JÖNKÖPING UNIVERSITY
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Virtual Reality Games for Team Building Interventions

Comparison of team building interventions for university students

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AUTHOR: *Grace Sekwao and Sarah Modolin*
TUTOR: *Andrea Resmini*
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Sarah Modolin and Grace Sekwao

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Abstract

Teams are essential in today's organisations. Thus, it is important to enable students early in the education process to work in teams. Moreover, we have new technologies emerging such as virtual reality (VR), that have the possibility to influence processes such as team building interventions. In addition, many researchers claim the importance of games in teaching as it leads to high engagement. Even though, there is much research available in the areas of VR, team building and games, no research connecting all three topics can be found. Nevertheless, it can be observed that VR and games have been used in teaching before, however not at the same time to enhance teamwork skills. This research provides a thorough literature review on the current possibilities and applications of VR in teaching and defines effective team building. Moreover, games in teaching and their possibilities and advantages are described. Eventually, the purpose of this study is to find out if team building interventions with the help of VR are more effective in comparison to non-VR based methods. We add to existing research by enhancing current team building techniques through VR technology. Being aware of the nature of this research we combine a qualitative and quantitative approach, namely content analysis and A/B testing, to research this topic. To support the content analysis, we apply a teamwork framework defined by Rosseau, Aubé and Savoie (2006). To validate our experiment results from A/B testing we triangulate by conducting an additional experiment. The analysis of this study shows that VR based team building interventions trigger more team processes than team building interventions without VR. Furthermore, the research points out possible future directions of studies since VR for team building is a rather new topic and thus needs to be further researched. Finally, the study can be used to encourage students and teachers at University level to apply VR technology when the opportunity is given.

Table of Contents

1 Introduction 1
1.1 Background 1
1.2 Problem 2
1.3 Purpose 5
1.4 Research Questions 5
1.5 Delimitations 5
1.6 Definitions 6

2 Theoretical Framework 7
2.1 Team Building 7
2.1.1 Teamwork Processes 8
2.1.2 Effectiveness of Team Building Interventions 14
2.2 Virtual Reality (VR) 15
2.2.1 VR in Education 16
2.2.2 Digital game-based Learning 17
2.2.3 Digital game-based Learning with VR 18

3 Research Methodology 19
3.1 Research Philosophy 19
3.2 Research Ethics 20
3.3 Research Approach 20
3.4 Research Design 21
3.4.1 Research Method 21
3.4.2 A/B Testing 22
3.4.3 Sampling Process 24
3.5 Data Collection Method 24
3.6 Analysis of Qualitative Data 25
3.6.1 Directed Content Analysis 26
3.7 Previous Research Review 27
3.8 Reliability and Internal Validity 27
3.9 Generalizability 28

4 Empirical Findings 30
4.1 Experiment Settings 30
4.2 Observation Schedule Results 33
4.3 Narration of Experiment A 39
4.4 Narration of Experiment B 40
4.5 Narration of Experiment C 42

5 Analysis 44
5.1 Specifying Goal of the Task 45
5.2 Planning the Task 46
5.3 Delegating Task 46
5.4 Coordination 46
5.5 Cooperation 46
5.6 Communication 46
5.7 Performance Monitoring 46
5.8 Systems Monitoring 47
5.9 Backing up Behaviours 47
5.10 Intrateam Coaching 47
5.11 Collaborative Problem Solving 47

5.12 Team Practises Innovation 47
5.13 Team Support 47
5.14 Conflict Management 47

6 Conclusion 48

7 Discussion 49
7.1 Results Discussion 49
7.2 Methods Discussion 51
7.3 Limitations 52
7.4 Implications for Practise 52
7.5 Future Research 53

References 55

Figures

Figure 1 A 3D VR Set Up at JIBS Creative Studio (BigLee) 3
Figure 2 Teamwork processes 9
Figure 3 Teamwork processes with focus on "before a team task" 9
Figure 4 Teamwork processes with focus on "during execution" 10
Figure 5 Teamwork processes with focus on "after completing a team task" 11
Figure 6 Teamwork processes with focus on "team maintenance" 13
Figure 7 Keep Talking and Nobody Explodes Game Design Look 1 23
Figure 8 Keep Talking and Nobody Explodes Game Design Look 2 24
Figure 9 Experiment Setting for VR methods 31
Figure 10 Experiment Setting for non-VR methods 32

Tables

Table 1 Observational Schedule for Data Collection 25
Table 2 Experiment A (Group 1 with VR) 33
Table 3 Experiment B (Group 1 without VR) 35
Table 4 Experiment C (Group 2 without VR) 37
Table 5 Experiment Frequency Results for Experiment A, B and C 45

Appendix

Appendix 1 62
Appendix 2 63

1 Introduction

This chapter provides a brief introduction on the research topic. It covers various areas such as background, the research problem, the main purpose of this research and the research questions formulated based on the purpose. This chapter also explores the delimitations of this research and the definitions of terms which are widely used in this study.

1.1 Background

Teams are essential to the accomplishment of today's organizational goals (Marks, Mathieu & Zaccaro, 2001; Klein et al., 2009). Additionally, companies are faced with ever changing environment(s) to which the employees need to be able to adapt fast to (Franceschi, Lee, Zanakis & Hinds, 2009). According to Brief (1995) and Ekimova and Kokurin (2015) efficiency and quality may be increased through teamwork. However, teams need to be developed and nurtured to achieve possible benefits (Brief, 1995; Ekimova & Kokurin, 2015). In order to develop teams, one can use team building activities and team development activities. Team development describes interventions directed towards the skill sets of team members whereas team building is focused on improving social relations and defining roles within a team (Klein et al., 2009). The improvement of social relations can increase group cohesion, which is the *"sense of connection group members have towards each other and towards the group as a whole"* (Birx, LaSala & Wagstaff, 2004, p. 175). Ultimately, group cohesion increases job satisfaction (Birx et al., 2004).

When it comes to university students, working in a team has proven to help them gain a better understanding of their courses (Boyer, Weiner & Diamond, 1998). Moreover, a study conducted by D. Johnson, R. Johnson and Smith (1998) show that working in a team for students leads to higher individual achievement than working individually or in a competitive way. Thus, it is important for students to be able to learn team building skills which can be helpful in their current studies and later be helpful in their future careers when they join various organizations.

An effective potential tool for helping students learn these team building skills is by using digital games. Since years the market for gaming has been thriving. According to the Pew Research Center in the USA *"about half of American adults […] play video games"* nowadays (Duggan, 2015). Video games are hereby counted as games that are played on a "*computer, TV, game console or portable device"*.

Usage of digital games for interactive learning has become more popular over the years. It has been proven that, digital games can be used to increase the visual perspective and enhance decision making and critical thinking (Yang, 2012). Furthermore, digital games are also said to be a good solution to engage many people at once which is essential for building teams (Kelly, 2004). According to research conducted by Yang (2012), the influence of digital games on students is expanding as technology grows since the games are not only played but they are also talked about, read about and fantasized about which ultimately increases their motivation for learning.

Virtual reality (VR) games are a type of digital games which are played in immersive three-dimensional (3D) environments (Ma, 2014). VR games can offer an interactive platform for learning various skills (Chang, Hwang, Chen & Muller, 2011). According to Ma (2014), in the education system, VR games can be successfully used as part of serious games which are games that have a purposeful educational goal and not just for amusement.

This paper focuses on digital games which can be used for team building interventions. Games can be used for various team building skills. In a research conducted by Bozanta, Kutlu, Nowlan and Shirmohammadi (2012) they used a game called Zoom to develop communication and problem-solving skills within a virtual team. The researchers used a combination of serious games and multi-user virtual environments (MUVEs) to determine its potential in building team skills. Their research results showed that the MUVEs and games can be used effectively to build teams and that organizations can benefit from them.

1.2 Problem

The idea of team building can be traced back to the Hawthorne studies which were conducted in the late 1920s. The centre of those studies was employee motivation. Ultimately, they reasoned about the development of an employee team to increase efficiency in the operations of the factory where the experiment was conducted. The researchers' findings included that employee freedom in defining their own work conditions, lack of pressure and feedback (including satisfaction thereof) were important contributors to successful teamwork (Ekimova & Kokurin, 2015).

De Leo, Goodman, Radici, Secrhist and Mastaglio (2011) performed research on digital team building activities and directly correlated a heightened "sense of presence" to an overall better outcome in team building activities, and in general to a more satisfying experience. They define "sense of presence" as "the subjective sensation of 'being there' that users experience when they emotionally and intellectually engage in an interactive virtual environment" (De Leo et al., 2011). Sense of presence has been long discussed from a sociotechnical (Turner & Turner, 2006) perspective and in its implications for the design of the digital landscape (McCullough, 2004). In the fields of information architecture and user experience, and specifically linked to a conversation on how digital and physical are blending, Resmini and Rosati (2011) relate sense of presence to place-making. Following Turner and Turner, they consider place, phenomenologically defined as including "in addition to physical space, memories, experiences, and behavioral patterns associated with the locale", as one of the elements influencing presence.

The way a person makes sense of a place is closely related to former experiences (memories, emotions, skills etc.) within the place or similar locations, and can be "personal, subjective, (or) communitarian". Since sense of place is experiential in nature, place-making is consequently an important element in creating and sustaining a sense of presence not only in physical but also in digital environments.

Experiences in digital environments correlate to experiences in physical environments (Resmini & Rosati, 2011; Slater, Pertaub & Steed, 1999). As an example, a member of a team ("guild") in World of Warcraft suffered a stroke in real life and passed. The guild decided to hold an in-game funeral service. A rival guild disturbed the ceremony, sparking a heated discussion on blogs and forums on the ethics around the happenings (Terra Nova, 2006). Very clearly, the in-game environment was perceived by all those involved, the mourners and the invaders, to be meaningful, "real", and deserving the same consideration one would give such occurrences in physical space.

"Virtual reality typically refers to the use of interactive simulations created with computer hardware and software to present users with opportunities to engage in environments that appear to and feel similar to real-world objects and events" (Weiss, Rand, Katz & Kizony, 2004, p. 1). These simulations are in 3D environments (Gutierrez, Vexo & Thalmann, 2008). A typical 3D VR set up consists of a head mounted display, controllers and a computer monitor (Parong & Mayer, 2018). Figure

1 below illustrates a 3D VR setup seen at the Jönköping International Business School (JIBS) creative studio (also known as Bigl.ee). In this case, the user is wearing the Oculus head mounted display and using its corresponding controllers on his hands. There is also a presence of computer monitor where depending on the VR application it can show the simulations of that the user is seeing.

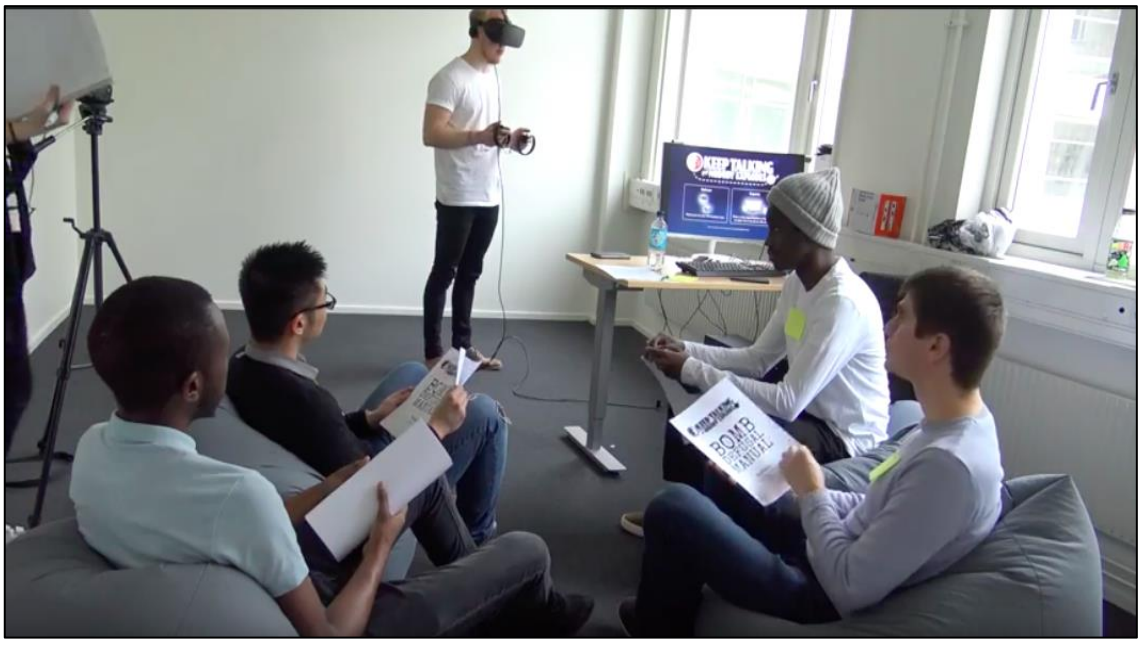

Figure 1: A 3D VR Set Up in the JIBS Creative Studio (Biglee)

Huang, Rauch and Liaw (2010) state that VR is defined as '3 Is' meaning it has three features which are Immersion, Interaction and Imagination. In this context, VR uses various user interfaces devices that offer the effects of immersion in a virtual environment. An important aspect of teamwork and team building is engagement. The existence of group engagement drives group synergies and hence overall performance of a group. Hence team members need to support each other on a constant basis even if the individual task is fulfilled, leading to self-organisation, which is an important skill nowadays in the ever-changing environment (Franceschi et al., 2009).

Digital games are so good in engaging their users that they tend to get addictive. Moreover, games have the possibility to create maximal engagement, also known as flow (Bartle, 2004; Csikszentmihalyi, M. & Csikszentmihalyi, I., 2000; Franceschi et al., 2009; Kelly, 2004). Engagement is hereby referred to as a "*situation in which an individual's attention is completely focused on a particular task*" (Franceschi et al., 2009, p. 78). Additionally, M. Csikszentmihalyi and I. Csikszentmihalyi (2000) attribute the state of flow as a state where the task at hand seems effortless and intrinsic rewarding. Moreover, the perceived time can be transformed in either a slower or faster passing of time. According to the authors there is usually a balance between being challenged with a task and being able to apply pre-existing skills in the state of flow. Last the goal at hand is clear to the person and thus control over the task exists (Csikszentmihalyi, M. & Csikszentmihalyi, I., 2000). At the point of flow, the highest level of performance can be reached (Bartle, 2004). Thus, the game industry takes advantage of this phenomenon to keep up the players interest. Consecutively, game features that enable engagement and eventually a flow state are in the centre of game design. Franceschi et al. (2009) performed a study focusing on learning in digital worlds. They concluded, that the

engagement in an activity is higher if it takes place in a digital place than it is in real life. Hence, given the opportunity students can benefit from learning in digital spaces such as VR. VR allows users to be completely submerged or engaged with a virtual environment (Dalgarno & Lee, 2010). Franceschi et al. (2009) state that there is a correlation between engagement and perceived sense of presence of an individual and a group. Hence it is important to consider factors that thrive engagement when developing digital mediated learning solutions.

