The Integration of Safety in Primary Education using Storytelling

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ABSTRACT: Safety is a fundamental concept that could have major consequences that will be discussed in many technical and social situations. The focus of this research is to include safety as an integral part of the curriculum of primary school. The Safety Cube Method will be seen as the basic and describes the importance of the three principle domains and their interactions. This paper, it is investigated how the best way of implementing storytelling is to reach a fun learning experience.

Key words: Safety, Safety Cube Method, Education, Primary school, Education, Storytelling

1 INTRODUCTION

In the current world are diverse examples where safety is under discussion. Think about the AZ stadium that partly collapsed due to a construction error in 2019 [1]. Or the stint accident in 2018. The brakes failed which was causing the death of four children [2]. In these situations is the focus on the safety of the system itself. Important to realize is that not only the system that plays a role in safety. The human and the environment should be taken into account to determine if the product is safe or not [3].
The best way to combat safety risks is to prevent them. To deal with those risks a thorough understanding of the hazards and possible issues is necessary to control them better [3]. Even though there is an approach that can be used it is not yet understood and integrated into the system. Dr. Mohammad Rejabali Nejad developed a suitable approach for the safety assessment system. This is represented by the Safety Cube.
The safety Cube Method (SCM) integrates different aspects into system architecture and provides more insight into the different dimensions of safety. Safe integration starts with the combination of the three principal domains, which are the social, technical, environmental, and their interactions according to the Safety Cube Theory. This results in a total of six aspects, see Figure 1. Proper integration demands attention to these domains and the interaction among them [3].
That humans must understand the different aspects of safety is clear. The human brain is learning by the formation of new, strong, and extensive neural networks or brain cells that connect. Several brain cells (neurons) make contact together and transmit a signal to each other. the brain cells connect, and a neural pathway is formed. When this pattern of connecting brain cells is repeated many times, something changed in the connection of those brain cells [4].

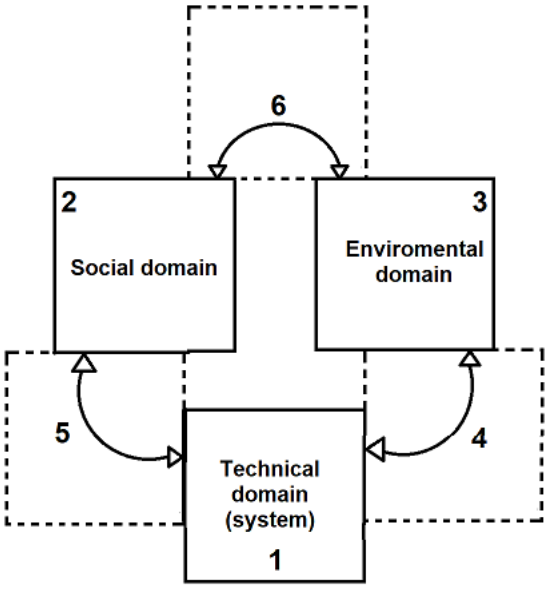

Fig. 1: Social, technical, and environmental domains and their interactions [3]

This in combination with the decision of the Dutch government that the primary school needs to provide lessons on science and technology [5], due to a shortage of technicians.
The focus of this research will be on children aged 10-12. This means that there is an environment where formal learning is a big part of life. Formal learning is defined as structured learning that typically takes place in classroom-based formal educational settings [6]. This is an ideal climate for continuously learn-

ing. There are three different kinds of learning strategies. Adaptive learning is reacting to a change in the environment. Generative learning is generating new knowledge and conditions. Transformative learning is creating and applying frame-breaking ideas and bringing about radically new conditions [7].
After conducting a literature review about the different dimensions of safety, how the brain works, the psychology, and how stories can be a way of communication. It is decided that the concept of storytelling will be used to create a positive learning experience. Storytelling can be defined as an art, whereby the process of using fact and narrative to communicate something to your audience. The story can be told in any way as long as it can explain the core message. According to the Safety Cube Method, there are six different dimensions of safety with each of their challenges. Therefore, will each domain be seen as the core message of that story.
For a great story, the success formula should be followed. This describes that in a story the hero only can solve his problem with his fifth plan. To do this, eighth story steps have to be taken into account while writing a story. These eighth steps are listed below [8] Step 1: The main character is missing something because his life is a second choice. At the end of the introduction, he has to face the problem.
Step 2: The main character thinks about the problem. In the end, he has to solve the problem and the dilemma starts.
Step 3: The main character comes up with an obvious plan to solve the problem. This plan Failed.
Step 4: The main character comes up with an extreme plan to solve the problem. This plan also failed, because everything turns out to be different.
Step 5: The main character re-evaluates his life and concluded that he has to make it better.
Step 6: Plan 3 fails due to fear which causes the main character to lose everything. He realizes his fear and chooses a better life. Come up with plan 4.
Step 7: Plan 4 almost succeeds. The benefit is that he now gets an idea of how to solve the problem.
Step 8: Plan 5 succeed. The main character gets what he needs.

