

Project Terminus: A study into the effect of branching storylines on replayability

A Master Thesis
Naomi Vogelpoel
7005938

Supervisors:
Sander Bakkes and Max Wolterink



**Utrecht
University**

Master Game and Media
Technology
Utrecht University
The Netherlands
January 2022

Abstract

A comparative study was conducted to determine whether in a narrative-driven game created for educational purposes the existence of branching story lines has influence on its replayability. To this end, three versions of an existing game, Terminus, have been created. To two of these versions changes to the degree of branching of the story have been applied. One version was left untouched to make a fair comparison to the base game. After providing demographic information, the users were each assigned a version of the game to which they reported their experiences regarding the story line and the number of times they played each section of the game. The findings suggest that the meaningfulness of the choices and the branching story lines themselves have no significant effect on the replayability but the enjoyment of the player, but which chapter was played and the difficulty level of the chapter did have a positive effect. Further research is warranted to determine if this is the case for students of the police academy using mobile devices as well.

Contents

1	Introduction	3
1.1	Research questions	3
1.2	Terminus the game	4
1.2.1	Learning goals	5
1.3	The importance of meaningful choice	5
1.4	The importance of replayability	6
1.5	The importance of this research	6
2	Related work	8
2.1	Narratives	8
2.2	Branching narratives	8
2.2.1	Different types of branching narratives	8
2.3	Meaningful choice	9
2.4	Replayability	10
2.4.1	Replayability in narrative games	10
2.5	Serious games	11
2.5.1	Narrative in serious games	11
3	Methodology	13
3.1	Overview of the experiment	13
3.2	Hypotheses	13
3.3	Participants	13
3.4	Materials	14
3.5	Variables that affect the experiment	14
3.6	Experiment procedure	15
3.7	Data collection and storage	16
3.8	Data analysis	16
3.9	Experiment details	18
3.9.1	Changes to the story line	18
3.9.2	Questions for participants	20
3.10	Evaluation Criteria	23
4	Results	25
4.1	Influence on the general replayability	25
4.2	The effect of success and failure	25
4.3	Effect of player enjoyment	26
4.4	Effect of perceived meaningful choices	27
4.5	Data for each chapter	28
5	Discussion	30
5.1	Limitations and future work	30
5.2	Small improvements	30
6	Conclusion	31
6.1	Answers to the research questions	31
6.2	Answer to the problem statement	31

1 Introduction

Branching narratives are a frequently used device for narratives and have the potential for deep and personal engagement with their readers [2]. In this study the effect of branching narrative on the replayability of the game Terminus will be explored. Terminus is a game made for the Dutch police academy designed to teach their students about the code of conduct in scenarios related to crossing the Dutch border to neighbouring countries. Each chapter of the game presents a different scenario which can range from a police chase moving across the border to assisting foreign colleagues when working in areas across the border. In Terminus, the students will work their way through the story and make decisions based on their knowledge gained from their classes. These decisions are important since they measure how well the student understood the material. Replayability is important for this game since the students are still learning, and so they may not make most optimal decisions the first time they play. Replaying the game gives them the option to make different choices while reflecting on their mistakes. replayability is also important because learning is based on repetition [4] and therefore the more often the students replay chapters of the game the more they will learn from it.

In hopes of improving the replayability of Terminus, this research will look into the potential of utilizing branching story lines.

By answering the following Problem statement, teachers can make more informed decisions when creating the story for educational text-based games:

To what extent can a branching narrative enhance the replayability of a point-and-click game made for the Dutch police academy (Terminus)?

1.1 Research questions

Research suggests that a branching storyline will improve the enjoyment of a player [23] and Patall et al. (2008) also mentions that providing choices to the player may improve their autonomy and intrinsic motivation which may lead to improved performance and learning as well [27]. Here we assume these things to be true. For the purpose of this research it is also assumed that an increase in the enjoyment of the player improves the replayability of the game and that the autonomy and intrinsic motivation of the player can be improved through the use of meaningful choice as described in 2.3. This is why enjoyment and meaningful choice will be used alongside the number of plays to measure the replayability of the game.

This is also why, to answer the main question of the research, the following research questions will be explored as well:

- **RQ1** Which criteria do choices in narrative games need to meet in order to be meaningful?
- **RQ2** To what extent does the player find the questions presented in Terminus meaningful?
- **RQ3** Which elements that make the game enjoyable are important for the replayability of Terminus?

- **RQ4** How enjoyable does the player find the different chapters of the game?
- **RQ5** How often is the player willing to play the different chapters of the game?

To answer these questions an experiment will be held to determine the replayability of the game *Terminus* where two versions of the game will be presented to different player groups. This experiment will be further outlined in chapter 3. The relation between these questions and the type of research performed can be found in table 1.

Research question	Research type	Related section
RQ1 Which criteria do choices in narrative games need to meet in order to be meaningful?	Literature study	Chapter 2.3
RQ2 To what extent does the player find the questions presented in <i>Terminus</i> meaningful?	Experiment	Chapter 4.4
RQ3 Which elements that make the game enjoyable are important for the replayability of <i>Terminus</i> ?	Literature study	Chapter 2.5
RQ4 How enjoyable does the player find the different chapters of the game?	Experiment	Chapter 4.3
RQ5 How often is the player willing to play the different chapters of the game?	Experiment	Chapter 4.5

Table 1: Relation between research question and sections

1.2 *Terminus the game*

Terminus is an educational game where the player needs to solve a case through interaction with the different characters presented in the world. Here, the player has to make choices on how to conduct themselves while working through different scenarios presented in the chapters. After each chapter the player will receive a score and feedback based on the actions that they chose. Some screenshots of the game *Terminus* can be found in figure 1.

The game *Terminus* may be regarded as a point-and-click game since all the input of the game is handled through clicking on objects [28]. Since *Terminus* was made with the objective of teaching its players code of conduct across the border, it is also a serious game [8]. It is debatable whether *Terminus* can also be viewed as a visual novel as well since it almost fits the description of a visual novel as described by Katerina Bashova.

These genres are important for this research since the game genres that the participant is familiar with may affect the results.



Figure 1: Screenshots of the game Terminus

1.2.1 Learning goals

Since this game was made for the Dutch police academy there are a couple of learning goals that need to be achieved while playing the game. These learning goals differ from chapter to chapter but all have the common theme of acceptable behaviour in the border area between the Netherlands and Belgium and the Netherlands and Germany. An example of such a learning goal is how to handle a police chase when it crosses the border. In this chapter, the player learns which procedures to follow before they cross the border and whether or not it is allowed to arrest a suspect once you have apprehended them across the border. Although the learning goals themselves do not have an direct influence on this specific research, they form a core element of the game and may therefore still influence the results.

1.3 The importance of meaningful choice

According to Nay and Zagal (2017) and Krcmar and Cingel (2016) [18] video games have the ability to create ethical experiences for their players that promote ethical reflection. This is usually done through the consequences to the actions of the player that the game

provides. For this to have effect, the choices must be significant, impactful, but most of all, meaningful. [25]. It is also suggested by Patall et al. (2008) that meaningful choice has an important effect on the motivation, performance and learning of the players [27].

This makes meaningful choices important to the game Terminus since the aim of the game is to have the players learn something. Since meaningful choice appears to have a positive effect on the motivation, performance and learning of the players it should be something that is present in the game. Ethical experiences and reflection may also be beneficial to the game since some of the scenarios presented the game may play out differently in real life from what the player may learn in their courses. For example, when looking into a suspect, at one point the player may choose to directly call a colleague across the border. This is not the correct protocol for the situation but it may happen that the player chooses to do so in real life as it is faster than the official route. This is why it is important for the players to think about what they would do in these scenarios before they encounter them.