Taking advantage of flow is also supported out of the guided social constructivist theory. According to Dede, Jacobson and Richards (2017) learning experiences which are supposed to teach complex knowledge and sophisticated skills are based on what the author terms as guided social constructivist theories of learning. This implies that people build up knowledge and skills based on their prior experiences and sociocultural background. In this type of learning, teachers and instructors do not impose a tightly fixed method of instructors rather than just offer a loosely structured guidance method such as coaching and mentorships. This type of learning is social and is done by the students themselves based on their experiences and their interactions with others. Therefore, the idea of self-organisation is supported in this theory as well. Just like games, using VR in education does not only facilitate engagement and interaction for users but it also promotes self-exploration and them stating their own point of view with minimal supervision (Dalgarno & Lee, 2010). Moreover, social learning can be facilitated by using VR. This is because VR offers an immersive experience to students that enhances exploration and collaboration among students (Dede, Jacobson & Richards, 2017). Due to this, current research has shown that VR is a promising tool in improving education and promoting the learning outcomes also (Dede, Jacobson & Richards, 2017). Additionally, because of the recent development and emergence of VR, Schneider (2017) points out that there is a lot of "*untapped potential in education*" (p. 220). The author proceeds by stating that those technologies shouldn't exchange all kinds of instruction but rather be used to maximize the learning effect. Based on the novelty of our topic and the coherent potential for education we seek to find out if VR games are more effective for team building interventions among University students than digital non-VR games.

Researching team building interventions, one can find a lot of information on its efficiency and team effectiveness (Klein et al., 2009; Kozlowski & Ilgen, 2006; Marks et al., 2001; McEwans, Ruissen, Eys, Zumbo & Beauchamp, 2017; Rosseau, Aubé & Savoie, 2006; Salas, Sims & Burke, 2005). Team efficiency refers to the team's ability to interact with each other in a way that supports the team's goals while also taking external factors into account. Hence team efficiency is concerned with different team behaviours. It is connected to team effectiveness which relates to the team's ability to achieve certain results (Salas, Sims & Burke, 2005). However, there is little research on how to facilitate interventions in a way that increases efficiency through technology. Moreover, during our research we found that many researchers write about VR as a topic in general. We also discovered that VR is especially researched in the case of healthcare application and in the military. Also, it has been proven that digital games have been useful in the education sector since they increase engagement which in turn leads to a better academic performance due to gaining of new skills (Ma, 2014). However, there is no research that looks at the combination of both VR and digital games as method to facilitate team building interventions.

Our research focuses on investigating students in higher learning institutions to determine their behaviours and the processes generated during digital team building interventions. A similar research was conducted by Ekimova & Kokurin (2015) whereas they investigated the

attitudes of students towards different team building methods. Their findings suggest that a positive learning experience within the area of teamwork can positively influence the attitude towards teamwork efficiency and eventually enhance the student willingness to work in team classes. Thus, they conclude, that the attitude of students towards team-based learning is highly dependent on the teamwork efficiency. The authors also reason that problem-solving practice, cooperation, individualistic tendencies and peer evaluation may be influencing factors for students to accept teamwork. Based on this Ekimova and Kokurin (2015) state that the impact of training students on *how* to work in teams needs to be researched. Following this call and taking into account all the research we did before, we compared different team building approaches to see if they are effective in regard to team efficiency.

1.3 Purpose

The purpose of this thesis is to investigate VR games as an educational tool to facilitate team building interventions. Eventually, we want to find out if VR games are an effective tool to increase team efficiency. In order to achieve results, this investigation starts by conducting an experiment that compares a non-VR team building intervention to a VR based team building intervention.

1.4 Research Questions

In order to accomplish the purpose of this research, the following research questions have been formulated

1. How does a VR game-based team building influence the intervention with focus on team processes?
    a. How effective is a VR game-based team building in comparison to non-VR game-based team building?
    b. Which team processes show a higher presence in a VR game-based method in comparison to a non-VR game approach? Are there processes that only visible in one method?

1.5 Delimitations

1. We do not include augmented reality or mixed reality.

Both AR and MR provide immersive learning experiences that can be used not only in the academic world but in other professions just like VR (Ferguson et al., 2015). According to Maylor and Blackmon (2005) research objectives can be based on personal interest. Thus, in order to narrow down our research area we decided to research VR instead of the other immersive technologies since we are more interested in that particular subject.

2. Our data sample is based on students from Jönköping University.

Jönköping University is our primary data pool as we are situated at Jönköping University. Also, our main research topic is based on evaluating VR as a learning tool for students thus students at Jönköping University fit that description. Moreover, the technologies applied are provided through Jönköping University which makes a transfer to another campus difficult. Moreover, the experiment used in this research is conducted in the creative studio located on the second floor of JIBS. The studio is also known as Big Lee and it contains the VR equipment used the research.

3. We focus on one team building framework (Rosseau et al., 2006).

Over the years there have been many researchers trying to summarize team processes within one framework. However, we found the framework provided by Rosseau et al. (2006) most

fitting as it was analysed before in regard to its conclusion on team building interventions and its effectiveness by McEwans et al. (2017).

4. We do not define any prerequisites within the experiment.As commonly known, prerequisites of team members can influence the performance of a team. A major model known within this area is the Input-Process-Output model (IPO model), which will be explained within the framework of this research. However, as we do not focus on the performance of the team, we do not need to include attributes of team members.

5. In order to answer our research question we use A/B Testing.
According to Bruce (2016), results of A/B testing can be random and many researchers implementing this method underestimate the scope of this natural random behaviour. The randomness can be due to extreme events or as Bruce (2016) calls them black swans which can be in our case all the team players having a positive attitude on the day of the experiment which can cause a massive significance to the results of the experiment.

6. The focus of the thesis is on VR games and its application in the team building context.
This thesis provides insight on VR technology and its application in the education. Thus, there is a lot of research on games and education available, however we aim to put it into a new context by introducing VR to the process.

1.6 Definitions

Team Building (Interventions): *Team building is defined as the process that aims to improve the performance of a group of people working together to achieve a common goa*l (Ekimova & Kokurin, 2014, p. 847). Thus, Team building interventions are actions taken to improve the effectiveness and functioning of a team (Klein et al., 2009).

Virtual Reality (VR): Virtual reality is a technology that involves visual, interactive and computer-generated environments which allows a user to move around and explore (Castree et al., 2013). In VR the interaction is done by using only virtual images with the aim of replacing the real world (Guttierrez, Vexo & Thalmann, 2008).

Team efficiency: Team efficiency refers to the team's ability to interact with each other in a way that supports the team's goals while also taking external factors into account. Hence team efficiency is concerned with different teamwork processes. It is connected to team performance/ effectiveness which relates to the team's ability to achieve certain results (Salas, Sims & Burke, 2005).

2 Theoretical Framework

This chapter outlines the foundation of this study by presenting a theoretical framework used in this study. It looks at the literature review involving team building and its processes and virtual reality together with its connection with digital games, education and team building. The chapter also explores the teamwork processes framework as described by Rosseau et al. (2006) which is used as a basis for conducting the study.

2.1 Team Building

Teams are essential in almost everything we do nowadays. Moreover, teams that are connected through technology over long distances (virtual teams) are becoming more important (Kozlowski & Ilgen, 2006). Virtual teams are important because they provide a wider and rich pool of resources for organizations by combining a mix of cultures, skills, perspectives and capabilities (Settle-Murphy, 2012). Moreover, using virtual teams offers a more sustainable approach since in some cases employees can work from home which implies less time spent in traffic and lower emissions (Strategic Sustainability Consulting, 2018).

In general, employers value staff members that have good teamwork skills as they are costly to develop (Lau, Kwong, Chong, & Wong, 2013). Hence training higher education students in those skills is a meaningful way of creating an advantage on the job market (Lau et al., 2013).

Klein et al. (2009) researched the effectiveness of team building interventions. They suggest that teams are essential in organisations, however they need to be "*nurtured, supported, and developed*" (p. 182). Team building interventions are actions taken to improve the performance and functioning of a team. Hence, team building is a common method for team development in organisations (Klein et al., 2009). It is important to distinguish between team performance and team efficiency. Performance refers to the ability of a team to complete a task whereas efficiency takes a more holistic approach by including other factors such as how the team interacted with each other or how external factors influenced the outcome. Thus, more factors are regarded when looking at team efficiency in comparison to team performance (Salas, Sims & Burke, 2005).
There are different methods to do team building, including outdoor/ indoor activities, social events, sport activities, discussion groups and workshops (Klein et al., 2009; McEwans et al., 2017; Salas, Rozell, Mullen & Driskell, 1999). Moreover, there are already concepts for doing team building within a digital space or with the help of technology such as, tablets, chat rooms, GPS or web conferences. Most of those sessions using these techniques last between 5 to 30 minutes. (Chen, 2013).

Beer (1976, quoted in Salas et al., 1999) defines four models of team building interventions: *"Goal setting, interpersonal relations, problem solving, and role clarification"* (p. 314). Within an intervention focused around goal setting participants need to practice defining and developing goals of individuals and the team. This includes action planning to reach those goals. When an intervention focuses on interpersonal relations skills, such as communication, support processes within the team are important. Thus, those interventions aim to build up trust and confidence among the team members. Targeting problem solving within an intervention aims to increase the ability of the team to identify problems within the team. Teams that do this kind of intervention are able to resolve problems (or conflicts) and implement solutions. Role clarification aims at communication skills of team members to

identify their roles within a team. This increases the understanding for each other's role within a team (Salas et al., 1999). Salas et al. (1999) suggest that all four models of team building interventions can be targeted within one single intervention, however to a different degree. This is supported by Buller (1986, quoted in Klein et al., 2009) who also states that all models are usually targeted within an intervention. According to a research based on 131 studies of organisational change from Macy and Izumi (1993), team building activities are the most influential activities performed by an organisation in regard to an effect on financial measurements. Hence it is important for companies to engage in team building in a meaningful manner.

2.1.1 Teamwork Processes

Literature distinguishes between teams and groups. Teams are able to discover synergies among the team whereas groups are not necessarily able to do so. Hence assembling people together does not ensure them of being a team. Certain processes within the group need to be ensured to make them a team (Lau et al., 2013). McEwan et al. (2017) suggest that teamwork (which is referred to team processes by Marks et al. (2001)) can be divided into taskwork and teamwork processes. Marks et al. (2001) define task work as *what* is being done by the team whereas teamwork processes indicate *how* those tasks are being processed within the team.

There are different definitions of categories of teamwork exist and their necessary number (e.g. McEwan et al., 2017; Rosseau et al., 2006). However, one thing the authors widely agree upon is that teamwork is comprised of multiple behaviours that can be measured and observed. Two of the most cited frameworks are Marks et al. (2001) and Rousseau et al. (2006). They both define between 10 and 14 categories of teamwork. To conclude the research McEwan et al. (2017) suggest summarizing the categories in two behaviours: 1. To regulate a team's performance 2. To keep the team together, which is also referred to as team maintenance by Rosseau et al. (2006).
Rosseau et al. (2006) provide a review on current teamwork frameworks and construct one integrated framework. Moreover, they only focus on teamwork in organisational settings, excluding articles about teamwork within military or similar settings. In total they review 29 frameworks that were published between 1984 and 2005. They point out the lack of consensus for one framework, supporting the articles purpose. The research was done by conducting an inductive analysis of the articles. Figure 2 shows a summary of all teamwork processes. A more elaborate definition of those is described below.

Figure 2: Teamwork processes (based on Rosseau et al., 2006; McEwan et al., 2017)

The first category of regulating team performance can be broken down into three categories, which are described below:

2.1.1.1 Before a Team Task and/or Performance

Those activities describe processes in which the teams general mission or purpose including goals and their corresponding strategies are defined. Thus, this ensures that every team member knows what is expected of them to make the team function. (Lau et al., 2013; McEwan et al. 2017; Rousseau et al. 2006). Hence a focus is put on the team's mission. Figure 3 provides an overview for the reader of this process.

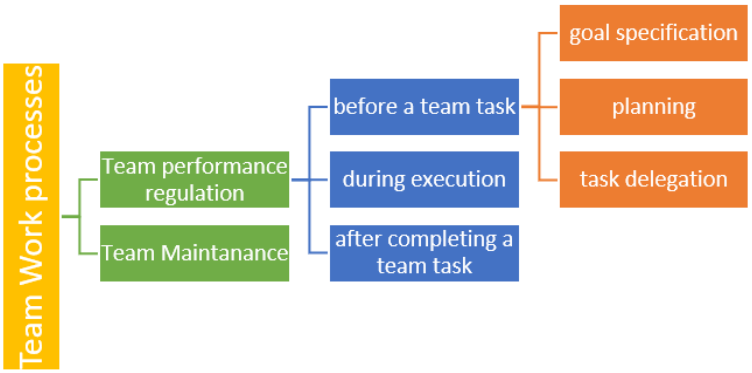

Figure 3: Teamwork processes with focus on "before a team task" (based on Rosseau et al., 2006; McEwan et al., 2017)

a) Goal Specification: The definition of the goal is important as it helps the team members to stay focused on the task at hand. Eventually, the definition of goals enables the team to further plan their next steps to reach those goals (Rousseau et al., 2006). Furthermore, Lau et al. (2013) state the importance of other team members acceptance of goals and possible compromises that may be encountered that way.

b) Planning: Based on the goal definition, an action plan can be set up to achieve certain outcomes Rousseau et al., 2006). If a team chooses to not set up a strategy plan or plans in an insufficient manner, it may be forced to improvise or act on past experience, which can lead to unforeseen difficulties. This is especially the case, the more complex or new a task is to the team members (Marks et al., 2001).

c) Task Delegation*:* Within this action plan, which is referred to as *"performance plan"* (Rosseau et al., 2006 p. 550) as well, different tasks are distributed and their correlating timing and method of achievement. This is in accordance to Marks et al. (2001) who state that team interactions are related to the goal that needs to be obtained in verbal, cognitive or behavioural format. Those interactions are referred to as team processes in their paper.

2.1.1.2 During Execution

This describes activities that are related to communication within the team. Moreover, the coordination, and cooperation with each other is an important factor. In this phase plans that were made in the former category are put into action (McEwan et al. 2017; Rousseau et al. 2006). Figure 4 shows the processes that are part of the "during execution" activity.

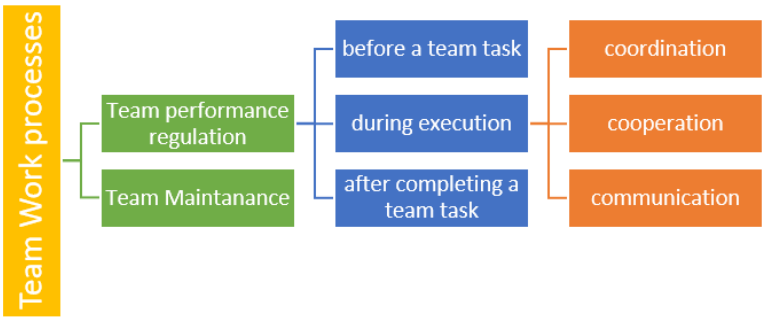

Figure 4: Teamwork processes with focus on "during execution" (based on Rosseau et al., 2006; McEwan et al., 2017)

a) Coordination is defined by ensuring that tasks of team members are integrated and achieved in a certain time span (Cannon-Bowers, Tannenbaum, Salas & Volpe, 1995 quoted in Rosseau et al., 2006). The absence of coordination within a team may lead to tasks that are not carried out or not done in a sufficient manner (Yeatts and Hyten, 1998 quoted in Rosseau et al., 2006). However, the presence of coordination ensures that tasks are done in the right order including synchronization. This also includes the avoidance of duplicating tasks (Spreitzer, Cohen & Ledford, 1999).

b) Cooperation exists when individuals contribute willingly to a task at hand to complete interdependent tasks (Wagner, 1995). Furthermore Lee, Lin, Huang, Huang, & Teng (2015) and Lau et al. (2013) state trust plays an important role regarding cooperation

and performance. Lee et al. (2015) refer to trust as *"the intention to actively undertake a risk in the context of a personal relationship"* (p. 530). Since trust is vital when doing interdependent tasks, it can increase cohesion and collaboration within a team and hence influence teamwork (Mayer, Davis & Schoorman, 1995).

c) Communication, which is referred to as information exchange by Rosseau et al. (2006), is important as it ensures that each member of the team can perform their tasks based on the latest information and is therefore linked to a team's effectiveness (Rosseau et al., 2006; Valls, González-Romá & Tomás, 2016; Wi, Oh, Mun & Jung, 2009). Information that is being shared may include changes in demands, new information from management or suppliers or delays in production (Rosseau et al., 2006). Hence it is necessary that this information is being exchanged (Lee et al., 2015).

