control

Cybersickness as design element: similarities between short-term effects of alcohol and cybersickness

- Disorientation
- Dizziness
- Nausea
- Vomiting

The students spent a lot of time discussing how to prevent cybersickness and on the other hand exploit this tendency in the mini-games. Most of the simulations successfully explored decision-making while drinking, but a few of the simulations became games promoting the fun of drinking and making questionable decisions. The gameplay in these prototypes linked drinking to winning the game, which was undesirable.

VR definitely has potential for supporting creative activities for training of alcohol & other drug resistance skills.

In conclusion, with a few exceptions, the mini-games developed in this course demonstrated the creativity of the students as well as an overall high level of learning outcomes among students, reflected in a good command of relevant programming skills as well as in the mostly successful use of certain design elements in the mini-games prototypes. However, in the future more focus should be put on stimulating positive or protective behaviour among users rather than just to motivate avoidance of harmful consequences of heavy drinking.

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