1.4 The importance of replayability

Even though both game companies and players think that replayability is important, current research has not devoted a lot of attention to repeated game play [31]. Repeated game play will henceforth be referred to as "replayability".

Replayability is especially important in the game Terminus because the player will most likely not make all the optimal choices in the first playthrough and they will likely make some mistakes and so receive feedback on these mistakes. After they have reflected on these mistakes it would be useful for the player to go back and correct these mistakes since learning is based on repetition [4].

To achieve the learning goals, the game Terminus utilizes decision making and narrative. Narratives heightens the role-play through narrative experiences. This led to the emergence of the phenomenon that is called the "Illusion of choice". This means that within a story the narrative branches appear to the user as being not sufficiently different from the branches discovered in earlier runs [23]. When this occurs the engagement of the players will most likely drop since the degree of engagement is dependent on the degree of the user's sense of control over their character [30].

Since the game Terminus is mostly narrative based and the goal is to have the participants learn something it seems logical to look into the effect of the branching narratives on replayability so it may be improved in future iterations of the product.

1.5 The importance of this research

It is time-consuming to create narratives, especially when considering different branches with different story lines. This research will contribute to the app Terminus in particular because research gives insight into to what extent time and energy should be invested into the creation of branching narratives for the game and therefore allows the stories to be created more efficiently leaving more room to focus on the educational aspect of the game.

Even though this is a benefit that directly impacts the game Terminus, this could also benefit the the general understanding of educational applications as a whole as well. This research will provide insight into how educational apps should be used and to what extent they should keep branching narratives into account when developing educational apps.

2 Related work

2.1 Narratives

A narrative can be seen as a sequence of events [3] [19]. In computer games narratives are able to add meaning different layers of meaning to the game and enhance or clarify content which can lead to higher engagement [19]. Narratives can be ordered in different ways such as a linear or a branching narrative [30]. In linear narrative, the order of the events from the beginning to the end of the story cannot be altered by the user. This is the usual narrative type used in video games. Branching narrative on the other hand has points where the decisions made by the user alter the way that the story progresses [30] [23] [5]. Branching narratives may improve the enjoyment and the experience of flow for the players [23]. Computer games may have different methods of providing the alteration to the storyline through different forms of interactivity [20]. An example of this is a system that is capable of generating stories according to the user's preferences and abilities. Such a system expands the replayability of a game [30]. The advantage of a branching storyline is twofold: The user is able to experience a dynamic story that unfolds in directions tailored for them and the user is able to experience a sense of agency of the story [23]. This sense of agency means that the player has a greater sense of presence and freedom in the world [23]. In structural narrative theory specific narratives represent the instances in time that tell the story. Each instance can be referred to as text which is available to the reader. [20]

2.2 Branching narratives

Branching narratives are a frequently used narrative device [2]. The branching storyline provides alternative pathways through the overall plot related to a shared story [20] [29]. Lindley mentions that branching storylines are the simplest way of structuring interactive story systems [20]. Branching storylines can be represented in different maps that chart all the possible narrative threads that can be followed by the player to reach the end point [2]. These maps will henceforth be referred to as "branching narrative structures". Alfieri [2] states that a branching story structure is complex to construct and may not deliver the richness of experience and the spectrum of choice that one would hope it does. At the same time they also say that branching storylines are one of the best methods to craft and interactive story which leaves room for both choice from the player and a larger narrative story arc [2].

2.2.1 Different types of branching narratives

In their article, Alfieri [2] describes different types of branching narrative structures:

- The string of pearls map: The base is a linear story structure but there are smaller branches along the way. These branches usually do not have a significant impact on the main storyline.
- The Branch-and-Bottleneck map: Along the core storyline there are decision points that lead the player down different story paths. These paths will be unique for a while but will eventually rejoin the larger narrative.

- Tracking the state of play: When playing out the main narrative certain choices that the player makes will impact variables in the main storyline. The story "remembers" what happened and the consequences of the players actions will be visible later in the story.
- The map of many endings: The player comes chooses between paths along the main storyline. This also directly impacts the flow of the story and the ultimate ending that will be achieved. Each option leads to an unique path to one of the many final outcomes.
- The true open world map: In this form, the player has unlimited freedom to roam the open map and the different story nodes can be approached from different angles.

2.3 Meaningful choice

Iten et al. (2018) found that games that heavily rely on narrative have the potential to influence the players attitudes, emotions and behaviour [16] [15]. This can be achieved through the interactive nature of the game, research by Patall et al. (2008) specifically suggests that choices that allow the player to reflect their personal values, goals or interests through their actions will have a positive effect on motivation, performance and learning [27]. Iten et al. (2018) supports this by saying that for interactivity to have an effect the choices must be perceived as meaningful by the player. They mention that making a choice that the player feels responsible for has a positive effect on learning since active reflection to reach the best decision is necessary. [16].

But what makes choice meaningful? Dechering and Bakkes (2018) suggest that meaningful choice requires four components [10]:

- Awareness: The player needs to know that they are making a choice and that there is a difference in the options that they selected.
- Gameplay Consequences: There must be consequences to the choice made by the player that are both gameplay oriented and aesthetically oriented.
- Reminders: The game should remind the player of their choice after they made it.
- Permanence: The player should not be able to go back to undo their choice after facing the consequences.

The research by Iten et al. (2018) suggests that meaningful choices may be crucial for narrative-rich games and interactive narratives. They also mention that awareness and gameplay consequences as described above may be important factors in how meaningful the choice is perceived to be [16] [15].

Meaningful choices may also lead to agency since, according to Burgess and Jones (2017), agency is described as the player being capable of meaningfully influence the video game world by contributing to events that are significant for that world and having an influence on their outcomes [5]. This definition of agency is described by Surber (2014) as a reason why the best computer games have an aspect of meaningful choice [32].

2.4 Replayability

Replayability is very important for both commercial [11] and serious games [14][13][7]. Usually replayability is seen as a characteristic of a good game [21]. There are many things that can make a game replayable for the user, such as the gameplay or the story. [1].

It is very difficult to determine what causes replayability exactly but it is widely agreed-upon that good gameplay through, for example, choice and challenge improve both the playability and the replayability of a game [33]. Replayability and playability heavily influence each other so it is difficult to make a distinction between the two [33]. However, a survey by Frattersi et al [11] does not show a link between a game that has a high replayability and a game that has a high play value.

When designing for replayability in a commercial game, there is an interesting dilemma that occurs. When you have too much replayability, it will not help to sell the future games since the customer does not feel the need for a new game. When there is not enough replayability then the game may not sell at all [11]. The survey by Frattersi et al. (2011) [11] has found a link between replayability and top selling games. Roth et al. (2012) mentions that replayability may also increase the presence and effectance in action-related components of a game but does not have an effect for narrative-related experiences [31]. As a player, having repeated action with the same game can result in very different game progress, story outcomes and events. Roth et al. (2012) also mentions that this variation is a key factor in replay motivation and can be used to entice the player to play the game again [31].

There are a few factors that impact the replayability of a game such as the difficulty [11] [33], the drive to completion, the social aspects of the game, the uniqueness of the experience of each playthrough and the overall experience and unique feeling that the game provides [11].