2.1.1.3 After Completing a Team Task

After completing task behaviours such as work assessment behaviours, and adjustment behaviours of the team are necessary actions. Doing so a team is able to adjust their action plan, behaviour and measure if a goal was reached or not. Additionally, reasoning for failure can be made (Rosseau et al., 2006; McEwan et al. 2017). Figure 5 is an extract of the whole model to ensure the understanding thereof.

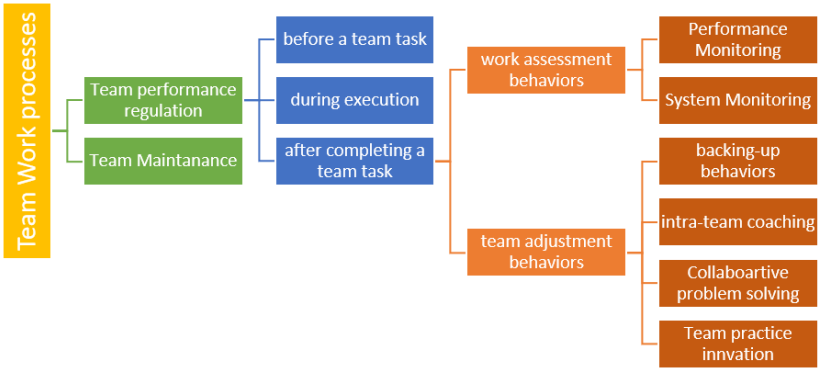

Figure 5: Teamwork processes with focus on "after completing a team task" (based on Rosseau et al., 2006; McEwan et al., 2017)

a) Work assessment behaviours: Those processes describe actions taken towards monitoring the team's performance on the way of reaching goals including an observation of the system they are acting in, which can also be referred to as the environment. This enables the team to ensure that they are doing the right things (Salas et al., 2005).

i) Performance Monitoring: Throughout this process an evaluation of which goals are reached is made. Accordingly, next steps are defined to reach unfulfilled goals (Marks et al., 2001). This includes evaluating other team members tasks while working on their own tasks (McIntyre and Salas, 1995 quoted in Rosseau et al., 2006). Thus, this ensures that goals are accomplished as planned, including timing and the way a goal is accomplished. Eventually, this empowers a team to realize mistakes or underperformance in a timely manner. Hence, they are given the chance to react to those unplanned situations as well (Marks & Panzer, 2004).

ii) Systems Monitoring: Additionally, to monitoring the team's performance, the environment can be evaluated as well. Hereby, the internal and external environment can be monitored. The internal environment refers to team resources, such as equipment, team members, and information that may come up. The external environment refers to market requirements and possible organisational changes. Overall, this process enables the team to respond to changes in the environment accordingly. The monitoring of the environment gains importance the more dynamic the environment is the team acts in (Marks et al., 2001).

b) Team Adjustment Behaviours: In some cases, the team might realize that they might not be able to reach their project goals due to challenges such as lack of resources, faulty project plan or other unforeseen changes that might erupt. Dibble and Gibson (2013) categorize these challenges as internal and external challenges especially for teams in multicultural settings. The internal challenges are those which develop within the team such as conflicts due to different backgrounds mishaps in coordination and structural breakdown. On the other hand, external challenges are those which originate outside the team such as changes in the physical settings of the teamwork like the political, economic and regulatory changes. The team's capability to handle this situation and still perform well is what is known as team adaptability (Bowers, Morgan Jr., Salas, & Prince, 1993; Cannon-Bowers et al., 1995 quoted in Rosseau et al., 2006; Salas et al., 2005). This process of adaptation can be categorized into two groups which are non-teamwork adjustment behaviours and teamwork adjustment behaviours. Non-teamwork behaviours can occur in different forms such as adding extra resources and increasing effort towards a project. Teamwork adjustment behaviours can include changing the project goals and increasing coordination among team members (Rosseau et al., 2006). According to Rosseau et al. (2006) the teamwork adjustment behaviours are namely backing-up behaviours, intrateam coaching, collaborative problem solving and team practice innovation.

i) Backing-up Behaviours: Backing-up behaviours described in this context indicates a method where team members help each other to perform their roles (Porter et al., 2003). In some instances, a team member might fail to accomplish a certain task which is defined by his or her role. Thus, another team member might step in to help that member fulfil that role by various ways such as correcting their performance-related mistakes which might exist or fill in that role (Rosseau et al., 2006). These backup behaviours are not part of a job description and they are not planned or required for a job. When team members backup another teammate it means that they have the time, capacity and resources to lend a helping hand (Rosseau at al., 2006).

ii) Intrateam Coaching: Intrateam coaching means to exchange constructive criticism and feedback between team members when doing a task in order to accomplish it. Intrateam coaching aims at allowing team member to learn from each other and thus result into high performance of the team. Coaching can come in various forms such as providing advice, suggestions, guidance and instructions and also by correcting errors that team members can make (Druskat & Kayes, 1998; Rasker, Post & Schraagen, 2000 quoted in Rosseau et al., 2006).

iii) Collaborative Problem Solving: Problems such as technical difficulties can occur and interfere with the accomplishments of the tasks. In order to solve this problem, the team members might need to collaborate so as to come up with a solution that can return the working environment to the desired working condition. The process of resolving such problems involves gathering and analysing information related to the problem, selecting the

best solution and implementing it (Steven & Campion, 1994). According to Steven and Campion (1994) when team members work together towards finding a solution, the diagnosis of that problem is more likely to improve since there are different perspectives being offered towards that problem.

iv) Team Practice Innovation: As the progress of the team's work is continuing, the team members might be required to find new and better ways of accomplishing tasks. This implies that they would have to innovate and come up with new practises to cope with the tasks demands in order to maintain or increase their performance (Spreitzer et al., 1999). The behaviour category that is associated with this process is called the team practice innovation and it is defined as a team members' activities that are based around inventing and implementing new ways of accomplishing tasks (Cohen, Ledford & Spreitzer, 1996). When team members are more innovative it influences a better way to react more to the changing requirements of the project and thus be more effective (Rosseau et al., 2006).

2.1.1.3. Team Maintenance

For a team to work efficiently and to be able to accomplish their tasks then they need to be maintained so as to continue to keep the team together (McEwan et al., 2017). According to Rosseau et al. (2006) one of the factors that can endanger the maintenance of a team are personal or interpersonal issues among team members. This is because any difficulties experienced among team members can result into conflicts and thus hinder the progress of the team. An effective method of managing the team maintenance is required so as to deal with these difficulties throughout the lifecycle of the team. Rosseau et al. (2006) states that there are two teamwork behaviours which are associated with team maintenance management and these are namely team support and conflict management. Figure 6 can be used as guidance within the model.

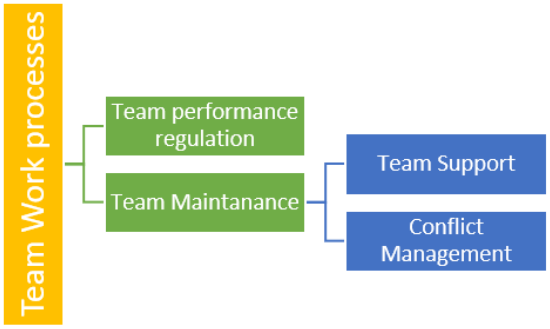

Figure 6: Teamwork processes with focus on "team maintenance" (based on Rosseau et al., 2006; McEwan et al., 2017)

2.1.1.4 Team Support

There are various personal or interpersonal issues that team members can go through while working on their team that can affect their performance such as failure, stress and job security concerns. Their fellow team members' supportiveness throughout this time can help these individuals cope with the difficult time (Rosseau et al., 2006). Support in this instance means the voluntary action of team members to reinforce and sustain a sense of well-being of their teammates. When team members support each other, they are able to show a sense of care and consideration, encouragement and also offer comfort and a method of coping with the

difficulties that these individuals might be facing. This supportiveness usually correlates with providing incentives from other team members to perform better and maintain that high performance (Marks et al., 2001).

Various organizations tend to encourage their teams to positive emotional feelings within teams by motivating their workers to control their emotional feelings and displays. Becker, Cropanzano, Wagoner and Keplinger (2018) terms this process of managing emotional feeling in teams within a workplace as emotional labor. In this context, when there are genuine emotional displays it is proven to have increased positive affect and reducing the level of work withdrawal. Moreover, it can also lead to higher levels of job satisfaction, performance and commitment to the organization. Becker et al. (2018) states that in team settings, it is more likely for these emotional displays to be communal because when people interact their behaviours tend to be coordinated. Thus, when an individual finds themselves in a team where there is a high level of support then they are more likely to mimic that behaviour and become supportive as well.

2.1.1.5 Conflict Management

Conflicts within a team are part of team dynamics and they are inevitable due to the fact that in teams there are people from various backgrounds and different perspectives on how to tackle tasks which in turn can cause a clash among them (Rosseau et al., 2006; McEwan et al., 2017). According to Hurt (2014) there are various forms of conflicts which have been identified by many researches but they all merge into two primary ones which are cognitive and affective conflicts. In cognitive conflicts, it is more task-focused and has proven to have positive effects to an organization because it inspires creativity and innovation since it allows different views to be discussed. However, high levels of cognitive conflicts are proven to be harmful and can damage the team. Affective conflicts are more relationship based as they are more based on emotions and personal feelings towards team members. This type of conflict is proven to have negative effects since it promotes mistrust, dislikes and lack of receptiveness towards other team members ideas. Conflicts have proven to be harmful when they are not managed properly due to the fact that they can affect the relationship between team members, the work process on how to accomplish the tasks thus affecting the overall goal of the project. Team members can work together to resolve their conflicts by integrating their interests to find a common goal. This implies putting into consideration of the team members' views when there is argument between the team members (Rosseau et al., 2006). By integrating interests, team members are able to generate better decision regarding conflicts and enables them to focus on accomplishing their tasks instead of the conflicts (Alper, Tjosvold & Law, 2000; Yeatts & Hyten, 1998). The ability of a team to resolve conflict in a fast manner can be seen as a source of new ideas. Thus, in some instances conflicts can be seen as a constructive impetus (Lau et al., 2013; Rosseau et al., 2006).

2.1.2 Effectiveness of Team Building Interventions

McEwan et al. (2017) provide a thorough review on teamwork interventions and their effect on the overall performance of the team. To achieve this, they conducted a literature review and a statistical analysis with comparison of all outcomes in the applied literature. Eventually, they conclude that interventions for teamwork training are especially effective when various categories of teamwork are targeted. Moreover, they mention a positive correlation between *"experiential activities for team members to actively learn about, practice and continually develop teamwork*" (p.19). The authors also state that a team's purpose is to achieve certain results and hence the team's effectiveness can be measured in its results, which is in accordance with what Rosseau et al. (2006) and Kozlowski (2017) state. McEwan et al. (2017) also found out that

an intervention is especially effective when at least two processes of teamwork training are targeted. Thus, this should be the (minimum) target of each intervention.

2.1.2.1 Input-Process-Output Model (IPO)

Marks et al. (2001) stress the importance of focusing on the processes within the team for evaluating teamwork in comparison to the Input-Process-Output-Model (IPO). The IPO only has a vague definition of processes as it highlights input and output of a team focusing on a team's prerequisites such as skills, organisational characteristics, experience and relationships. Hereby, *inputs* are defined as conditions that are given a priori. The transformation of those *inputs* to *outputs* is called *process* (Marks et al., 2001). Hence prior knowledge, experiences and other abilities are monitored within the IPO (Kozlowski, 2017). Thus, within this model processes are enablers to use the input teams have to generate a certain output. Yet, this model does not provide us with a definition of those processes to measure the effectiveness of a team. Hereby, the effectiveness is measured by its outcome alone based on the input described beforehand. Hence the concept of team processes does not have a focus within this model. Additionally, Marks et al. (2001) see the IPO model as an ever-occurring cycle within teamwork processes. Those cycles are recurring, and goal directed. Hence performance and feedback can be seen within each cycle. Each cycle is a part of the projects which needs to be kicked-off by another part and ideally finished by a pre-defined goal.

However, teams need to multitask to achieve several goals simultaneously nowadays. Meaning that there is a need for coordination, communication and develop a plan to master all tasks. To handle this complexity team processes are necessary. Doing so the importance of defining plans, specifying goals (and subgoals) and their action plans is stressed. Throughout those processes pressure (external and internal) can create confusion and conflict and hence may interfere with the motivation, morale and confidence of the team. Eventually processes are the way teams manage all these concerns while accomplishing goals within a project. Hence, processes describe the way a team interacts with each other, which is what teamwork does (Marks et al., 2001) and what our experiment focuses on (See Chapter 3 which shows our research methodology). In addition to the IPO, Ciasullo, Cosimato, Gaeta and Palumbo (2017) point out that the way a team is made up can play an important role in regard to the team's performance. They back this statement by comparing two management approaches and measuring the performance thereof. They conclude that having a team selecting the members itself leads to higher performance than having a manager organizing the team top-down. Hence, they support the notion of Wi et al. (2009) who also state that the way a team is made up is an important factor for the team's success. However, this is a prerequisite we do not focus on within our thesis. This is due to the fact that we research the effectiveness of team building interventions with focus on team processes and not the effectiveness of the way a team is made up in the sense of skill sets, inputs and alike.

2.2 Virtual Reality (VR)

Virtual Reality (VR) is a technology that allows participants to engage with a computer-simulated environment while completely replacing the physical one (Craig, Sherman & Will, 2009). In a virtual environment, there are computer-generated simulations that convince a person's brain of the true sense and authenticity of the environment that they have been immersed into by monitoring the movements of the participants. According to Craig et al. (2009) VR can also be used as a medium to share ideas and experiences. Experiences in this manner implies sharing the entire virtual reality participation.

The computer simulations which are used in VR generate 3D environments so that participants can interact with them and navigate. In this context, navigation means to move around and explore the 3D environment. Interaction means the ability to select and manipulate objects in the 3D environments. (Gutierrez, Vexo & Thalmann, 2008). An example of the interaction and navigation can be seen in the VR application called Spacewalk by BBC which is used for immersive astronaut experiences. In this application, users can walk around space, interact with the objects inside and outside the space shuttle such as the door handles and other objects floating around space. Users also utilize the controllers in order to move around space.