2.4.1 Replayability in narrative games

Creating different paths that the player can use to complete the story can be used to improve replayability [1][21]. When using replayability in narrative games the points from which the story can be replayed can be used by the players to improve their chance of receiving positive feedback from the game. To maximize the positive feedback, the player will replay the story and try the different options available [17]. Thygesen (2014) suggest that games with different pathways toward a goal, which is the case in games a branching storyline, may accomodate replayability more than linear games [33].

The replayability of a game may be influenced by the presence of branching storylines, specifically if a Branch-and-Bottleneck map is present there is a risk that the participant may feel that their previous choices are not meaningful since their choices did not have a real impact on the larger story [2]. The map of many endings has a positive effect on the replayability of the game but it may be difficult to achieve. [2]

2.5 Serious games

Serious games are games designed for educational purposes rather than entertainment [35] [26]. Learning through serious games is also referred to as Game-based learning (GBL) [6] and it can be an effective tool for education. This is because games can have a positive influence on their players' mood [35]. Therefore it is easier to motivate students and engage them in the learning experience that the game provides [6] [12]. Serious games are also able to enhance learning. They are able to encourage their users to repeat their efforts several times in order to play the game, which engages them in trial-and-error gameplay [12]. Serious games could be especially effective on students who are not motivated by learning through the traditional practice of working on paper [12].

Player enjoyment is also important for serious games. Since the player usually does not decide by themselves that they want to play but are rather asked to play by their teachers player enjoyment can help keep them interested in continuing to play, returning to play and maybe even recommending the game to others. This way the effectiveness of the game as an educational tool is enhanced [7].

Since Terminus is aimed toward adults who are studying to join the police force, it is important to look into creating serious games for an adult target audience. When designing serious games there is a distinct difference between designing a game for children and designing one for adults [26] [6]. Games for adult learning has had less attention than game design for children [6]. There are six factors that have an influence on the enjoyment and motivation to play a game for adults [6] [34]:

- Community: Collaborative activities and the ability to communicate with other players.
- Competition: Playing versus other players.
- Completion: Achieving goals and completing the game.
- Creativity: The ability to creatively express themselves.
- Narrative: The engaging storyline of the game.
- Puzzle-solving: Interesting puzzles that the players can solve.

In serious games the players performance is usually scored through the process of playing the game [35].

2.5.1 Narrative in serious games

Because serious games aim to deliver specific learning outcomes, the role of narratives becomes more pronounced [29]. Narratives are a central part to serious games [19]. Narrative-based serious games are capable of using interactive narrative to present pedagogical content and are often utilized because they are usually better at achieving behaviour change in their users and conveying knowledge in general [9]. Introducing narratives into serious games may be relatively simple, which is why it is argued that this approach is both accessible and cost-effective [22].

Narratives are able to evoke critical thinking skills and promote the acquisition of knowledge [19]. It is unclear what the exact relationship is between gameplay, narrative and

pedagogy [19] but research has suggested that serious games (and other game-based learning environments) can be improved through the incorporation of storytelling elements [24]. Narratives are able to provide a powerful and flexible approach to introduce the terms and language associated with the topics of learning. Narrative in serious games may make learning more meaningful to students [24].

Narrative games are also perceived as more exciting, engaging and fun by their users [22]. For serious games, the main objective is to improve one's skills the ability to recognize the information that is useful in real life within this fictional world. This is something that will help the user in the future since they are able to transfer it to new contexts [29].

3 Methodology

A between subjects design was chosen for this study, since it results in a more acceptable experiment duration for the participants. To conduct this experiment two variations on the original version of the app Terminus were created. These versions roughly possess the same story as the original and were created from 03-05-2022 to 03-07-2022. The story reflects the story in that time frame. Since changes to the story were planned, a copy of the original version was created as well.

3.1 Overview of the experiment

The experiment was done with 30 participants who were all students and proficient in the Dutch language. The participants were asked to fill in a survey, then play the game on a computer. A hypothesis was set up for each research question. The participants were split up into three groups: version 1 where no changes were made to the game; version 2 where all even chapters contained a branching story line and the odd chapters a linear story line; and version 3 where all the odd chapters contained a branching story line while the even chapters were made linear. Then this data was anonymized and stored. Then the data was analyzed based on the hypotheses so a conclusion can be drawn.

3.2 Hypotheses

In this study, the effect of branching narratives on the replayability of the game Terminus is measured. To determine the extent of this effect, several factors were taken into account such as the number of times a chapter is played, what the player thought of the chapter they played and if they completed or failed the chapter.

This is represented in the following main hypothesis:

H1 The use of branching narratives will improve the replayability of the game Terminus.

This hypothesis will be explored using the following sub hypotheses:

H1a If the player fails a chapter, they are more likely to play that chapter again

H1b A branching narrative improves how enjoyable the player finds the game and will therefore improve the replayability.

H1c Branching narratives improve how meaningful the choices the player is making are, which will improve the replayability.

H1d Which chapter was played by the tester makes a difference in the replayability of that chapter.

3.3 Participants

A total of 35 participants participated in the study out of which 3 participants quit the experiment before playing the game and two participants participated in the study who did not fit the target audience. Their results have been excluded from the research. All participants were gathered by means of convenience sampling. The experiment was conducted from 08-09-2022 till 09-10-2022. The participants were not compensated for their time, as participation was completely voluntary.

The experiment was conducted with 30 participants who completed the entire study (21 male, 7 female, 2 other). 3 participants reported to be below 20, 25 in the range of 20 to 25 and 2 in the range of 26 to 30. All participants were proficient in the Dutch language. All participants were students doing higher education. Out of all the participants 25 were doing their bachelors. They were in the study year ranging from 1 to 6 ($M = 2.92$, $SD = 0.96$). One participant was in the first year of their premaster. 4 participants were doing their masters. They were in the study years ranging from 1 to 3 ($M = 1.75$, $SD = 0.96$). Notably, only 7 participants did not study in an IT related field.

The participants were asked to fill in their experience with games and their knowledge of police terminology (specifically acceptable behaviour across the border) on a 5 point likert scale. For the experience with games the scale ranged from 1-never to 5-every day, on this scale they reported a mean of 3.9 and a standard deviation of 1.05. For police knowledge across the border the scale ranged from 1-Not familiar at all to 5-I know everything about it. On this scale they reported a mean of 1.9 ($SD = 1.18$).

3.4 Materials

To conduct this experiment, the participants were first instructed to fill in a demographic survey. They could do this on either their mobile device or their computer. This survey included a mandatory checkbox that needed to be ticked to be able to continue with the experiment. Ticking this checkbox meant that they agreed to not further spread the game. This was done in an effort to prevent the game becoming widespread as it belongs to the Dutch Police academy. After a check to see if they completed this survey, the participants were sent the second part of the experiment which they could only do on a computer. In this part they had to play a game and fill in a short questionnaire after each chapter.

3.5 Variables that affect the experiment

There are several variables that may have an effect on the experiment such as:

- Due to a limitation in the app where the decisions in one chapter are not able to affect the other chapter the branching storylines will only be tested chapter by chapter. To account for this, a Branch-and-Bottleneck map structure will be used to make the branching storylines.
- It could be the case that the replayability of a chapter is affected by the narrative of the chapter itself, this is why all the chapters should have the same narrative in all versions of the test and they should be tested both with and without branching storylines.
- The willingness to replay a chapter could differ from participant to participant. To remedy this all participants should have both branching and non-branching chapters.
- The longer a participant is playing, the more tired they will likely be, this may also have an effect on their willingness to replay the chapter. To remedy this, randomizing the chapter order was considered. However, this will also take the storyline out of order and therefore it likely make less sense which, in turn, may

also affect the willingness to replay a chapter. Therefore it was chosen to simply give the participants ample time to complete the experiment.

- The knowledge that a chapter is branching may also have an affect on how willing the participant is to replay a chapter. To remedy this the player will not be made aware of which chapters are and which chapters are not branching.

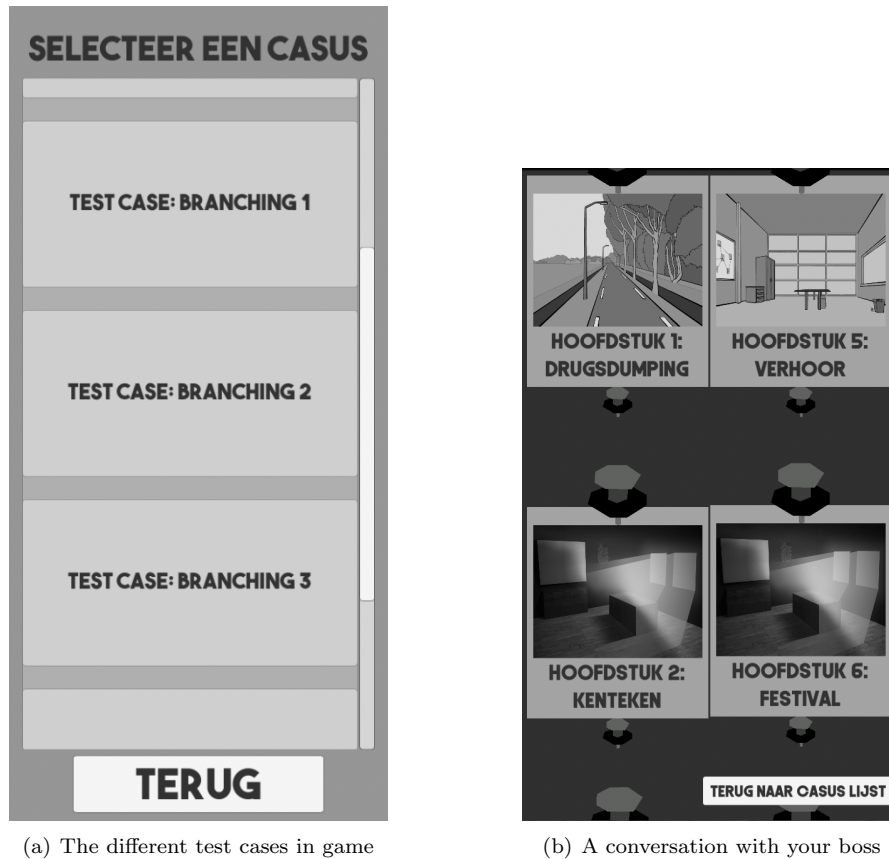


Figure 2: The setup of the test cases

3.6 Experiment procedure

Keeping these variables into account, the following experiment setup was created: Three variations of the app were created as shown in figure 2a. All these variations followed the same story line. One version, henceforth referred to as "version 1" or "V1" served as the control version. Here, no changes were made to the game. For this there was a separate version made to keep the versions as close to one another as possible since the game was still in development. In the second variation of the game, henceforth referred to as "version 2" or "V2", the game was changed in such a way that all the even chapters contained a branching story line and the odd chapters possessed a linear story line. The

third version, henceforth referred to as "version 3" or "V3" mirrors this. Here the odd chapters contained a branching story while the even chapters were made linear. The participants were asked to play the game in order (chapter 1 to chapter 8) but as shown in figure 2b, all the chapters were open to provide clear insight into how many chapters are to come.

Before the actual experiment was conducted with all the participants, the experiment was done with a single participant. The goal of this experiment was to see if there were any points that were missed during the experiment setup that should have been in the experiment and so any mishaps could be fixed beforehand. The data from this first experiment has been excluded from the actual experiment. In this first experiment the main thing that came to the surface was that the experiment was significantly too long and the participants would be unlikely to invest that much time. And so, it was decided that the participant does not have to finish all the chapters for the data to be useful.

Each participant will get one of these versions assigned to them and will be asked to play through the game and answer the questions on the questionnaire which will be provided to them through google forms. An equal number of participants will be assigned to each variation of the app. The participants for this experiment will be gathered through the police academy. For this experiment the aim is to have a minimum of 30 participants, 10 for each variation of the app.

3.7 Data collection and storage

During the experiment quantitative data was collected through surveys. As mentioned before, at the start of the experiment the participants answered questions about their demographic information. After each chapter that they played the participants were asked several questions about how often they played the game and how they felt about certain aspects of the game. In all surveys the participant was asked for their name which was solely used for the purpose of connecting the different surveys to one another. All these surveys were done through google surveys and then stored in google sheets files. Once the data was in the google sheets file, it was copied and then transferred to another google sheets file where all surveys were combined, sorted per participant and the data analysis was performed. The findings of this research can be found in the following spreadsheet: <https://tinyurl.com/9p34dz7a>¹.

3.8 Data analysis

The collected data was anonymized so by assigning every participant an ID and then removing the participants names. This way no participant can be recognized when looking at the data. For all the dependent variables (enjoyment, meaningfulness and how often they are willing to play) first the variances were calculated using an F-test. Then independent one tailed t-tests or one-way ANOVA tests were performed. When checking the assumptions for these tests, an alpha of 0.05 was applied everywhere to calculate the statistical significance. For both the population size and the sample size 30 was used.

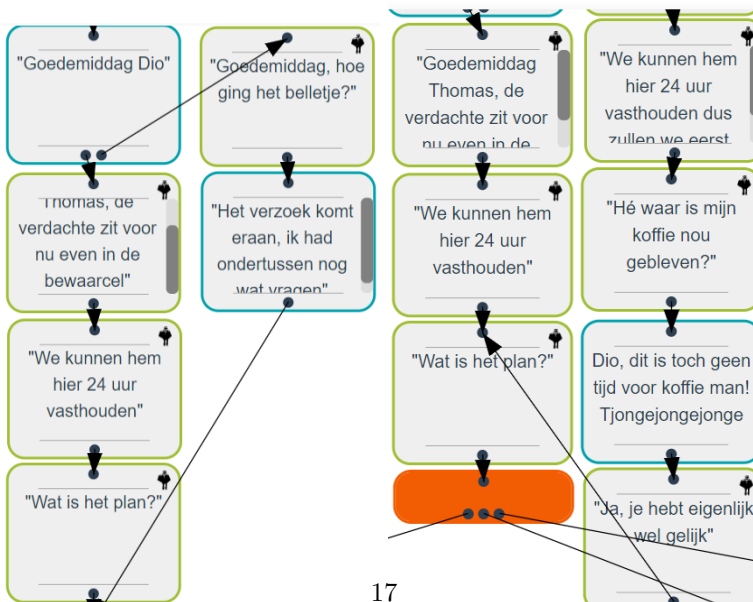
¹This data has since been removed from the drive for privacy reasons



(a) Coffee indifference



(b) Coffee reaction



(c) Coffee indifference 2

(d) Coffee reaction 2

Figure 3: An example of the dialogue difference between versions

3.9 Experiment details

As mentioned in the previous chapter, there will be two versions of each chapter, one with and one without a branching story line. First, it was determined if a chapter was initially branching or not, based on rules further described in 3.9.1. Then changes were made to each chapter to either add or remove the branching from them based on these same rules to make it so that for V2 the even chapters were branching and the odd chapters non branching and for V3 the odd chapters were branching and the even chapters were non-branching. When the chapters were sufficiently changed, each chapter used in the experiment was systematically tested and bugs were removed. Then the score was checked to see if the branching score remained the same. If not, the bugs were compensated for through new changes and then the chapter was tested again. This process was repeated until it was believed that the number of bugs present in the story was minimal.