Generally, there are two categories of VR systems that currently exist. The first category of VR is known as immersive VR which in the past it has utilized various equipment such as large projection systems like CAVE, head-mounted displays, haptic technology and surround systems (Johari, Chen, & Toh, 2005; Patera, Draper, & Naef, 2008). With the development of technology, the focus has been more on head-mounted displays that offer a 3D visual representation the experience that conveys a sense of depth. In order to create this depth, immersive VR systems use a more advanced 3D display also known as stereoscopic display or head mounted display (Parisi, 2015). Some of the most common helmet or head mounted displays used in immersive VR currently are Oculus Rift, HTC Vive and PlayStation VR (Parong & Mayer, 2018). For an immersive VR system to work it requires real-time graphics, a head mounted display that produces the illusion of 3D and computer hardware for tracking and monitoring the movements of the participants. Immersive VR also requires input devices such as game controllers that can be used to track the motion of the users and a computer hardware, operating system and software used to run the VR applications (Gutierrez, Vexo & Thalmann, 2008; Parisi, 2015). The example given above about Spacewalk describes an immersive VR experience. This is because in this experience, a user can use the controllers that appear as hands in the 3D illusion which allow them to navigate within the experience. It also has motion tracking devices that track body movements and allows a person to interact and navigate within it. Moreover, one needs to use a VR headgear that offers the 3D illusion of walking in Space. The experience is available in HTC Vive and Oculus.

The second category of VR is known as non-immersive VR or desktop VR (Chittaro & Buttussi, 2015; Johari et al., 2005). This technology uses game systems with 3D graphic environment. In this case, the interaction in the virtual environment is done through conventional computing devices such as mouse. keyboard and other game interfaces (Dubovi, Levy & Dagan, 2017; Lehmna, Baer & Schuster-Amft; 2017). This thesis focuses on immersive VR and any reference to the word VR throughout this paper implies immersive VR.

2.2.1 VR in Education

Various industries such as healthcare systems, home entertainment and telecommunication have been exploring and utilizing VR applications for creating value in their business. An example of a VR application used in the healthcare system is Immersive Touch. This application can be used to train medical residents for surgery by providing simulations that enhances that training (Immersive Touch, 2018). Eve: Valkyrie - Warzone is also another VR application game which is used for entertainment and can be played either by a single player or multiplayer. This is an action game which involves shooting and fighting in space and if it in in multiplayer mode, users can communicate with one another to defeat the monsters present in the game (Oculus, 2018).

Moreover, throughout the years, VR systems have become more sophisticated and researchers worldwide have been evaluating the potential of a VR learning environment for students of different ages. This research has been around different aspects such as the usability, design requirements and effectiveness of VR technology in a learning environment (Bricken & Bryne, 1993). More recent researchers such as Makransky and Lilleholt (2018) claim that the immersiveness of VR can expedite learning by generating positive emotions such as enjoyment.

Due to the development of technology, the costs of the high-end equipment used in VR have dropped which results into VR being explored for its use as an educational and a learning tool for students of various ages (Patera, Draper & Naef, 2008). Over the years, the usage of VR technology in the education sector has proven to be a successful method. According to Jou and Wang (2013) VR creates a learning environment in cyberspace that is more effective than traditional 'chalk and board' type of learning that is used in various institutions. According to Schneider (2017) VR offers new possibilities to engage students and learn in an effective and efficient manner. In VR, participants exchange technological interactions with other participants or the system software that are being used. Jou and Wang (2013) also identify common virtual teaching environments that are present which are technical skill training, virtual instructions, virtual campus and virtual distance learning.

2.2.2 Digital Game-Based Learning

Playing games can range from puzzles, role-playing and video games (Ferguson et al., 2015). Games in general has the appeal of being fun, intuitive, engaging, interactive, challenging and yet relaxing at the same time (Hoffman & Nadelson, 2010). Just like VR, the usage of digital games has increased in the recent years due to technological breakthrough (Chee, 2016). In games, this breakthrough has resulted into high graphics processing engines and better pixel-based colour displays thus prompting various researcher to consider digital games as method of supporting learning (Chee, 2016). When it comes to education and learning, Macdonald and Hursh (2006) argue that in the twenty first century, digital games have considerable possibilities regardless if the game is played by one person only or by various people at the same time.

Various literature and research identifies two main contemporary trends that are related to digital game-based learning. The two trends are namely serious games and gamification (Chee, 2016).

2.2.2.1 Serious Games

The term 'serious games' means games that have a careful meaning with a well-though educational goal that are played not only for amusement but to fulfil that goal (Chee, 2016). Serious games are used to provide some form of training or instruction or changing the attitude of its players but also in the form of enjoyment (Blumberg, Almonte, & Hashimoto, 2012). This training or instruction can be used in different industries such as health, air force, military and many more. Using serious games in education or schools is one part of the whole concept of serious games (Chee, 2016). For example, authors like Annetta (2010), distinguish between serious games and serious educational games by defining serious games as digital games which are not developed for commercial purposes, but they are used to train a particular skill set. Meanwhile serious educational games are used alongside with serious games to target the formal educational system (from middle school to higher learning).

Serious educational games allow students and teachers to connect real-world scenarios with regular school content (Annetta, 2010).

2.2.2.2 Gamification

Gamification is the method of incorporating game mechanics in non- game situations (Prince, 2013). Gamification in various industries started off in the form of loyalty points where users for companies such as Starbucks and different airlines have been awarded loyalty points as an incentive to make its customers continue to use their services. In Starbucks, they have a rewards system called My Starbucks Rewards whereas users download the Starbucks application to register for it. Each time a user purchases a Starbucks product they accumulate stars. The way the game works is that it is divided into various levels which implies degree of loyalty of the customer. The more a customer accumulates stars then the more their chances of being upgraded to a higher level. When a user moves up a level, they are rewarded by gifts such as a free cup of coffee or gifts tailored just for the particular customer (Chou, 2017).

Kapp (2012) provides an even deeper meaning of gamification, by stating that gamification is not only about giving rewards and badges to users but it's about using game-based mechanics and game thinking to influence engagement, motivate action, promote learning and solve problems. Kapp (2012) also discusses the relationship between serious games and gamification by stating that they are both trying to achieve the same goal which is to promote learning, create engagement and solve problems. However, the author argues that serious games are a part of the gamification concept. In gamification, the main goal is to take the typical content that is presented in a learning environment such as a classroom or an e-learning course and add game-based elements to it so as to generate a gamified learning opportunity which can exist either in form of an educational game or in the form of engaging classroom experience (Kapp, 2012).

2.2.3 Digital Game-Based Learning with VR

Game-based learning as a methodology of teaching has been proven to captivate and engage learners with the ultimate goal of learning new skills. In the case of students, this engagement is highly associated with academic achievement (Ma, 2014). On the other hand, VR is also used as a method for learning that goes beyond providing entertainment and enjoyment it can be used to gain new skills and enhance existing skills. VR training has various advantages such as easy customization, gamification and real time alteration of scenarios and no severe mistake consequences as those would happen in a critical field such as health sector and vehicle operation training. Applications that provide such training are referred to as serious games for VR (Bozgeyikli, Raij, Katkoori, & Alqasemi, 2017).

Since serious games aim to teach users a specific skill which can be incorporated in a later stage which implies that they involve a number of tasks which need to be practised. For a user to be able to accomplish these tasks and not get confused, they require instructions which are clear and understandable. Moreover, VR is not currently mainstream like other technologies such as mobile application usage, thus in most cases it is expected that the user will not have experience in using VR. Due to this, then getting user-friendly instructions is a key element on making VR games as an effective method of learning (Bozgeyikli, Raij, Katkoori, & Alqasemi, 2017).

3 Research Methodology

This chapter focuses on the research methods used in this study and the motivation behind the chosen methods. It outlines the research philosophy, ethics, approach, design, how the data is analysed and how the previous research review was conducted. Furthermore, this chapter also outlines the quality of the study by looking at its reliability, validity and generalizability.

3.1 Research Philosophy

The research philosophy is concerned with the values that influence the investigation of a research question. Thus, it focuses on the world view of the research which is pre-existent. Saunders et al. (2009) suggest a certain flexibility regarding the research philosophy as, depending on the research questions, several philosophies might be applicable. Being aware of your own research philosophy may support you in defining assumptions made throughout a research and thus minimizing their impact or including them in the research itself. This makes it an important part of a research. Some authors even claim it being more important than the method as it influences everything (Guba & Lincoln, 1994; Saunders et al., 2009; Tashakkori & Teddlie, 1998). Tashakkori and Teddlie (1998) also argue that a research should be about what interests the researcher and thus the research be aligned in the way the researcher deems the most fitting way. Hereby they state that the philosophy plays a side role as the results need to bring value and thus have to be interpreted in the best fitting manner which may lead to using different philosophies at once.

The philosophies can be differentiated into positivism, interpretivism and realism. When the positivist approach is applied observable data is preferred. Thus, they believe that only things that can be seen lead to credible data is a major belief in this approach. Often hypothesis testing is used by positivists. Moreover, positivist aim to have a value-free research. Value-free in this case means that they do not intend to judge based on their data. This is usually the case with statistical based research in combination with huge data sets. The interpretivist researcher argues that insight into phenomena that include people can only be gathered by interpreting the behaviour and roles of the people. A reason for this is that people are usually involved in complex systems making it necessary to look at is as a whole. Thus, empathy plays an important role during this kind of research as the researcher needs to be able to understand the world out of the perspective of a person and/ or system that is being researched.

Due to the nature of systems (they consist of people) the interpretivist views systems as something unique and thus doesn't aim to generalize from his findings. Realism has similarities to positivism as it takes the same approach in the development of knowledge; it being observable and thus credible. This philosophy can be further distinguished into direct realism and critical realism. Direct realism takes the phenomena as they are without putting them into context. Critical realism however, aims to put them into context believing that for example, business processes are interrelated. Thus, the world view of a direct realist is rather constant whereas the critical realist sees room for change looking at different levels of a phenomena and thus understanding it as a whole (Saunders et al., 2009).

Andjuar and Brunet (2015) state that experiments in VR have an inherent complexity due to the nature of VR as being technology that is human-centred. Thus VR, combines two categories: a technological artefact that is being tested and humans that ultimately test this artefact. Our research aims to understand the influence of technology on team building

activities. Thus, relationships among people play a major role. Hence, on one hand our research has a rather interpretivist approach. This enables us to understand the team processes that are happening within our experiments (Research Question 1b). However, on the other hand, we also make use of the realism approach when we aim to compare the applied methods through observation and taking the technology applied into account (Research Question 1a). This means that overall, we have a certain flexibility within our study as suggested earlier, which is also referred to as pragmatism (Saunders et al., 2009).

3.2 Research Ethics

Over the years, there have been systems in place to protect the participants (sample data) that have been involved in research. This is because in some cases, researchers only focus on the science (the research subject area) and disregard the participants or become unaware of the changing values in the society thus causing ethical disruption (George, 2016). Carrying out a research in an ethical manner is important because not only it protects the participants, but it also protects the research itself by creating a manner of being able to independently evaluate the research and get approval from external researchers which can ultimately improve the research. It also protects the reputations of organizations involved in the research such as financial backers and universities. Thus, when carrying out a research, approval from the participants is required (George, 2016).

In this particular research, we started the research by explaining what the research is about and provided an agreement paper to all the participants to read and understand better about the research topic. In this agreement paper, we asked the participants for the approval in monitoring their behaviour and filming them when conducting the experiment. We also agreed that the data collected from this research would only be used in the context of this thesis and no public distribution outside the scope of this thesis. Moreover, we also showed concern to the participants health to make sure that they are comfortable using the VR equipment and that they are free from any illness that would hinder them from participating in the experiment. All the participants read and signed the agreement paper prior to starting the experiment. This agreement paper can be seen in Appendix 1.

3.3 Research Approach

In conducting a research, it is important to first analyse literature surrounding that research topic. A critical literature review provides a foundation on which the research is being built on. It provides insights and understanding about the relevant research based around that topic and also helps different trends that have emerged throughout the years (Saunders et al., 2009).

There are mainly two types of research approaches which are inductive and deductive research. Deductive approach is about testing a theory whereas it various theories and ideas are analysed, and the result is a theoretical or conceptual framework that tests out the data used in a research. Inductive research involves using the data collected from the research to build a theory that relates to that relevant literature (Saunders et al., 2009).

This thesis focuses on team building activities and its relationship to VR thus it starts by conducting a literature review that identifies the Rosseau framework that defines team building processes. This framework is used as a foundation to guide how the research is done thus making our research approach a deductive one.

3.4 Research Design

3.4.1 Research Method

In this research we implement mixed methods in order to answers our research questions. Mixed methods involve using both the combination of quantitative and qualitative research methods. Saunders et al. (2009) argues that both quantitative and qualitative methods can be mixed since they are compatible. Moreover, a good research design usually involves a combination of both methods. This is entirely dependent upon the research questions formulated. Our research questions are aimed at understanding VR as a medium for facilitating teamwork processes which we use structured observation. It also involves comparing between VR and non-VR games and determining which one is better thus we use A/B testing. A/B testing is mostly used in statistical experiments which are more common in a quantitative inquiry (Bruce, 2016). Structured observation is used in a qualitative inquiry. However, our results are not aimed to generalize theories or prove a hypothesis as seen in a quantitative inquiry but to add up to the current theory thus making the whole umbrella of this study a qualitative research inquiry.

The mixed methods approach is supported by Andjuar and Brunet (2015) who state that research in the area of VR ultimately involves humans and technology and thus the method needs to focus on both areas depending on the research question. As mentioned before in the interpretivist point of view human interaction is best understood by questioning the phenomena and thus applying a qualitative approach. Technology on the other hand needs to be put in context enabling us to take a statistical based method.

According to Patton (2002) a qualitative research inquiry is used to seek an understanding, insights, patterns and identify themes of a phenomenon. The data sources used in a qualitative inquiry are based on three categories which are: Interviews, direct observations and written documents.
Interviews develops direct quotations and in-depth knowledge about the people's feelings, their experiences, knowledge and opinions about research questions (Patton, 2002). Direct observations show detailed descriptions and narratives about people's behaviours, activities, actions and other interpersonal interactions between them. Moreover, written documents are used in a qualitative study to analyse excerpts, quotations, passages, records, memoranda, publications, reports, letters and other forms of documents in order to answer a research question (Patton, 2002).

We chose observation as our research method, based on the purpose and research questions of this research. We focus on comparing VR and non-VR games as means for team building for students. Additionally, we seek to understand the effectiveness of VR games for team building thus we needs to understand the behaviour, activities and interpersonal relations between students when using both VR and non-VR games.

According to Saunders et al. (2009), observation involves systematic observation, recording, description, analysis and interpretation of people's behaviour which means that in some cases both the data collection and analysis is done at the same time. There are mainly two types of observation which are participant and structured observation. In participant observation, a researcher participates fully in the activities of the research subjects thus becoming part of their member group. This is done so as to enable researchers to fully experience what the subjects are experiencing and not just by observing on the side-line. Structured observation is involves observing something specific at a specific time interval. This type of research is

guided by an observation protocol or schedule and it analyses the frequencies of the actions of the research subjects. Due to this, it can generate both qualitative and quantitative data (Saunders et al., 2009).
This research uses the structured observation method for data collection whereas the teamwork processes/behaviours generated from the Rosseau et al. (2006) framework are used as actions for the research subjects in the observation protocol. The purpose of this is to determine the frequencies and of the team processes and the behaviour of each subject. Based on this data we would be able to determine the effectiveness of VR in team building activities.