3.9.1 Changes to the story line

For both versions of the chapter the story line will remain largely the same with small differences to accommodate the branches where needed. This is to limit the number of variables as much as possible so the possible differences in the results are most likely the result of the differences in branching. The correct answers and scoring will remain the same in both versions and will be shown in the results of each chapter. This is because the player may want to replay the game in order to get the highest score possible. Although this falls under the "completion" part of player enjoyment, it was chosen to not change the scoring as it may have an impact on the replayability but is not directly related to the branching storylines.

In the non-branching chapters, to not make the player too aware of whether a chapter is branching or not the player will still be provided with a choice, as can be seen in figure 4. Here an extreme version of illusion of choice will be utilized to remove the branching storyline. This means that no matter which option was chosen the choice will lead to the same or a similar answer. This will impact the meaningfulness of the choice because, although the player is aware that they need to make a choice, there is no real difference in the choices they can select from and there are no gameplay consequences. The removal of the branching story lines also impacts the puzzle-solving aspect of the game since the choices will have no feedback regarding their impact on the score. An example of a non-branching choice is depicted in figure 5.

In the branching chapters the players will be given the same choices and the same storyline as the non-branching chapters but these choices will lead to different dialogue. An example from the same point in game in V2 and V3 is depicted in figure 4. Since a Branch-and-bottleneck structure is used, these chapters will not influence each other and always start at the same point. An example of one of the choices can be found in figure 6.

As some chapters already have a branching storyline, some chapters the branching storyline should be added while in other chapters the branching storyline should be removed. To determine which chapter has which originally, an initial branching score will be determined for each chapter. The scoring of the branching will work as follows:



(a) Option Chapter 5 V2: non-branching



(b) Option Chapter 5 V3: branching

Figure 4: An example of the choice difference between versions

- If a dialogue contains no options for the player (and is therefore completely linear), the score remains the same.
- If the player can end the chapter in more than one way, for each additional way to end the chapter, 15 is added to the branching score
- When a chapter is non linear: For each dialogue box that ends the dialogue 10 is added to the branching score
- If a dialogue branches off based on a previously made choice (which isn't directly before the dialogue itself) 5 is added to the branching score.
- If the result of a choice leads back to that same choice -5 to the branching score.
- If a dialogue contains a choice and the choice leads to the same path as the another

Chapter	Branching Score	Branching?
1	58	Yes
2	26	Yes
3	85	Yes
4	71	Yes
5	9	Yes
6	-58	No
7	25	Yes
8	-16	No

Table 2: Branching per chapter

choice the scoring works as follows:

- The branch is merged without additional dialogue: -10
- The branch is merged within 1 dialogue box: -7
- The branch is merged within 2-3 dialogue boxes: -5
- The branch is merged within 4-6 dialogue boxes: -2
- The branch is merged with more than 6 dialogue boxes in between: -1

Despite the linear dialogue adding to the quality of the game it was chosen to be omitted from the branching equation as it has no direct effect on the branching.

All the chapters that have a positive branching score will be seen as branching and all the chapters with an negative branching score will be seen as initially not branching. The scores for the individual dialogues can be found in the following sheet:

<https://tinyurl.com/bd4fejfc>

All the branches were changed to be either branching or non-branching following the same rules mentioned above. To ensure that the chapters were distinctly branching or non-branching, changes were made to the chapters until the non branching chapters had a branching score of less than -25 and the branching chapters had a branching score of more than 25.

3.9.2 Questions for participants

Prior to the start of the experiment, the participants were asked to provide the following data:

- Their demographic data consisting of their age, their gender and in which year of their studies they currently are.
- How familiar the participant is with video games. For this question a five-point likert scale was used.

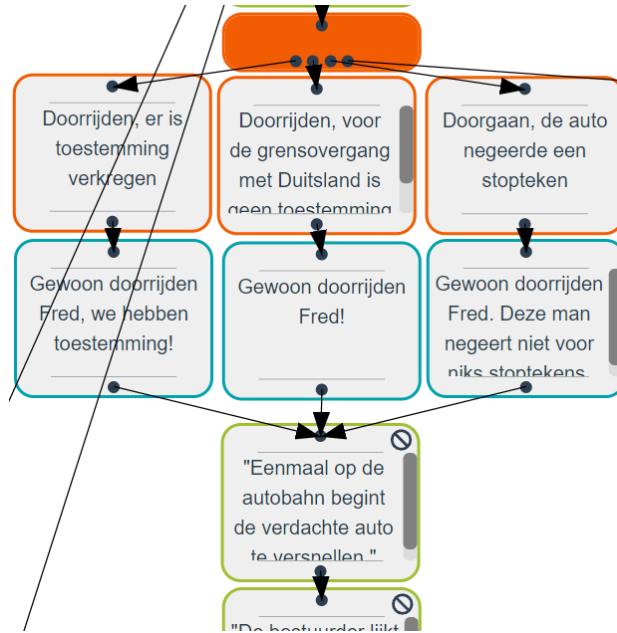


Figure 5: An example of a non branching choice from the Terminus editor

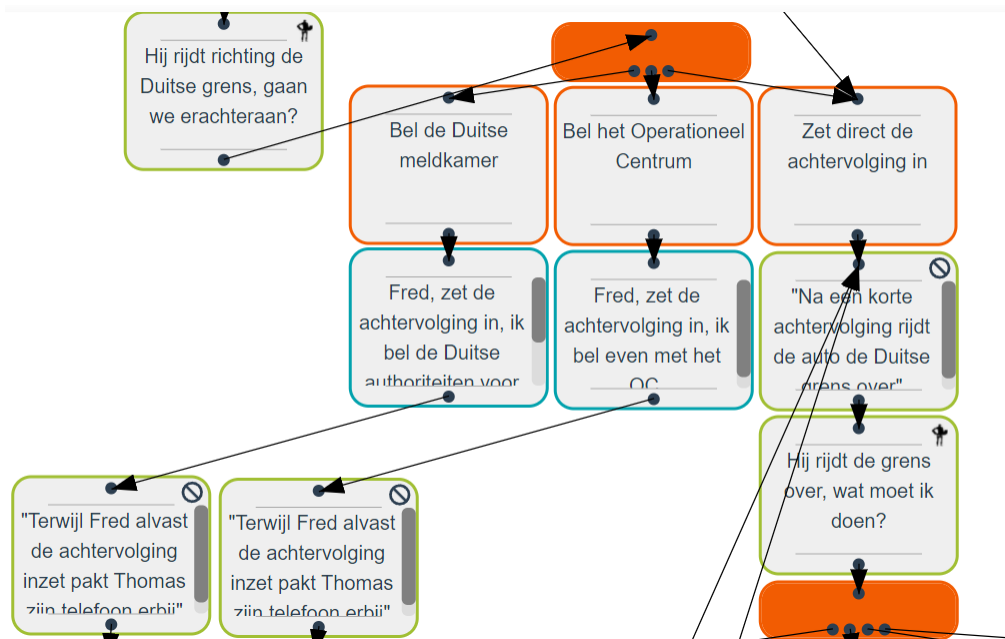


Figure 6: An example of a branching choice from the Terminus editor

- Which game genres the participants are most familiar with. For this question different genres were listed and the participants were able to check the boxes of the genres they feel they are familiar with.
- How familiar the participant is with the knowledge presented in the game (code of conduct across the border). For this question a five-point likert scale was used.

The demographic data was asked of the participant to gain a better understanding of our participants. This allows for a better comparison if the experiment would be reproduced. The participants familiarity with video games and their familiarity with the knowledge presents in this game were asked because, although not explored in this research specifically, these elements may have an influence on the results. This allows for exploration in these areas if it appears there is influence that is not explained by the research questions explored by this research.

After the participant finished each chapter, they were asked to fill in a survey where questions were asked based on four topics: Their enjoyment of the game; the perceived meaningfulness of their choices and questions to determine how often they played a certain chapter.

The questions that were used to determine the enjoyment of the player:

- How enjoyable did you find playing this chapter? For this question a five-point likert scale was used.
- Did you like the storyline of this chapter? For this question a five-point likert scale was used.
- Was there anything unclear about this chapter? This was an open-ended question.

Here, the first question was asked to determine if the player enjoyed the story line of this chapter. The second question was asked to define if they did like the story of the chapter since, although not specifically explored here, this may have an influence on the results. The participants were asked if anything was unclear about the chapter so that potential bugs could be found.

The questions that were used to determine how meaningful the player found their decisions to be:

- For the decisions you made in this chapter, to what extent did you feel like the options different from one another? For this question a five-point likert scale was used.
- To what extent did you feel like your choices impacted the story line? For this question a five-point likert scale was used.
- To which extent did you feel like you were reminded of choices you had made earlier in the chapter? For this question a five-point likert scale was used.
- Did you feel like you wanted to go back to make a different decision? This was an open-ended question.

Here, it was interesting to know if the participant felt that the decisions differed from one another and to what extent they felt reminded of choices that were made earlier in the chapter because, according to the literature study in chapter 2.3, the difference in choices may impact how meaningful a choice is perceived to be. It was also found important to directly gauge the meaningfulness through asking the participants to what extent they felt their choices impacted the story line. Lastly, the players were also asked if they wanted to go back to make a different decision to get a better grasp of how often wanting to go back yielded the result of them actually taking action and redoing the chapter.

Then some questions were asked about how often the chapter was played:

- How often did you play this chapter? This was an open-ended question.
- Did you solve this chapter? If yes, after how many times? This was an open-ended question.

It is interesting to know how often the chapter was played so the different variables could be compared against each other. An example of this would be the branching and the non-branching chapters. It is interesting to know if the chapter was solved right away so it can be explored if the difficulty level of the chapter had something to do with its replayability.

3.10 Evaluation Criteria

The questions that will be used to answer the main question fall under one of two categories in this research. Questions that will be answered through the literature study and questions that will be answered through the experiment described in the Methodology section 3. The questions that will be answered through literature study are:

- **RQ1** Which criteria do choices in narrative games need to meet in order to be meaningful?
- **RQ3** Which elements that make the game enjoyable are important for the replayability of Terminus?

The following questions will be answered through the experiment:

- **RQ2** To what extent does the player find the questions presented in Terminus meaningful?
- **RQ4** How enjoyable does the player find the different chapters of the game?
- **RQ5** How often is the player willing to play the different chapters of the game?

To answer these questions during the experiment, several questions from the questions for participants have been aimed towards a specific sub question. This relation between questions is depicted in the following table:

Overarching question	Questions for participants
RQ2 To what extent does the player find the questions presented in Terminus meaningful?	<ul style="list-style-type: none"> • For the decisions you made in this chapter, to what extent did you feel like the options different from one another? • To what extent did you feel like your choices had consequences? • How often did you feel like you were reminded of your previous decisions? • Did you feel like you wanted to go back to make a different decision?
RQ4 How enjoyable does the player find the different chapters of the game?	<ul style="list-style-type: none"> • How enjoyable did you find playing this chapter? • Did you like the storyline of this chapter? • Was there anything unclear about this chapter?
RQ5 How often is the player willing to play the different chapters of the game?	<ul style="list-style-type: none"> • How often have you played this chapter? • Did this chapter end in success or failure?

Table 3: Relation between research question and questions asked

4 Results

4.1 Influence on the general replayability

To investigate general hypothesis **H1**, the null hypothesis **H0**: "The use of branching narratives has no effect on the replayability of the game Terminus" was used. V1 was used as the standard population since it functions as the control group. From V2 and V3 the branching and the non-branching chapters were separated and put into different groups, a branching group and a non-branching group. This data can be found in table 4. The summary of the general statistics for these groups can be found in table 5. For this group, an one-way ANOVA test was conducted which resulted in a p-value of around 0.71. This is above the predetermined alpha threshold of 0.05. This means that our null hypothesis (**H0**) should be accepted and our hypothesis (**H1**) should be rejected.

Chapter	V1	Branching	Non-branching
1	14	11	11
2	15	8	15
3	8	11	13
4	13	16	15
5	14	14	10
6	9	7	11
7	9	24	14
8	6	8	11

Table 4: V1 compared to branching and non-branching chapters

Type	V1	Branching	Non-branching
Mean	11	12.38	12.5
Variance	11.43	31.70	4

Table 5: Summary of statistics

4.2 The effect of success and failure

Regarding the effect of whether the chapter was a success (**H1a**), the null hypothesis **H0a** is: "Whether the player succeeds or fails a chapter has no influence on whether they play the chapter again.". Since the hypothesis **H1a** states that they are more likely to play the chapter again, a one-tailed t-test is used. To determine the values used for the f-test and the t-test, two options were made: "succeeded in one try" and "succeeded in more than one try". Then, for every chapter the number of times the chapter was played was added until 2 columns (succeeded in one try and not succeeded in one try) and 8 rows (chapter 1 to 8) were left. This data can be found in table 6. In the data, certain edge cases were present. These were handled as follows:

- If the participant did not solve the chapter at all, the number of times they played the chapter was added to the "succeeded in more than one try" column.
- If the participant submitted a number of times that they played the chapter that is lower than the number of tries it took them to complete the chapter, the number of times that they played the chapter was added to the "succeeded in more than one try" column.
- If the question to whether or not they solved the chapter was answered with simply "no" their results were added to the "succeeded in more than one try" column.
- If the question to whether or not they solved the chapter was answered with simply "yes" their results were added to the "succeeded in one try" column.

An f-tests on these two columns gives a value of around 0.35. This means that there are equal variances in this data. The t-test for this group returns a p-value of around 0.037. Since this is lower than our alpha threshold (0.05), our null hypothesis (**H0a**) is rejected and the hypothesis (**H1a**) is accepted.