3.4.2 A/B Testing

According to Bruce (2016), A/B testing is an experiment that tests out two groups to see which one of the two is more superior according to preordained criteria. In our case that meant, that room, instructions, room set- up, participants and the game were kept as constants. Thus, the technology can be defined as intervention in this context since one of the research questions involves comparing between VR and non-VR methods in team building activities then A/B testing is required to determine which one is a better method. When doing A/B testing a control group (in our case experiment B) is necessary. The control group is to assure that we can compare the results of the intervention to what would have happened without the intervention. Thus, the experiment is done twice; one time with intervention and one time without intervention. Any other variables need to be equal for the results to be comparable. Ultimately, this means that the control group is subject to the same preordained criteria except for the intervention itself (Bruce, 2016).

To conduct our research and perform a thorough comparison, we required a commercial game that has versions in VR and without VR (computer). The game also needed to be based around teamwork and thus connected to our chosen framework which is the Rosseau framework. We conducted a search of such a game by using Google and viewing various commercial games available that fit these criteria. We found various games like "Pictionary", "Soundstage: VR music maker", and "Keep Talking and Nobody explodes". We tested all these games and selected "Keep Talking and Nobody Explodes" because it is a game that required collaboration, communication and other teamwork processes to play the game. All these processes are highlighted in the Rosseau framework, which is why it was a reasonable choice for us.

Within our experiments "Keep Talking and Nobody Explodes" was played with a team of 5 people. The aim of the game is to diffuse a bomb. The challenge is hereby that only one person can see the bomb whereas the other four have the manual to diffuse the bomb. Hence the 4 people with the manual need the guidance from the person seeing the bomb to know which modules are to be solved. The 4 participants seeing the game manual need to describe to the bomb diffuser how to defuse the bomb. The bomb itself is rectangular with different modules located on it. Each module needs to be solved in an undefined order. The modules are random and described within a 23-page long diffuser game manual. Each bomb consists out of 7 modules. To successfully finish the game all 7 modules need to be solved. The game is played in three rounds each lasting 10 minutes. If the participants make three mistakes (also called strikes) the game is stopped by an exploding bomb. After 10 minutes the time runs out and the bomb explodes as well. However, if mistakes are made the timer runs faster and the participants have even less time. The time is visible to the participant seeing the bomb at all time. Figure 7 and 8 show the bomb out of the perspective of the person within VR or at the computer.

In both experiments the people meet within "Biglee", a studio space for systemic exploration, collaboration, and innovation at Jönköping University. After discussing who is to use the VR set or the computer the participants get seated. The person using the VR in experiment A is standing whereas the person using the computer in experiment B and C is sitting. The experiments are conducted on different days.
A short introduction on each day of the game is given so that the participants understand their task and goal of the game. Moreover, the game manual with instruction on how to diffuse a bomb is handed out. The participants are not allowed to look into the instructions prior to start of the game. Upon verifying by the researchers if the players are ready the game is started by one of the researchers. From here on no more information from the researchers is given.

First off, we conduct the experiment with the help of VR (experiment A). To ensure viability of the VR experiment the participants get to play random VR games prior to the experiment. Doing so they gain experience and are able to navigate within the experimental game. Next, we conducted experiment B with focus on a non-VR intervention. Following up on the results of experiment B, we conducted experiment C. Since data triangulation became necessary. Data triangulation is concerned with the use of different sources of data within the same theoretical background. Thus, it enables the researcher to look at issues from various perspectives (Flick, 2007). Saunders et al. (2009) states that triangulation is a valid method for ensuring that the data is really telling you what it is telling you. Thus, it is a way of verifying results by using another data set while applying the same theoretical background (Flick, 2007; Saunders et al., 2009). For our research this meant redoing the experiment B as the data here was unexpectedly different to experiment A and named it Experiment C.

Figure 7: Keep Talking and Nobody Explodes Game Design Look 1

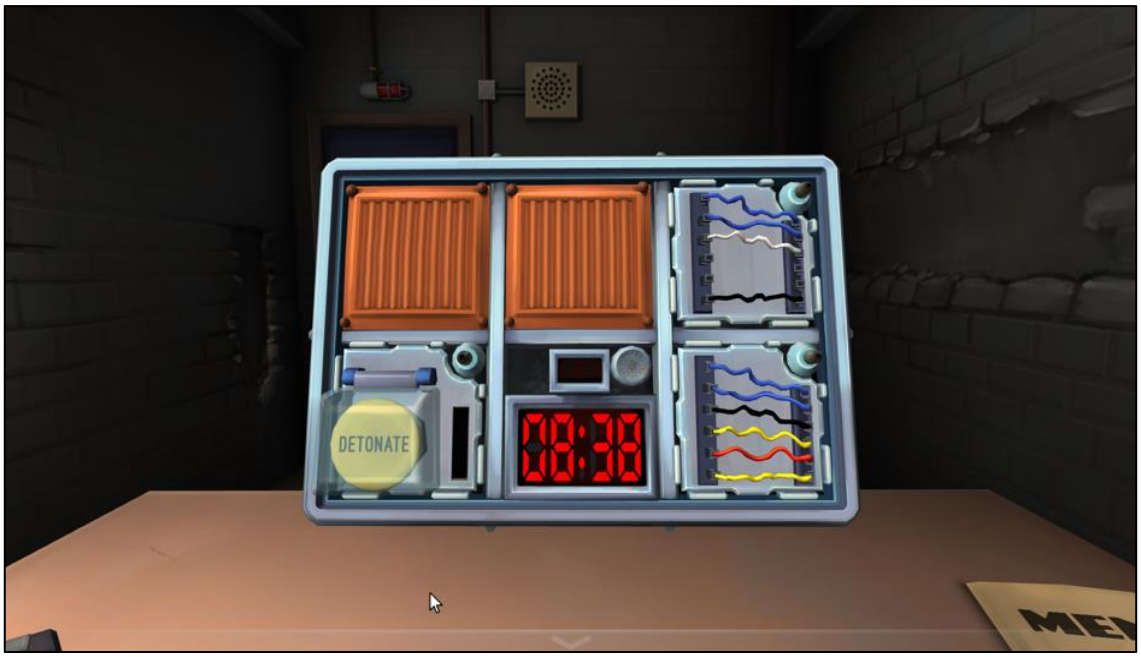

Figure 8: Keep Talking and Nobody Explodes Game Design Look 2

3.4.3 Sampling Process

As the focus of this study is based on the effectiveness of VR games in team building activities for students the main sample used were students at Jönköping University. To develop a random sample, we distributed a Google form on Facebook. The Google form was online for a period of one week. Overall 10 students signed up to conduct the experiment of the research.
The first 5 individuals were used in experiment A and B and when the results of experiment B was significantly different from A, we used 5 more students as subjects for experiment C.

Experiments in VR are very time consuming and complex to set up. The technology is new to many people and thus guidance is necessary in the beginning (Andjuar & Brunet, 2015). Due to those challenges we weren't able to choose a bigger sample considering the time frame for this thesis. Moreover, we currently have access to one VR set, limiting the amount of people that could be researched.

3.5 Data Collection Method

As mentioned earlier, the Rosseau framework of team processes behaviours is what was used to guide the observation schedule of the study. Each participant (P) in a team was given a number between 1-5 that identified them as the data source for this study. Data was gathered by counting the frequency of occurrence of the behaviours expressed in the framework beside each subject and writing remarks about the occurrence of that behaviour for all participants in that team. For each participant, if any behaviour occurred then they were marked as (x). Another source of data for this study included video recordings showing the interactions between the team members when playing the game. After recording the video, we generated a summative narrative of the events that occurred when playing the game. Table 1 below shows the observation schedule used in this study.

Table 1: Observational Schedule for Data Collection

Behaviour	**Participants**					**Remarks**
	1	2	3	4	5	
Specifying the goal of the task						
Planning the task						
Delegating task						
Coordination						
Cooperation						
Communication						
Performance monitoring						
Systems monitoring						
Backing-up behaviours						
Intrateam coaching						
Collaborative problem solving						
Team practices innovation						
Team support						
Conflict management						

3.6 Analysis of Qualitative Data

Graneheim and Lundman (2004) suggest different methods for analysing content: qualitative and quantitative. Weber (2011) proposes using content analysis if social interaction is a central aspect of the research. Since we are mainly focusing on the processes within the team we consider the content analysis a meaningful analysis technique for our data set. When

doing observations Graneheim and Lundman (2004) suggest applying a qualitative approach to gain as much insight as possible.
There are different ways to approach a content analysis: conventional, directed and summative. All approaches differ in the way the initial code is developed. When applying the conventional method categories are defined during the analysis of the data. A summative approach is based on looking at the data as single words. Herby, patterns are defined which can be interpreted to gain insight in a contextual meaning of specific words or phrases. Directed content analysis on the other hand used pre-existing theory or research to derive the code (Hsieh & Shannon, 2005). The code can be referred to as "label of meaning unit" as they are derived from the meaning unit at hand. They allow data to be seen in a new and different way (Graneheim & Lundman, 2004). Overall, enables researchers to extend existing theory (Hsieh & Shannon, 2005). The later was the aim of our research which is why we chose to go with this approach.

3.6.1 Directed Content Analysis

As mentioned before the code is pre-defined when applying the directed content analysis. Thus data, that was not included in the initial code can be grouped into new possible codes to a later point of time, depending on its value for the research. Moreover, Hsieh and Shannon (2005), propose to define subcategories of bigger categories to increase the quality of the study.
The findings of a directed content analysis can be either supporting or not supporting of a theory (Hsieh & Shannon, 2005). To visualize those findings Curtis et al. (2001) suggest ranking and/or comparing the frequency of codes that were used. Additionally, one might describe the findings in textual form. Thus, we count the number of occurrences of each process and compare them to the opposite approach. Hereby, we simply create the sum of each process manually (Saunders et al., 2009). Eventually, this enables us to conclude which processes are triggered more often in which approach and derive a conclusion thereof. Overall, the theory used in prior research is used to guide the discussion of the findings. If new categories have been identified throughout the studies those may offer new insight or an opposing view of a current theory. Thus, this may lead to an extension of the theory (Hsieh & Shannon, 2005).

A common limitation of a directed content analysis is that the researcher is easily biased towards finding supportive evidence for a study than non-supportive (Hsieh & Shannon, 2005). Moreover, a blinding effect can take place when a theory is stressed so much, that contextual events are neglected. To avoid this, an audit process can be implemented. We chose to take a video of our research, which we used to verify the data collected during the test (Hsieh & Shannon, 2005).
Ultimately, this meant for our study that we filled out our observation schedule during the test of our team building approaches. We fill in the observation schedule by using crosses (X) for each participant exhibiting a particular process. Then we proceed by counting the crosses to get the frequency of occurrence of the process for all the participants as a team. Afterwards we revaluated our results by looking at the videos taken from the test. Based on this we were able to compare the frequency of our findings.

3.7 Previous Research Review

Reviewing prior literature is necessary in academic work to create the basis for new knowledge (Webster & Watson, 2002). Moreover, using secondary data enables us to spend more time on analysing our data (Saunders et al.x, 2009). Thus, Hart (1998) defines the literature review as *"the use of ideas in the literature to justify the particular approach to the topic, the selection of methods, and demonstration that this research contributes something new*" (p.1). Keeping this in mind, we performed a literature review with the following concepts, and keywords:

- VR
    - VR in education
    - VR technology
    - Gamification and Serious Games
- Team Building
    - Methods
    - Effectiveness thereof
    - Teamwork processes

To identify our literature, we used search tools from our University Library (primo) and Google Scholar. To identify the most important literature we chose to work with major findings and papers surrounding the concepts and evaluate those. Additionally, citations within the papers/ findings were analysed to gain a full understanding of the topic.

Furthermore, we only chose articles which were peer-reviewed to increase the quality of our research (Levy & Ellis, 2006). The amount of citations was not used as a major indicator due to the recentness of the topic. However, if the choice presented itself due to issuing date of an article, we prioritized papers which have been cited more often.
We summarized our findings in a concept matrix, which can be seen in Appendix 2. Overall, we worked with 39 journals and 12 books / handbooks. The matrix is organized by naming the articles according to their appearance in the research on left side. Those articles are then categorized according to our concepts. If a paper covered a certain concept this is indicated through a cross (X). As mentioned before this matrix underlines that there is no paper covering all concepts.

Based on our literature review, we analyse various frameworks for teamwork processes and select the one described by Rosseau et al. (2006). We chose this framework because it is based on organizational settings which is our main focus since our research is aimed at team building interventions for students that can later be incorporated in their careers. Moreover, the framework presented by Rosseau et al. (2006) is based on many former articles providing us with a summative framework that covers all processes in teams.

3.8 Reliability and Internal Validity

Reliability refers to the possibility of a measurement procedure to recreate the same results, whenever carried out. Validity on the other hand is concerned with the correctness of the answers given and therefore answers to the question if the data shown actually represents what we were researching (Kirk & Miller, 1986; Saunders et al., 2009). According to Kirk and Miller (1986), both concepts are important in a qualitative observation. Thus, other observers would have to be able to reach similar results and transparency of our data had to be ensured. To increase the validity of our research we applied the guidelines proposed by Saunders et al. (2009). Thus, we focused on the following attributes before applying the by Rousseau et al. (2006) inspired observational schedule:

- What's the purpose of the observational schedule? Does it fit the research questions?
- Are any overlaps among the behaviours that need to be observed eliminated? Does your observational schedule cover all behaviours you have an interest in?
- Are all behaviours defined in a way that every observer would put them in the same category?
- Is there any observer interpretation necessary?
- Did you mention all behaviours on the observational schedule?
- Are all observed behaviours relevant for the study?
- Are there any sources for observers' bias? Can they be eliminated?

(based on Walker, 1985 quoted in Saunders et al., 2009, p. 306)

Moreover, using a pre-defined observational schedule decreases the threat to the research reliability and validity as the code has been tried and tested (Saunders et al., 2009).
According to Saunders et al. (2009) reliability is most threatened in structured observation. Thus, subject error, time error and observer error are the most common mistakes. When the subject error occurs, it can cause your data to be unreliable because the wrong persons (subjects) were chosen to be observed. To avoid this problem, we chose students that would account for being typical University students. Hence, we excluded students with problems when interacting with people as this might have influenced the experiment. To ensure this the students confirm prior to the experiment confirming that they feel comfortable interacting with different people. A time error takes place when the time slot chosen for an observation is untypical in a way that things are happening that usually not happen. For example, a sales person might have more sales shortly before Christmas than in any other month. Therefore, Christmas wouldn't be a good season to observe this salesperson. Having students as subjects we avoided doing our observation during "exam season" as students might be preoccupied (Saunders et al., 2009).
A mistake we had to be particular aware about was the observer effect, which can affect reliability and validity of a study. This effect occurs when the behaviour of an observed person changes due to the fact of being observed (Saunders et al., 2009; Patton, 2002). Robson (2002) describes two methods to avoid the observer effect. The first method is habituation. When applying this, the subject is being familiarized with the process of observation meaning that several sessions are necessary to apply this method. Since this was not possible within our research we chose to go with the method of minimal interaction (Robson, 2002). Hereby, the observer tries to be as much out of sight and in the background of the person observed as possible to minimize any interaction.