Chapter	Completed in one try	Completed in more than one try
1	34	2
2	35	2
3	31	0
4	17	26
5	34	4
6	18	9
7	7	40
8	23	2

Table 6: Comparing success and failure

4.3 Effect of player enjoyment

Regarding the effect of player enjoyment (**H1b**), the following null hypothesis **H0c** was adopted: "The enjoyment level makes no difference in the replayability of that chapter". To determine this, a table was made with the rows being the chapters (1 to 8) and the columns being the enjoyment level (1 to 5). If the enjoyment level field was left empty, the result was discarded. Then the reported number of times the chapter was played were added together in the cell that was the intersection between the perceived enjoyment level and the chapter of that questionnaire and then added together once more to form three groups: "low enjoyment" for columns 1 + 2, "medium enjoyment" for column 3 and "high enjoyment" for columns 4 and 5 to make for an easier comparison. The data for these groups can be found in table 7 and the general statistics of these groups can be found in table 8. Then an one-way ANOVA test was performed on these groups. This resulted in a p-value of around 0.00000054 which is below our alpha threshold, therefore the null hypothesis can be discarded and the hypothesis **H1b: A branching narrative**

improves how enjoyable the player finds the game and will therefore improve the replayability is accepted.

Chapter	low enjoyment	medium enjoyment	high enjoyment
1	5	12	19
2	3	15	19
3	1	17	13
4	5	10	25
5	5	4	30
6	3	4	20
7	5	10	30
8	1	8	16

Table 7: Player enjoyment

Type	low enjoyment	medium enjoyment	high enjoyment
Mean	3.5	10	21.5
Variance	3.14	22	39.14

Table 8: Summary of statistics

4.4 Effect of perceived meaningful choices

Regarding the effect of perceived meaningful choices (**H1c**), the following null hypothesis **H0d** was adopted: "How meaningful the choices are perceived to be has no influence on the replayability". To test this, a table was made with the rows being the chapters (1 to 8) and the columns being the perceived meaningfulness (1 to 5). Then the reported number of times the chapter was played were added together in the cell that was the intersection between the perceived level of meaningfulness and the chapter of that questionnaire. Then, the column 1 and 2 and 4 and 5 of the perceived meaningfulness were added together to form three groups "not meaningful" for column 1+2, "meaningful" for column 3, "very meaningful" for column 4+5 to make for an easier comparison. This data can be found in table 9 and the general statistics of these groups can be found in table 10. Then an one-way ANOVA test was performed on these groups. This resulted in a p-value of around 0.18 which is above our alpha threshold, therefore the null hypothesis cannot be discarded and the hypothesis **H1c: Branching narratives improve how meaningful the choices the player is making are, which will improve the replayability.** is therefore rejected.

Chapter	not meaningful	meaningful	very meaningful
1	23	12	4
2	11	15	13
3	11	17	13
4	12	10	29
5	10	4	24
6	9	4	13
7	10	10	38
8	12	8	5

Table 9: Meaningful choices

Type	not meaningful	meaningful	very meaningful
Mean	12.25	10	17.38
Variance	19.93	22	141.98

Table 10: Summary of statistics

4.5 Data for each chapter

To determine if the chapter played made a difference **H1d**, the following null hypothesis **H0d** was adopted: "Which chapter was played by the tester makes no difference in the replayability of that chapter". The data on how many times each chapter was played was added up as can be seen in table 11, the general statistics for this data can be found in table 12. On this data, an one-way ANOVA test was performed which resulted in a p-value of around 1.25E-11. This means that our p-values are below the predetermined alpha threshold of 0.05 and therefore **H1d: Which chapter was played by the tester makes a difference in the replayability of that chapter** should be accepted.

Chapter	Once	Twice	Three times	Four times	Five times
1	23	5	1	0	0
2	23	3	3	0	0
3	20	2	1	0	1
4	10	5	1	1	3
5	15	3	3	2	0
6	13	5	0	1	0
7	5	8	3	3	1
8	18	2	1	0	0

Table 11: Data for each chapter

Chapter	Once	Twice	Three times	Four times	Five times
Mean	15.88	4.13	1.63	0.88	0.63
Variance	40.70	4.13	1.41	1.27	1.13

Table 12: Summary of statistics

5 Discussion

5.1 Limitations and future work

This study has a couple of limitations. Firstly, the ideal target audience for this experiment were students of the Dutch police academy specifically. Unfortunately, due to time constraints it was not feasible to have these students participate in this study. For the general understanding of the effect of branching narratives on the replayability of educational applications this does not form a limitation. However, when looking at the results with the specific purpose of improving the application *Terminus*, it might bring merit to do this study again with this group as the participants.

The participants also did this experiment on their computer despite *Terminus* being a mobile application, this was due to how the application belonged to the Dutch Police academy and therefore the mobile application should not be distributed to unauthorized individuals. Even though an requirement for the participants was to agree that they would not spread the application further, creating a build for computers rather than mobile phones was chosen as an extra security measure. If this experiment is done with the students of the Dutch police academy, this risk is mitigated and therefore it can be tested on mobile devices. This could be interesting as playing on a different device than the application was intended for may have impacted the results of this study.

Secondly, when calculating the branching score, as shown in chapter 3.9.1, the content of the dialogue bubbles was not taken into account. In future research, taking the content of the bubbles into account when calculating the branching scores might yield different dialogues which may, in turn, yield different results. In a similar vein, due to constraints posed by the application a branch-and-bottleneck structure was used in every chapter of the story which may have impacted the results as well. Although when doing research on this specific application this constraint will remain, it does present reason to redo this experiment within the frame of a different application.

5.2 Small improvements

There were also a couple of things that in hindsight could have been improved upon but do not warrant a completely new experiment to justify these points separately. As a whole they may have had an effect so if this experiment is repeated, these points should be taken into account. Firstly, while most of the questions were mandatory, it would have been beneficial if all of them had been. It also would have been better to simply ask the participants for their age rather than using age ranges to give a clearer view of the chosen demographic. The standard messages that I had written to prepare the participants for the experiment were not applicable in the context of some of the conversations. If this experiment were to be repeated, it would be advisable to make a separate message for each person containing a list of points rather than a premade message. This message also did not include that this experiment can be done without direct surveillance which is something that had to be clarified afterwards. This should be added to the list of things to send.

6 Conclusion

To summarize, the results of the present study indicate that for the influence on the general replayability, using branching or non-branching story lines did not have a significant effect on the replayability of Terminus.

To further explore why this is the case, several components that are believed to have influenced this result were studied: The success and failure rate of the chapters, the effect of player enjoyment, the effect of perceived meaningful choices and the data for each different chapter.

6.1 Answers to the research questions

Through literature study related to the **RQ1** (Which criteria do choices in narrative games need to meet in order to be meaningful?) Four components that have influence on how meaningful a choice is perceived to be were found. These components were: Awareness, Gameplay Consequences, Reminders and Permanence. When looking at the data from the experiment related to **RQ2** (To what extent does the player find the questions presented in Terminus meaningful?), it was found that the effect of meaningful choices had no significant effect on the replayability of the game.

Regarding the enjoyability of the game Terminus, literature study related to **RQ3** (Which elements that make the game enjoyable are important for the replayability of Terminus?) suggests that there are a couple of factors that affect the enjoyment of the players such as the difficulty of the game; the social aspects of the game; how unique each playthrough is; the players' drive to complete the game and the experience and feeling that the game gives to their player. Looking at the data related to **RQ4** (How enjoyable does the player find the different chapters of the game?) The data suggests that if the player finds a chapter more enjoyable, the player will replay the chapter more often. This may be because they like the chapter more and therefore want to see more of it. Through the data related to **RQ5** (How often is the player willing to play the different chapters of the game?) the impact of the difficulty is suggested, if a player fails the chapter they seem to be more likely to play this chapter again. A reason for this could be that the participant feels like they want to be able to complete the chapter before moving on to the next chapter. Lastly, the results suggested that the chapter that was played had an influence on the replayability which could be due to the difficulty level of that chapter.

6.2 Answer to the problem statement

Looking at the general problem statement of this research, *To what extent can a branching narrative enhance the replayability of a point-and-click game made for the Dutch police academy (Terminus)?* The answer appears to be that while the branching narrative itself holds no significant influence on the replayability, the enjoyment of the player and the difficulty level did have a positive effect.

References

- [1] Riannatta Adellin, Chen Tet Khuan, and Leo David Gertrude. Conceptual framework puzzle game with high replayability. In *Journal of Physics: Conference Series*, volume 1228, page 012070. IOP Publishing, 2019.
- [2] Louis Alfieri. The past, present and future of interactive narrative storytelling: multi-branching narratives. *blooloop*, 2021.
- [3] Hans-Joachim Backe. Narrative rules? story logic and the structures of games. *Literary and linguistic computing*, 27(3):243–260, 2012.
- [4] Malte Brinkmann. Repetition and transformation in learning. In *Transformative learning meets Bildung*, pages 73–83. Springer, 2017.
- [5] Jacqueline Burgess and Christian M Jones. “is it too much to ask that we’re allowed to win the game?”: Character attachment and agency in the mass effect 3 ending controversy. *Bulletin of Science, Technology & Society*, 37(3):146–158, 2017.
- [6] Nathalie Charlier, Michela Ott, Bernd Remmele, and Nicola Whitton. Not just for children: game-based learning for older adults. In *6th European Conference on Games Based Learning, Cork, Ireland*, pages 102–108, 2012.
- [7] José Lauciano Ferreira de Almeida and Liliane dos Santos Machado. Design requirements for educational serious games with focus on player enjoyment. *Entertainment Computing*, 38:100413, 2021.
- [8] Alessandro De Gloria, Francesco Bellotti, and Riccardo Berta. Serious games for education and training. *International Journal of Serious Games*, 1(1), 2014.
- [9] Olga De Troyer, Frederik Van Broeckhoven, and Joachim Vlieghe. Linking serious game narratives with pedagogical theories and pedagogical design strategies. *Journal of Computing in Higher Education*, 29(3):549–573, 2017.
- [10] Anna DeChering and Sander Bakkes. Moral engagement in interactive narrative games: An exploratory study on ethical agency in the walking dead and life is strange. *Foundations of Digital Games 2018 (FDG’18)*, August 7–10, 2018, 2018.
- [11] Timothy Frattesi, Douglas Griesbach, Jonathan Leith, Timothy Shaffer, and Jennifer DeWinter. Replayability of video games. *IQP, Worcester Polytechnic Institute, Worcester*, 2011.
- [12] Varvara Garneli, Michail Giannakos, and Konstantinos Chorianopoulos. Serious games as a malleable learning medium: The effects of narrative, gameplay, and making on students’ performance and attitudes. *British Journal of Educational Technology*, 48(3):842–859, 2017.
- [13] Stefan Göbel, Sandro Hardy, Viktor Wendel, Florian Mehm, and Ralf Steinmetz. Serious games for health: personalized exergames. In *Proceedings of the 18th ACM international conference on Multimedia*, pages 1663–1666, 2010.
- [14] Andrew Hicks. Bots: Harnessing player data and player effort to create and evaluate levels in a serious game. In *Educational Data Mining 2013*, 2013.

- [15] Glena H Iten, Sharon T Steinemann, and Klaus Opwis. To save or to sacrifice? understanding meaningful choices in games. In *Extended abstracts publication of the annual symposium on computer-human interaction in play*, pages 495–502, 2017.
- [16] Glena H Iten, Sharon T Steinemann, and Klaus Opwis. Choosing to help monsters: A mixed-method examination of meaningful choices in narrative-rich games and interactive narratives. In *Proceedings of the 2018 CHI conference on human factors in computing systems*, pages 1–13, 2018.
- [17] Rilla Khaled, Pippin Barr, James Noble, Ronald Fischer, and Robert Biddle. Fine tuning the persuasion in persuasive games. In *International conference on persuasive technology*, pages 36–47. Springer, 2007.
- [18] Marina Krcmar and Drew P Cingel. Moral foundations theory and moral reasoning in video game play: Using real-life morality in a game context. *Journal of Broadcasting & Electronic Media*, 60(1):87–103, 2016.
- [19] Theodore Lim, Sandy Louchart, Neil Suttie, Jannicke Baalsrud Hauge, Ioana A Stanescu, Ivan M Ortiz, Pablo Moreno-Ger, Francesco Bellotti, Maira B Carvalho, Jeffrey Earp, et al. Narrative serious game mechanics (nsgm)–insights into the narrative-pedagogical mechanism. In *International conference on serious games*, pages 23–34. Springer, 2014.
- [20] Craig A Lindley. Story and narrative structures in computer games. *Bushoff, Brunhild. ed*, 2005.
- [21] Amy Shirong Lu. Narrative in exergames: Thoughts on procedure, mechanism, and others. *Games for health journal*, 4(1):19–24, 2015.
- [22] Tim Marsh, Li Zhiqiang Nickole, Eric Klopfer, Chuang Xuejin, Scot Osterweil, and Jason Haas. Fun and learning: Blending design and development dimensions in serious games through narrative and characters. In *Serious games and edutainment applications*, pages 273–288. Springer, 2011.
- [23] Christopher Moser and Xiaowen Fang. Narrative structure and player experience in role-playing games. *International Journal of Human-Computer Interaction*, 31(2):146–156, 2015.
- [24] Emily Naul and Min Liu. Why story matters: A review of narrative in serious games. *Journal of Educational Computing Research*, 58(3):687–707, 2020.
- [25] Jeff L Nay and José P Zagal. Meaning without consequence: virtue ethics and inconsequential choices in games. In *Proceedings of the 12th International Conference on the Foundations of Digital Games*, pages 1–8, 2017.
- [26] Eleanor O’Rourke, Eric Butler, Yun-En Liu, Christy Ballweber, and Zoran Popovic. The effects of age on player behavior in educational games. In *FDG*, pages 158–165, 2013.
- [27] Erika A Patall, Harris Cooper, and Jorgianne Civey Robinson. The effects of choice on intrinsic motivation and related outcomes: a meta-analysis of research findings. *Psychological bulletin*, 134(2):270, 2008.

-
- [28] Alaa Qaffas. An operational study of video games' genres. *iJIM*, 2020.
- [29] Carlton Reeve. Narrative-based serious games. In *Serious games on the move*, pages 73–89. Springer, 2009.
- [30] Mark O Riedl and Robert Michael Young. From linear story generation to branching story graphs. *IEEE Computer Graphics and Applications*, 26(3):23–31, 2006.
- [31] Christian Roth, Ivar Vermeulen, Peter Vorderer, and Christoph Klimmt. Exploring replay value: shifts and continuities in user experiences between first and second exposure to an interactive story. *Cyberpsychology, Behavior, and Social Networking*, 15(7):378–381, 2012.
- [32] Jere O'Neill Surber. Freedom as 'meaningful choice': Philosophical lessons from computer gameplay. In *The Philosophy of Computer Games Conference*, 2014.
- [33] Lasse Weissenberg Thygesen. Replayability: A structural approach to players and computer games. *Master's Thesis, Aalborg University*, 2014.
- [34] Nicola Whitton. Alternate reality games for orientation, socialisation and induction (argosi), 2009.
- [35] Yu Zhonggen. A meta-analysis of use of serious games in education over a decade. *International Journal of Computer Games Technology*, 2019, 2019.