3.9 Generalizability

Generalizability, also known as external validity, describes the extent to which "*findings may be equally applicable to other research settings, such as other organisations*" (Saunders et al., 2009, p. 158). Thus, it refers to the validity of a research in another setting than where it was tested initially (Lee & Baskerville, 2003). According to Lee and Baskerville (2003), a theory is only useful if applicable in other settings as well. Therefore, generalizability is an important topic in research.
Generalizing from theory to description (of results of a theory in new settings) is one of the most important forms of generalizability in business-school research. In IS research the new setting is often the usage of a new technology, which in our case is the VR information technology applied for team building interventions. To claim validity of a theory in the new setting one needs to test and confirm the theory in the new setting. Ideally by comparing the results that were supposed to be achieved according to the theory to the results that were

obtained (Lee & Baskerville, 2003). This is why we chose, to do A/B testing as well, however we cannot confirm if the intervention has a lasting effect on the team which is why we can only add to the already existing theory. Hence, our research is not generalizable. Moreover, our sample size is too small to drive conclusions to the whole population (Lee & Baskerville, 2003). According to Andjuar and Brunet (2015) generalizability is hard to achieve when doing experiments with the help of VR. This is due to the nature of the technology being dependent to the person using it and thus influencing the result based on the affinity of the person to VR. Moreover, they state that there is no standard process for evaluating VR experiments which discourages its applicability in other settings.

4 Empirical Findings

This chapter outlines the findings generated from the three experiments used in this thesis. It starts by describing the experiment settings and proceeds with a summative narration of the events that occurred during each of the experiments. This chapter also shows the observation schedule results based on the behaviour seen by the researchers.

The following description will give a summary of the experiments. During experiment A we focused on experimenting using VR technology to facilitate team building interventions. In experiment B we used a laptop to facilitate the intervention. The experiments with the help of VR took place in a 4 to 5 hour time span whereas the experiments with the help of a laptop lasted for about 2 hours. This time span included time to set up the experiment, allowing the participants to get used to the VR technology (for the VR experiment) and the duration of the experiment itself. Each experiment started off by the two researchers (R1 and R2) whom prompted the players of the game to introduce each other since some of them did not know each other. Then the researchers gave a brief overview about the game but did not provide step by step instructions on how to play the game. We invited five students for experiment A and B from Jönköping University to conduct the intervention.
For the purpose of this research we anonymized the players by labelling through a combination of numbers from 1 to 5 and using the letter of the name of the experiment. For example, in experiment A, the players are AP1, AP2, AP3, AP4 and AP5. The same concept is applied in experiment B and C therefore resulting into BP1, BP2, CP1, CP2 etc.

The game 'Keep talking and nobody explodes' was played for 30 mins consisting of 3 rounds each lasting for 10 mins. Each round had 7 modules which could be solved. The players were able to start the game themselves making any interferences from the observant unnecessary. Throughout the game each participant was visible to the others.

Based off these two results, we realized that the data looks on the opposite ends of a scale, so in order to confirm the results of experiment B, we decided to triangulate the data by conducting a third experiment. The third experiment also known as experiment C, was based off another group of 5 people within the same settings as experiment B. Thus, a laptop was used to facilitate the intervention.

4.1 Experiment Setting

All experiments were conducted in "Biglee", a studio space for systemic exploration, collaboration, and innovation at Jönköping University. The room's walls were painted with a white colour. The room had four bean bags, a desk in the middle corner of the room and a chair. The bean bags were placed on a grey carpet floor so as to enable comfort to the other 4 participants who are reading the manual. Two big windows were present in the room on one side with two blue doors one being locked and another one that can be used to exit the room. On top of the desk there was a computer monitor screen together with its corresponding keyboard and mouse. A tower PC was also present below the desk to control the computer monitor display.

In experiment A, AP1 wore the VR headset together with the two controls in his hands thus this was the VR experiment as seen in Figure 9 below. This Figure shows AP1 wearing the Oculus Rift headgear and holding its controllers to control the movements. The rest of the players are seated on bean bags holding the game manual while two cameras are recording them. In Figure 9, R1 is seen on the far side observing the players behaviours. For experiment

B, BP2 was the one behind the computer and was sitting on a chair located inside the room thus making it a non-VR experiment. BP2 also wore headphones so as to listen to the sound generated by the game and he is the only one who can see the bomb inside the game. The rest of the players sat on the bean bags holding the game manuals. The same user group was used in both experiment A and B. Experiment C was also done to conduct a non-VR experiment which involved a different user group from the two previous experiments. In this experiment, CP2 was the one behind the computer screen and wore the headphones to listen to the game sounds and this can be seen in Figure 10 below. Just like in experiment A and B, the rest of the players sat on bean bags holding the game manual as seen in Figure 9. Moreover, there is a presence of a bystander who was not involved in the experiment and R1 is also present observing the players.

Figure 9: Experiment Setting for VR methods

Figure 10: Experiment Setting for Non-VR methods

There was also a presence of two video cameras whereas each was mounted on top of a tripod. The cameras were used to record the activities, behaviours and interpersonal relations between the players during the game. One of the cameras was focused on the person wearing the VR headgear in the VR experiment and the one behind the computer in the Non-VR experiment. Each researcher was placed behind the each of the two cameras to record the observation. Every participant was aware about the presence of the cameras.

The four participants holding the game manuals were sitting on the bean bags and they were arranged in a circle which according to Patton (2002) it is a better way to generate discussion rather than a lecture style arrangement.

4.2 Observation Schedule Results

The following tables show results of the observation schedule on all the experiment days

Table 2: Experiment A (Group 1 with VR)

Behaviour	**Participants**					**Remarks**
	1	2	3	4	5	
Specifying the goal of the task						
Planning the task	X	X	X	X	X	Participants created a rough plan on how to play the game but midway through it they didn't stick with the plan.
Delegating task		X	X	X	X	Participants delegated whom does what in solving the game through in some situations they discarded the delegation plan
Coordination						Participants didn't complete the game before the timer went off.
Cooperation	X	X	X	X	X	Participants cooperated well within the team
Communication	X	X	X	X	X	There was clear communication between the team members.
Performance monitoring	X					Participant 1 clearly communicated when the timer was almost off
Systems monitoring	X					Communicated well when the game had strikes however didn't realize that the timer went off faster when a strike is recorded.
Backing-up behaviours			X			Participant 3 was the clear leader and coordinated other participants on how to proceed with the game. P3 also helped finding solutions
Intrateam coaching						

Table 2 cont.: Experiment A (Group 1 with VR)

Behaviour	**Participants**					**Remarks**
	1	2	3	4	5	
Collaborative problem solving	X	X	X	X	X	Participants collaborated well to solve the modules by discussing solutions and they confirmed the solutions within the team. However, participant 1 got distracted when the alarm went off in the game thus confusing the other participants briefly but didn't distract the other members.
Team practices innovation	X	X	X	X	X	Team members innovated their processes after the 2nd phase to improve their chances of winning the game
Team support	X					Participant 1 who had the Oculus headgear cheered the other participants when they solved one module of the game, this encouraged others to continue playing and thus motivated them.
Conflict management						

Table 3: Experiment B (Group 1 without VR)

Behaviour	**Participants**					**Remarks**
	1	2	3	4	5	
Specifying the goal of the task						
Planning the task			X		X	Participant 3 took over as the leader of the team and generated a plan on how to solve the modules by distributing the work among each player except participant 1 who did not take any responsibilities. Participant 5 also generated a plan on solving the easy module first
Delegating task			X			As the leader of the team, Participant 3 took over the role of delegating the tasks to each player.
Coordination						Participants didn't complete the game before the timer went off.
Cooperation			X		X	There was a brief cooperation between participant 3 and participant 5. The rest of the players didn't cooperate really well.
Communication		X	X	X	X	Communication was present among the players however it was not very lively. Participant 1 didn't communicate at all with the other players and was the loner of the group.
Performance monitoring						Participant 1 didn't communicate well the time remaining in the game
Systems monitoring						Participant 1 was not aware that of the strikes generated in the game after making a mistake and didn't realize that time goes faster when a strike is made.
Backing-up behaviours						
Intrateam coaching			X			Participant 5 tried to solve a module at some point and was not offered any help by any other players. Participant 3 was the clear leader of the team and provided guidance in some instances

Table 3 cont.: Experiment B (Group 1 without VR)

Behaviour	**Participants**					**Remarks**
	1	2	3	4	5	
Collaborative problem solving						There was no collaborative problem solving since each player tried to each module independently. However, when the alarm went off during the game or when the screen went dark, Participant 1 did not seem distracted
Team practices innovation						
Team support			X			Participant 3 was very happy with his achievement when he solved one of the modules and cheered on the team to continue
Conflict management		X				

Table 4: Experiment C (Group 2 without VR)

Behaviour	**Participants**					**Remarks**
	1	2	3	4	5	
Specifying the goal of the task						Participants didn't have a clear description on what are the goals of the game
Planning the task						Participants looked confused and didn't have a clear plan on how to solve the modules inside the game. In some cases, they spent too much time on one puzzle, or tried to solve the difficult modules first which in turn cost them to lose time.
Delegating task						There was no clear delegation of tasks of who does what and which section instead participants decided to do all tasks together as a whole.
Coordination						Participants didn't complete the game before the timer went off.
Cooperation						
Communication		X	X	X	X	Communication among participants was not very good. Participants formed sub-groups among the team and then talked over each other thus causing confusion. Participant 1 didn't communicate at all with other team members and was the loner of the group
Performance monitoring						Participant 2 didn't communicate well the time remaining in the game and when he did communicate it was too late in the game.
Systems monitoring						
Backing-up behaviours						
Intrateam coaching						No clear leader of the team

Table 4 cont.: Experiment C (Group 2 without VR)

Behaviour	**Participants**					**Remarks**
	1	2	3	4	5	
Collaborative problem solving						Sometimes the team worked together to understand the modules and tried to solve the game. Participant 2 showed frustration with one of the modules of the game and other team members didn't understand why it was difficult for him. There was also no reaction from participant 2 when the alarm went off
Team practices innovation						
Team support						
Conflict management						

4.3 Narration of Experiment A

After the players decided among themselves who is to play on the VR and who has to solve the modules with the help of the manual, the game was set up. This meant helping the participant on the VR (AP1) get familiar with the tool and putting on the head set. After the game was started it indicated to AP1, how to use the buttons, to interact with the bomb in the game. After a short period of time, AP1 eased into the game, the manuals were handed out to the other 4 players and the game was started. Once the manuals were handed out the participants instantly scanned through them trying to understand their task. This created communication among the participants on how to best diffuse the bomb. The fact, that the participants sat closely together enabled them to work easily together. Once AP1 was accommodated in the digital space he started describing all modules of the bomb. While doing this the other participants defined commonly which modules had to be solved according to the game manual. Afterwards they decided to solve module after module together. The communication among the participants was lively as many questions were asked. While trying to solve the first module the team didn't succeed and got a first "strike" within the game. Shortly afterwards, AP1 realized that little time is left and communicated that to the other players. Although only 40 seconds were left, the team stayed focused until the first phase was over.

In the second phase AP1 suggested beginning with the wires (a module which consists of different coloured wires. It can be solved by cutting the right wire) at the start of the game. Since everyone agreed on that, they read in the manual on how to solve the module which was described by AP1. Although the first attempt to solve this module was unsuccessful, they stayed on the problem and solved it eventually. Upon solving this module everyone was happy and AP1 said "good job" to the other participants. Then the next module was described thoroughly by AP1. The other participants tried to find a solution commonly again, however couldn't find the right page in the manual. Although, they seemed to have encountered yet another problem, the whole group stayed interactive and many questions were asked. Eventually, they decided to move on to another module. Which was then commonly solved and followed by a cheerful AP1 saying "good job" again. Next, the following module was described by AP1. As the others did not seem to find the right information on this module in the manual again he (AP1) tried to intervene by asking what kind of information is missing. Eventually they solved also this module. Throughout this phase AP1 kept track of time and the participants stayed focused on the task. When only 6 seconds were left in the game, the participants unanimously decided to give up on this round of the game.

Like in the phase beforehand the third phase started off by solving the wire module first. This was decided without any clear strategy between the participants beforehand. AP3 took clear leadership by making this decision for the team. AP1 described this module thoroughly and in detail however, after the description the other participants decided to change strategy. They did this by delegating the tasks through giving each person one module to familiarize themselves with. Then the participants decided to go back to the wires module where they succeeded by solving it right away. AP1 was again cheerful and said "nice". The next wire module was also solved. However, some communication issues occurred as words were mispronounced. This was solved through constant communication.

Next, the in-game features of an alarm clock going off and the VR space getting dark took place. Thus, AP1 was not able to see the bomb anymore and had problems listening to the others due to a constant beeping in the game. AP1 was annoyed by the alarm and

communicated this to fellow participants. The others seemed helpless. Shortly afterwards the game went back to normal and the interference was not mentioned again. Next, the group wanted to solve the "Morse code" module, which was not in accordance to the plan they had made before. AP1 didn't know what a Morse code is and communicated this. The other participants helped him by explaining what it is supposed to look like. Since this module was in fact not existing on the bomb and thus a misunderstanding of the manual AP1 could not find this module and they moved on to another module. The participants solved this module then successfully. Afterwards, they realized that the Morse code is actually another module, however AP1 stated that the time is nearly run out. They proceeded by trying to solve modules by luck and eventually blew up the bomb.

Throughout the game, the players improved their strategy and got more familiar with the different aspects of the game. Sudden changes such as an alarm going off, did annoy the players, it did however not hinder the group in succeeding with solving modules. Overall, everyone was engaged and seemed to have an interest in solving the bomb. Since the game took place in VR for AP1, he had to get used to the different possibilities within VR in the beginning as he had no experience with VR beforehand. After a short introduction this seemed to be no problem for him. Last, the communication throughout the whole game was very vivid and purpose driven, enabling the players to stay focused on the task at hand.

4.4 Narration of Experiment B

On the day of the game, the players selected among themselves who would become the one behind the computer. In this case, BP2 became the one describing the bomb behind the desktop and the other 4 players held the bomb game manual. Just like in the VR version of the game a short explanation on how to navigate within the game was given. In the first few seconds of the first phase of the game, BP2 looked confused behind the computer in trying to understand how the bomb game looks like and started describing the different modules in the game. BP2's strategy was to describe all the modules at once together with their positions despite the fact that the game's modules position is not a requirement.

BP3 took on the leadership role immediately and described a game plan by suggesting starting with the two wire modules. BP3 also delegated this task of handling solving the wires module to BP4 without the inclusion of the other players but he was not met with any resistance from them. BP2 continued to describe further both the wire modules. However, BP3 asked if BP4 needed more time to solve this particular module and BP4 replied with resistance that he was not ready thus the players decided to abandon the idea of starting with the wire modules but to continue with other modules. In the meantime, BP1 had not contributed into this dialogue and looked lost. BP3 then proceeded to ask further clarification on the button module however BP4 interrupted by asking clarification on the wire modules again which BP2 replied to both requests with concrete descriptions.

The players continued to work on the modules by splitting the tasks among themselves which module to solve and BP5 selected one module and asked for more clarifications on it. In the meantime, BP1 had not said a word nor had selected any module to solve. Then BP3 asked more questions about the module that he had selected, and he finally provided instructions to solve that module. He looked pleased with his accomplishment. BP5 continued to try to solve the module that he had selected by asking for more descriptions about the module. In this case he was working alone while the other players sat back and watched him. Then finally he solved that particular module. BP4 also tried to solve the module that he had selected but without any luck. Eventually the timer went off and the bomb exploded. During this time,

BP2 never alerted the other players about the time left at any point during this phase and did not seem concerned about the time left.

In the second phase, BP2 gave clear descriptions of one of the modules in a clearer manner than in the first phase. BP3 recognized one of the modules from the manuals and decided himself that he would take on that particular task. Then BP3 suggested that BP2 should continue describing the other modules so that the other team players can solve those ones as well. BP2 started describing briefly the numbers module and BP5 got excited and decided to take on that module. BP2 still continued to describe the modules and BP4 recognized the wire modules and decided that he would try to find a solution for that module since that was sort of his 'speciality' based on the task delegation from the previous phase. Since BP5 had agreed to take on the numbers module, BP5 decided that it was his turn to try to solve that particular module. BP5 read the game manual and gave instructions to BP2 on how to solve it. The way the numbers module works is that a player needs to solve it in various steps. BP5 asked for more clarifications on the numbers and created some notes on the game manual. Then, BP5 gave read out the instructions on how to solve that module step-by-step but there was some miscommunication between the two since the first few attempts were incorrect. At this stage, BP4 intervened and decided to help BP5 in solving the game for a few seconds then left BP5 to continue solving it. While this was happening BP3 looked agitated and had his hands on his head. Finally, BP5 was able to offer instructions that helped to solve the module. For the first time since the players started playing the game, BP1 looked involved and chose a module to solve by asking BP2 to provide more clarifications. He continued to read the manual and gave instructions to BP2 whom responded that his instructions were incorrect thus making the bomb box move and they were running out of time without saying exactly how much time is left. This was the first time that BP2 had mentioned anything about time and she also did not realize that when the bomb box moved it implied that there was a strike recorded and the timer had accelerated. Then BP4 attempted to solve the wire module again but the time had run out and the bomb exploded.

In the third phase, the players decided to first start with the wire modules however BP2 relayed the information that there were no wire modules in this phase. The team did not look distracted by this information however BP2 later realized that she had not looked carefully and discovered there actually is a presence of the wire modules. BP2 started describing both the wire modules with precision and with better descriptions than the other phases since she was already used to the module. This information seemed to be more interesting to BP4 since he was the one paying attention to that particular module since it was 'assigned' to him in the first phase. Then BP3 asked for clarification for a different module and he noted some things down by using a paper on top on the game manual. BP4 continued to ask questions about the wire module and BP5 asked if the modules looked similar to the previous phase and BP2 replied that they looked different. BP3 then gave instructions on how to solve the wire module and BP2 did what he said but she did not see any changes besides the bomb box moving. BP4 then gave instructions on how to solve a module that he had selected and BP2 announced that the bomb had exploded. During this phase, BP2 had made three mistakes and had not clearly understood the information which was being relayed to her by BP3 and BP4 thus she made a mistake and got three strikes. However, BP2 had not realized that when the bomb box moved a strike was recorded and the timer was accelerated thus this round only lasted less than 5 minutes (4:49 minutes) which is half of the time set. Throughout this phase BP1 continued to be completely silent, was the loner of the group and did not participate in the game activities. BP5 was also less vocal in this phase as well as he did not attempt to solve any of the modules.

Throughout the game the participants communicated well (except for BP1) but did not coordinate and strategize clearly. They showed less enthusiasm than in experiment A and lacked full engagement and interest with the game. Issues like managing time was not a priority like it was in experiment A.

4.5 Narration of Experiment C

After the researchers labelled each player from number 1 to 5 and asked the team players to decide among themselves whom should be the one behind the computer describing the modules of the game to the players. CP2 volunteered to be the one behind the computer and the rest of the participants opted to solve the game by reading the manual.

On the first phase, CP2 started off by describing all the modules at once that they were seeing on the computer screen. CP2 was not fully engaged in discovering other aspects of the game and was only focused on what he was seeing on the screen. One of the researchers (R1) had to tell CP2 that they can move the bomb box using the computer mouse. During the description of the modules by CP2, other participants kept turning the pages of the manual and looked confused since BP2's game play tactic was to describe all modules at once. It has to be noted that CP2 didn't realize that he was describing all modules at once as he didn't see them as individual puzzles. Thus, after some confusion among the group they were able to define what a single module looked like.

While playing the game, other participants kept talking among themselves in order to identify the modules and at the same time CP2 also kept on describing the modules thus the participants were talking over each other. Eventually, CP2 wasn't sure anymore what information was needed from him. Additionally, the players were confused about the order of the modules and if they had to be solved in a certain line-up. The players eventually read in the module that this is not the case and go on with identifying the modules. Over time, the other participants identified 3 out of 7 modules and decided to start with one of the most complex modules which is the Morse code module. While trying to solve the module, the other participants asked CP2 more questions in order to gain more clarification and CP2 provided vague descriptions and discouraged them by using words like "This is hard" and "This is messed up". CP2 tried to decipher the Morse code but didn't succeed on his first try. The other participants then tried to explain the module to CP2, but this did not lead to a solution either. They tried to decipher this until the participants realized that this is not working out. Especially, after CP2 also asked once which information is specifically needed not being sure or understanding what was missing. Meanwhile CP1 was the loner of the group and had not fully engaged in the game and the other participants did not make him feel included. Also, CP2 completely disregarded the time and only announced the timer when there was two minutes left. After the announcement of the time left, the other participants moved to another module which they did not complete. They tried to cheer each other up that this was just the first try. The participants were able to define the first steps solving the second module. They did that by communicating with CP2 and working together on a solution. However, they all started talking at once again after CP4 explained the module in detail to CP2 and eventually, the bomb went off.

In the second phase, CP2 started with the same strategy of describing all the modules at once. However, this time around the participants were a bit familiar with the modules unlike the first phase. The participants together chose one module and solved it successfully. One of the features of the game involves an alarm sounding off and lights being dimmed out in order to distract the players. When continuing playing the game, this occurred and CP2 was

unfazed and did not seem distracted. CP2 also made a mistake while playing the game and was given a strike but he did not mention this to the other players until later in the game. While solving the modules, CP2 and CP3 tried to solve one module on their own and at the same time CP4 and CP5 were discussing other modules thus forming sub-groups within the team and CP1 did not engage in the conversation at all. In this phase they spent too much time trying to solve one module and CP2 did not communicate at all how much time was left. CP2 announced to the group that the bomb had exploded thus the game was over.

In the third phase, the participants discarded the strategy of describing all modules at once and instead focused on one module (simple wires module). In this case, CP5 just gave instructions to CP2 on solving that particular module without discussing it to the other team members and it ended up being the wrong decision thus they got a strike. However, they did not give up by continuing with the same module and decided to discuss on the best strategy to solve that particular module and finally were successful in solving it. The team then moved on to a module which they had solved successfully in the previous phases and worked together and solved it successfully. While moving on to other modules, the participants completely isolated CP1 and only discussed it among themselves thus forming a team of their own. The game was only played for about 5 minutes (half the time set) since the players made a mistake and got more strikes and the game was over.

During the beginning of the game, the players did not seem familiar with the game and their familiarity increased as the phases went by. They improved their coordination, but this was not the case for CP1 who did not participate at all in the game and was isolated from the team. The team also did not have a clear set of objectives and a plan on how to solve the modules within the game when playing the game in all the three phases of the game. Time was also an issue which was not raised since CP2 did not communicate how much time was left and the other participants did not raise any concerns regarding the time left when playing the game.

5 Analysis

This chapter outlines the analysis of our findings. It first starts by comparing results for all the three experiments conducted in this study. It then proceeds by taking a closer look at each of the processes and analyse each process for experiment A and B.

Based on the findings displayed on the previous chapter, we quantified our qualitative data by calculating the sum of the frequencies of the different teamwork processes / behaviours exhibited by the players when playing the game as seen in each observation schedule. This sum was generated from counting the crosses (X) marked in each row containing a process in the observational schedule. By doing so we were able to get data of each process for the whole team. This data showed how many players in general expressed one specific process that can ultimately influence the team. For example, in experiment A, for the teamwork process "Planning the task", there were 5 crosses thus the result of that particular process is 5. For the same process, in experiment B there were only 2 crosses thus the result is 2. In experiment C, there were no crosses for that process, so the result is 0. Then we used this data (the sum) to compare between the three experiments as seen on Table 5 below.

In all instances Experiment C results was inferior to Experiment B (and A). This is why we chose to leave it out of our analysis, as it confirmed that a non-VR approach is inferior, however the data added to our research was limited to the Teamwork Process *Communication.*

Table 5: Experiment Frequency Results for Experiment A, B and C

Teamwork Process	**Experiment A (VR)**	**Experiment B (non-VR)**	**Experiment C (non-VR)**
Specifying goal of the task	0	0	0
Planning the task	5	2	0
Delegating task	4	1	0
Coordination	0	0	0
Cooperation	5	2	0
Communication	5	4	4
Performance monitoring	1	0	0
Systems monitoring	1	0	0
Backing up behaviours	1	0	0
Intrateam coaching	1	1	0
Collaborative problem solving	5	0	0
Team practises innovation	5	0	0
Team support	1	1	0
Conflict Management	0	0	0

5.1 Specifying Goal of the Task

Based on the results, we can see that in both experiments, the players did not specify the goals of the task. In this context, specifying a goal implies having a discussion on what are the goals of the game in solving each module. Another possibility would have been to define their own goals for the game. Neither of the teams did not have a clear structure of the goals

of the task at hand (playing the game). This made it somehow difficult to plan ahead what they are next steps are in order to achieve that goal.

5.2 Planning the Task

Despite not stating the clear goal for the game, the players in experiment A worked better together to plan how to solve the different modules within the game. In the first phase since the game was new and unfamiliar to them they had a difficult time planning a clear strategy. But as the game moved to other phases, it was easier for the players to create a plan. Despite having a plan, they abandoned this plan midway. However, when it came to the players in experiment B only two of them planned the tasks, but the rest were just playing the game without an actual strategy. This in turn caused frustration and some players looked uninterested.

5.3 Delegating Task

When you have a clear plan then it makes it easy to delegate tasks. For the players in experiment A, 4 out of the 5 players were fully involved in making delegating the tasks among themselves. This was not the same when it came to the players in experiment B as only one player took over the role of delegating tasks among the players. The rest of the players looked lost. Instead the players just solved the modules individually rather than together as a team.

5.4 Coordination

For coordination, we were looking for behaviours where the players would be able to accomplish modules before the timer went off which was initially set at 10 minutes. The order of which module to solve first was not necessary in our case. In both experiments, the players did not complete the game before the timer went off. The order of how the modules were done was not an issue in this case as long all the 7 modules were solved before the timer went off. In the experiment B, players were unconcerned about the timer unlike in the experiment A whereas the player wearing the VR headgear clearly stated how much time was left and communicated this with their team.

5.5 Cooperation

Comparing the VR based intervention to the non- VR based intervention one can see that overall this process is triggered in both types. However, the experiment A showed significant strengths when it comes to this process as all 5 participants showed activities within this process. Within the experiment B it was present among only 2 participants. Moreover, the cooperation of those two people was rather briefly and didn't seem to last very long.

5.6 Communication

In both methods communication was triggered. However, in the experiment B method we could see one person excluding himself from the group and not communicating at all leaving the group with an overall score of 4. Within experiment A everyone communicated clearly and lively and thus created an engaged environment.

5.7 Performance Monitoring

Performance monitoring could be, amongst other possibilities, achieved by monitoring the time and remaining modules within the game. Within experiment B this did not take place at all. The players with the manual were neither interested about the time remaining nor was the person at the computer. Comparing this to experiment A the person using the VR headgear seemed to be immersed and was able to communicate changes in time.

5.8 Systems Monitoring
Systems monitoring involves the ability of realizing changes in the environment and adapting the plan accordingly. Within this game this meant that players would realize that the time would run out faster after 'strikes'. Moreover, it included the awareness that strikes were displayed. Within both methods the players did not realize that the time was running faster at some point, however in the experiment A participant 1 realized that strikes were displayed above the timer and thus communicated this change to the other players.

5.9 Backing up Behaviours
Backing up behaviours were only visible in experiment A, as AP3 helped his fellow participants find solutions.

5.10 Intrateam Coaching
During experiment A, AP3 helped other players find solutions by correcting or proposing other solutions in the game manual although those tasks weren't delegated to him. Since this was done by two players in the non -VR based approach this was the only time this kind of intervention can be assumed to be better.

5.11 Collaborative Problem Solving
Collaborative problem solving takes place when the players solved tasks together or delegated tasks in a way that would support collaboration. In experiment A the players discussed modules and possible solutions to them among each other. This did not take place within the non-VR method (experiment B) where each player focused on one chosen module instead of engaging in a discussion with the others. However, it needs to be mentioned that when technical issued occurred within the game such as lights going off or an alarm beeping unrelated to any task at hand, none of the experiments show any sign of the participants handling this issue.

5.12 Team Practises Innovation
Team practice innovation was visible when the team tried to renew the way they approached the tasks within the phases. This was visible within the VR based method but not within the non-VR based method. Thus, the VR based method was better than the non-VR based method.

5.13 Team Support
During experiment A and B team support process was visible once. In experiment A, AP1 cheered the other participants in a lively manner when they achieved a sub goal, creating an engaged environment. Within experiment B, BP3 was also very cheerful when the participants accomplished a task and thus motivating the others to move forward.

5.14 Conflict Management
Conflict management would have occurred if the team was faced with inter-personal issues. This did not take place on any of those days as the participants acted friendly among each other.

6 Conclusion

This chapter offers a reflection of the research conducted first looking at the purpose of the study and analysing the research questions. It then concludes the most relevant findings of the study.

The purpose of this research was to investigate VR games as an educational tool to facilitate team building interventions for university students. We also wanted to find out if VR games are more effective than non-VR games in team building interventions for these students. Moreover, the research aimed at analysing various team building processes that define team building processes and determining which processes occur more in which approach between the VR and the non-VR approach. The literature review conducted in this study helped to identify a framework described by Rosseau et al. (2006) that defined these teamwork processes. This framework was later incorporated in the study as a guiding tool to observe various behaviours/processes that can occur within a team using VR games and compare them with a team that utilizes a non-VR approach.

Based on the sample and the settings of the game, the results of the study show that VR games are more effective than non-VR games in team building interventions. This is due to the fact that there were more teamwork processes that occurred in the experiment set by using VR games than the one in non-VR games. VR games offer an immersive and captivating experience than non-VR games. As a result, participants were more engaged and performed better that when they were in non-VR setting. Data gathered in experiment C as a method for data triangulation further proved this research results.

In conclusion, the study shows that there is promise for VR games as an educational tool for university students despite the lack of VR research standards. Our research adds to the theory that VR games are an effective method for teaching various skills. Thus, Universities should invest in this type of technology in order to prove an 'out of the box' type of a teaching method that can be more beneficial to the students. This method can lead to high engagement and therefore effective team building which might be beneficial to the students in the long run during their careers after completion of their studies. Eventually this study shows that VR games for team building increase team efficiency by triggering more teamwork processes. Thus, the interventions with the help of VR are more effective.

7 Discussion

This chapter focuses on the discussion of our results. It starts by discussing the results of the experiments and the research method discussion. Then it proceeds by discussing the limitations of this research, the implications for practise and future research suggestions.

7.1 Results Discussion

The framework applied from the theoretical background was used to analyse the results of the experiments which were conducted. As seen above, the framework contained various teamwork processes which ultimately exhibit effective team building interventions. In these particular experiments three out of fourteen teamwork processes were completely absent in both experiments. These three processes are specifying goal of the task, conflict management and coordination. In specifying goal of a task, we were looking for the participants to show that they can clearly define the goal of game from the beginning in order to have a clear picture of what to do. This behaviour was absent as the participants looked lost especially in the first phases of all the experiments. This might be the case because the game itself was straight forward and had one clear goal which was to diffuse the bomb within a certain time frame. In our opinion, this goal was self-explanatory and did not need to be expressed. We believe this might have influenced the way specifying a goal process for this particular research. In the case of conflict management, we were looking for behaviours that would display that participants can solve their conflicts within the team. There were no clear conflicts existing within the team that would have caused them to underperform. For coordination, we were looking for behaviours that would ensure that tasks within the game can be achieved in a certain time span. The participants did not coordinate well to achieve various results within the time set in the game. It could have been that the modules set were too many for the players within the set time frame which in our case was 10 minutes.

In the remaining behaviours, the experiment that used VR as a medium for team building showed more positive results than that used non-VR methods (computer) with the exception of team support and intrateam coaching that showed similar results in both experiments. The participants were more immersed in the VR technology and were engaged than the those who used the non-VR technology. Despite the fact that the game in both experiments was set in a digital environment but the results show that VR technology offer a more effective way for team building interventions.

In team practises innovation, we were looking for behaviours from the participants that would show that they are creative in trying to find better and new ways of solving the game modules. This was not the case with experiment B as they did not find innovative ways to solve the game modules. This might have been the case since the game manual itself was extensive with 23 pages. In these pages, it is where all the solutions for the modules exists, thus the players did not have a chance to think outside the box since the game limits their creativity by only allowing solutions based on the game manual. However, for experiment A, they overcame this and found new ways to solve the various game modules. This might be due to the immersiveness of the VR technology as users were engaged and involved in the game which increased their general interest thus they strived to find creative solutions despite the extensive game manual.

All of this is backed up by experiment C which involves a team of participants which was different from experiment A and B. As stated earlier, experiment C was conducted by using

non-VR technology and the results were far negative than the experiments A and B which in turn solidifies our results.

Based on the results generated in the experiments we can answer the research questions generated in chapter 1. The results show evidence that VR technology influences team building interventions that focus on team process by offering more engagement and immersion. Since the participants were more engaged then it was not difficult for them to exhibit more team processes than non-VR technology.

To answer research question 1, we can state that VR makes participants become more immersed and engaged in team building interventions. Thus, team processes were triggered in a livelier manner in comparison to a non-VR technique. For example, looking at the process of communication it can be stated that both techniques trigger this process. However, within experiment A the communication was livelier, and people were more engaged than in experiment B. As a result, the participants were able to interact in a better way and ultimately were able to perform efficiently despite not solving the whole game. Thus, making VR technology a more effective medium for team building interventions in comparison to non-VR methods therefore answering our research question 1a. This meant that in experiment A 11 processes were triggered while in experiment B 6 processes were triggered out of 14 potential processes within the framework. Making them both effective interventions according to McEwans et al. (2017) however to different degrees.

Most of the teamwork processes showed a higher presence in the VR experiment than in the non-VR experiment. These processes are planning the task, delegating task, cooperation, and communication, collaborative problem solving and team practise innovation. Other processes are performance monitoring, systems monitoring, and backing up behaviours which were only visible in the VR experiment and completely absent in the non-VR experiment. Participants in VR experiment had a better strategy in solving the game modules and delegating the tasks for each module. There was no process, that was only visible in experiment B. Thus, this answers our research question 1b which about the team processes' presence and the comparison of team processes between VR and non-VR game.

Communication was the most evident process in all the three experiments. Players were able to exchange information which ultimately helped them to perform more efficiently. In our case, communication was the most important process since without it, the person behind the screen or wearing the VR headgear could not be able to describe what they see and thus the other players would have not been able to solve any of the modules. In the VR experiment, communication was better than in the non-VR experiment since there was vivid information exchange between the players as they described the modules, solutions and the timer.

However, despite the fact that experiment A and B had the same participants and were in the same settings, the results could have been different since there were two different people behind the game in both experiments. In experiment A, AP1 was the one wearing the VR headgear and in experiment B, BP2 was the one behind the computer screen. The idea behind this was to let the players organize among themselves and delegate whom would be the 'eye' for the bomb without influencing any results.

7.2 Methods Discussion

We applied a mixed method approach in accordance to our pragmatism paradigm which encourages us to always go with the best solution to fulfil the purpose of our thesis. Consecutively, we applied A/B testing while extracting data with an observation schedule and examining that in a qualitative way. The fact that we focused on students, made it easier for us to gain access to the participants and put ourselves in their positions (empathy), which is important when doing observations. Additionally, there is no standardized process on how to evaluate data generated with the help of VR which gave us the freedom to apply what fits our purpose (Andjuar & Brunet, 2015).

Overall, A/B testing proved to be a resourceful method to serve the purpose of our research. When doing A/B testing one has to be aware of many challenges such as the observer effect, which was sometimes present although the observers were standing in the background and not saying anything. We assume that this was due to the familiar environment the experiment took place for the participants. The experiment was conducted among students (participants and observers were students), decreasing the barrier of asking additional questions and thus encouraging conversation. Our usual reaction to in-game questions was not to react at all, however we cannot be sure that this did not influence our data. Moreover, we gave a thick description of what happened during the experiment and how the room was set up to enable future researchers to follow up on our findings. Thus, reliability is ensured in this research. Andjuar and Brunet (2015) claim that reliability is hard to achieve in VR experiments due to the technology being adapted for experiments. However, we used a (commercial) game which was not adapted in combination with a (commercial) VR system (Oculus Rift) enabling other researchers to replicate what we did.

Additionally, we chose not to do a survey or interview to prevent subjective views in regard to the methods as our applied framework was focusing on visible processes. Although this might have enhanced our whole research we did not aim to gather data in this direction. Looking back at this decision, interviews might have helped us to interpret the data as in some cases we weren't clear in how to interpret certain behaviours as they might have been based on irony or simple randomness. Consecutively, we chose a model that would look at the processes within a team and not focus on the team's personal attributes which is the case with the IPO model. We believe it would have been interesting to see if there is a correlation between teams' abilities and the technology, however this issue would have been misplaced within our research questions. Discussing the applied framework, one needs to be aware that there are many frameworks discussing teamwork and we chose to go with one that is very detailed and elaborate. We sometimes had the feeling that it was nearly too detailed and that we might have benefited from a model, such as applied by Ekimova and Kokurin (2014), that had the same contents but in a simplified manner to fit their research; thus, categories are broader organized. Hence, we could have categorized the teamwork processes in a for our research beneficial manner as well. For example, Ekimova and Kokurin (2014) organize all teamwork processes into 6 categories.

Lastly, we chose a random sample to research team building activities. However, a team is may not made up randomly. In the organisational context there are often selected team members depending on their skill set that work together for a longer time. Thus, it would have been interesting to conduct the experiment with a pre-existing team as the participants not knowing each other from the start might have influenced our results. Our research may still be applicable in the University context however, as teams are (depending on the lecturer) randomized.

7.3 Limitations

We set out to research the effectiveness of VR for team building activities. Since this is a master thesis we had our learning moments, which ultimately led to limitations in our research.

First of all, we weren't able to gather more data regarding our research question due to time restraints. We collected data on three instances: experiment A (team building with VR), experiment B (team building without VR), and experiment C (team building without VR). Experiment A and B were designed according to the guidelines of A/B experiments, with one being the control group and thus always having the same people doing team building. Unfortunately experiment C was only used to triangulate experiment B but did not enhance our method as there was no second experiment in accordance with the A/B experiment method done. Thus, it would have been helpful to have the people playing in our experiment C also do the same game again with the help of VR, to give us a good comparison to the first data set. Due to the small sample our research has a limited external validity, it however adds to the existing theory.

Another issue we encountered was that not all participants showed an affinity towards technologies and thus were not confident in the usage of VR or sometimes even the laptop game. Based on our framework we do not consider those variables; however, it would be interesting for future research.

Due to time limitations of the game, we couldn't play the game longer than 30 mins. This is additionally supported by the usage of VR, which makes many people feel dizzy after a certain time, which is why we were not able to play longer (Regan, 1995).

7.4 Implications for Practice

According to Klopp and Yoon (2005) applying current technology in educational institutions is a meaningful way of preparing students for future studies and professional employment. Thus, using VR to engage in team building is an effective way of combining good team building techniques with current technology. Technology is playing an ever-increasing role in today's world which is why it should be included in educational institutions as well (Klopp & Yoon, 2005).

However, we saw in our experiments that certainly not every student shares the same affinity for new technologies which is why this team building with the help of VR might not be a solution for every student. Additionally, practitioners need to be aware that VR – especially for first time users – can often not be used for more than 30 mins at once, limiting its applicability (Regan, 1995). Within our experiments we tried to increase the technological affinity to VR by preparing our participants. This meant that we had each one play different VR games such as "Spacewalk" and "Bullet Train" which are both available in Oculus Rift so as to get used to the technology and thus be able to navigate in the game later. Furthermore, once an institution invested in VR technology it has the possibility to expand on this investment in a nearly unlimited manner as there are new releases for games and additional software (Sigitov, Hinkenjann & Roth, 2013). Attention has to be given to the setup of a VR game. Within our experiments we made the experience that due to the immersiveness of VR people tend to move around a lot although it is not required by the game they are playing. Thus, we recommend providing at least 2 meters to each side of the person playing the VR to avoid injury (e.g. by walking into walls or furniture) or breaking the equipment.

Due to the limited external validity our research can be seen as an idea which needs further testing in "real life". However, we can most certainly confirm, based on our data and literature review, that VR has the capacity to fully immerse students and thus help teachers/ professors to reach their goals in a more effective manner. In regard to team building VR can be used as an effective method if the team is open to VR technology. In the case of Jönköping University, the technology and game/ intervention are accessible, enabling the actors within the institution to benefit from this approach right away.

7.5 Future Research

To compare studies in digital technologies that are more mature such as multimedia and web-based platforms, the research of immersive technologies in education is still at an early stage and the evidence of its impact to teaching is still shallow (Wu et al., 2013). To be more specific the application of VR technologies in teaching and learning skills which are not part of the curriculum such as team building is also still shallow. Most researchers investigate VR and education when it comes to medicine (eg. Curtis et al., 2001; Dubovi, Levy & Dagan, 2017; Ferguson, Davidson, Scott, Jackson & Hickman, 2016; Dede, Jacobson & Richards, 2017; Ma, 2014; Parong & Mayer, 2018; Regan, 1995). Other researchers focus on VR with its implementation in the military (eg. Bowers, Morgan, Salas & Prince, 1993; Chittaor & Buttusi, 2015).

Our experiments were conducted in a way that the person wearing the VR headgear and the person behind was visible to the others since they were all located in the same room. However, due to the various technology advances and an increase in business demands, virtual teams have become more popular in various organizations (Gilson, Maynard, Young, Vartianen & Hakonen, 2014). Therefore, this research does not anticipate how VR would affect virtual teams. This calls for more research to be done in this area to analyse which team processes would be affected and how does VR influence virtual teams.

Moreover, the sample used in this research was based on 10 students chosen at random. Which in turn makes it difficult to use these results to generalize the outcome of the research questions. Thus, in the future we would recommend more research to be conducted with a larger sample to gain a better understanding of VR and its implications to the teamwork processes. However, especially in the research context, VR experiments may involve a lot of time as the technology is new to many people and thus a lot of guidance is necessary. Thus, we recommend estimating at least 4-5 hours for each experiment round as this was our average when it came to conduct the experiments.

Also, according to Andjuar and Brunet (2015), in VR research there are few standards thus making it difficult to fully research the area. Thus, there needs to be more research based on standards in order for it to be applicable to research about the application of VR and digital games for team building interventions. Lastly, we need to mention that there is a call for interdisciplinary research in regard to VR it combines human-centred research and technology. Thus, many more disciplines should be involved and given input by (for example Psychology) to generate meaningful results (Andjuar & Brunet, 2015).

At a more strategic level, further developments of Resmini and Rosati's conceptualization of pervasive information architectures (2011) have looked at how digital and physical elements are freely arranged by individual users into personal, goal-directed ecosystems (Resmini & Lacerda, 2016). In such a view, the VR experience would be considered part of a larger system, in this case centered on training, involving a variable number of other individual

touchpoints that might span across physical locations (the office, a temporary location such as an airport, or the home) and multiple digital environments (the VR space itself, email, websites, or apps). The potential of such an approach rests on its capabilities to unearth the systemic loops connecting contextual conditions, organizational as well as sociotechnical, that might have an important but non immediately perceivable impact on the individual VR training experience.

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Appendix

Appendix 1: Participant Agreement in the Experiment

Participation in the Experiment for the Master Thesis of Grace Sekwao and Sarah Modolin

By participating in the experiment, you agree:

1. That data will be collected based on your behavior
2. That we will be filming you
3. That we will use the data only for the purpose of the thesis, thus there will be no public distribution which does not serve the thesis (should we need to make something public, an extra agreement has to be made)
4. To use the VR equipment from Jönköping University in our best interest
5. To inform us, in case you don't feel comfortable using the provided material or technologies
6. That you are a Student at Jönköping University
7. That you don't have any known (mental) sicknesses preventing you from working in teams or using the provided technologies

By signing this paper, you confirm that you have read the above text and that you agree with all of the above terms.

Name	Date	Signature

Appendix 2: Concept Matrix

Articles	Concepts						
	Team building			VR			
	Methods	Effectiveness	Team work processes	Technology	Gamification	In education	Serious Games
Kozlowski & Ilgen, 2006		x	x				
Settle- Murphy, 2012		x	x				
Lau et al., 2013	x	x	x				
Klein et al., 2009	x	x	x				
Salas et al., 2005		x	x				
McEwans et al., 2017	x	x	x				
Salaset al., 1999	x	x	x				
Macy and Izumi, 1993		x					
Marks et al., 2001	x	x	x				
Rosseau et al., 2006	x	x	x				
Spreitzer et al.,1999		x					
Wagner, 1995			x				
Lee et al.,2015			x				
Mayer et al., 1995			x				
Wi et al.,2009			x				
Valls et al.,2016	x	x					
Marks & Panzer, 2004		x	x				
Dibble and Gibson, 2013			x				
Porter et al., 2003			x				

Articles	Concepts						
	Team building			VR			
	Methods	Effectiveness	Team work processes	Technology	Gamification	In education	Serious Games
Steven & Campion, 1994			x				
Cohen et al., 1996			x				
Becker et al.,2018			x				
Hurt, 2014			x				
Alper et al., 2000			x				
Yeatts & Hyten, 1998			x				
Kozlowski, 2017		x	x				
Ciasullo, et al., 2017			x				
Craig et al., 2009				x			
Gutierrez et al., 2008				x			
Johari et al., 2005				x			
Patera et al., 2008				x			
Parisi, 2015				x			
Parong & Mayer, 2018				x			
Dubovi et al., 2017				x			
Lehmna et al., 2017				x			
Bricken & Bryne, 1993						x	
Makransky & Lilleholdt, 2018						x	
Patera et al., 2008						x	
Jou & Wang, 2013						x	

Articles	Concepts						
	Team building			VR			
	Methods	Effectiveness	Team work processes	Technology	Gamification	In Education	Serious Games
Schneider, 2017						x	
Ferguson et al., 2016						x	
Hoffmann & Nadelson, 2010							x
Chee, 2016							x
Macdonald & Hursh, 2006						x	
Blumberg et al., 2012							x
Annetta, 2010							x
Prince, 2013					x		
Chou, 2017					x		
Kapp, 2012					x		
Ma, 2014							x
Bozgeyikli, Raij, Katkoori, & Alqasemi, 2017						x	x