2 PROBLEM

Since our brain is an association machine and pattern seeker, in which we relate new information to existing knowledge or skills [4]. Is it for optimal learning progress important to learn our children about the different dimensions of safety so that they can build on the strong neural pathways in their brains when they are older. In combination with the fact that the Dutch government has determined that primary school needs to provide lessons on science and technology [5], safety is a logical part of this education curriculum. Therefore, the different dimensions of safety should be an integral part of the education curriculum for primary schools. The primary school provides children with basic knowledge of language and mathematics. In addition, it is the place where children get the chance to find out what they are interested in a playful manner. Therefore, the learning experience about the different dimensions of safety should be fun.
Taking this into consideration, it is decided that the focus will be on the following research question: *What is the best possible way to educate the different dimensions of safety through storytelling for 10 - 12 years old children?*

3 METHOD

To gain more insight into the different dimensions of safety, how the brain works, psychology, and how stories can be a way of communication, a literature review was conducted. This information is used to write six stories to teach children 10-12 about the different dimensions of safety in a fun way. After that, an experiment is conducted to test if the stories provided a fun learning experience.

3.1 Safety Cube Method

In this section, the six fundamental domains of the SCM will be discussed for a better understanding of the concepts. In Figure 2, a visual representation of the different principles can be found.

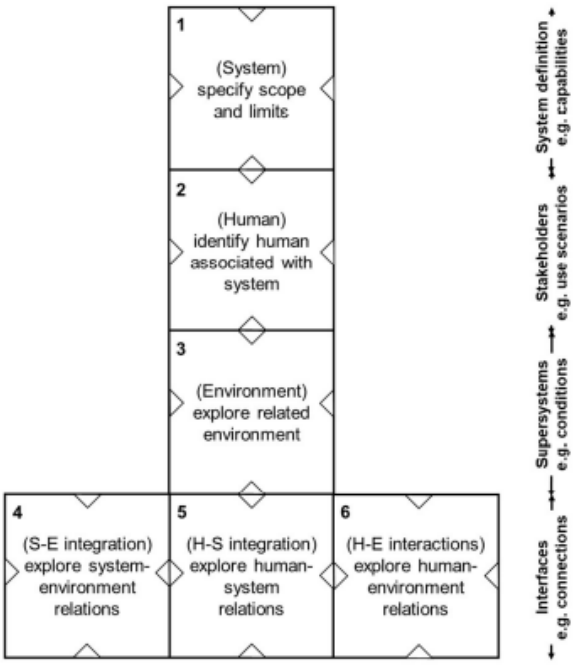

Fig. 2: The six views of Safety Cube [9]

3.1.a Technical domain

The technical field or system (S) is often the technical system of interest. The technical domain is a set of elements that interact according to a design, where an element can be another system, called a subsystem [3].

3.1.b Human domain

The social or human domain (H) includes stakeholders who have a direct or indirect interest in the system of interest. They may cooperate or compete with the system of interest. Humans interact with the system at different levels of the hierarchy and across different phases of a life cycle. There is interaction with the system at different levels of the hierarchy and across different phases of a life cycle [3].

3.1.c Environmental domain

The Environmental domain (E) includes the context or environment of technical systems. It consists of all of the relevant aspects that can influence or be influenced by the technical system in any life cycle phase [3].

3.1.d Socio-technical domain

The socio-technical domain (H-S) refers to the relationship between the human and the technical system. It can also include the relationship between the human and the supporting systems. Socio-technical interactions can have different kinds of relationships which may be physical, logical, or emotional [3].

3.1.e Techno-environmental domain

The technical-environmental domain (S-E) describes the relationship of the system with the environment, which may be in the physical or non-physical form. A technical installation leads often to a physical connection [3].

3.1.f Socio-environmental domain

The socio-environmental domain (H-E) falls mostly beyond the scope of the technical system in the design phase. However, it may have a dominant influence on the technical system. A change of regulations in a dynamic and competitive political context, interaction affecting the technical system. These relationships often become very complicated for systems in which multiple stakeholders are involved [3].

3.2 Human brain

Memory is a structurally and chemically changing neural network. These changes occur under the influence of the six brain principles illustrated in Figure 3. The first brain principle focuses on getting attention and directing this attention. The repeat brain principle is about the power of spaced repetition and practice to master and consolidate knowledge and skills. The building on brain principle is about activating relevant prior knowledge in advance and how reorganizing the knowledge afterward. Emotions are mechanisms aimed at the survival of us as a species. The brain principle creation is about thinking deeply and creating meanings for yourself. The last brain principle sensory is about using different senses and movements.

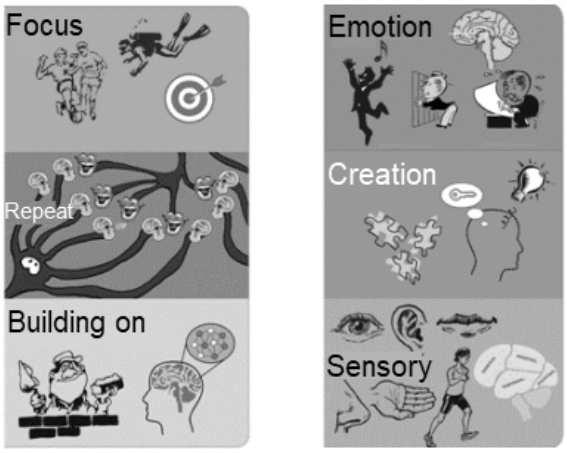

Fig. 3: The six brain principles [4]

3.3 *Psychology*

To create a better understanding of the influence that storytelling can have on the learning process two different learning theories should be discussed.
The theory of planned behavior (TPB) is a commonly used theory to predict and explain proximal influences on behavior [10]. In this context, the theory will be used to determine factors that can be influenced to make the concept of storytelling effective. There are three determinants of intention [11]. Firstly, attitude means whether the person evaluates the behavior as something beneficial or not, see Figure 4. Secondly, the subjective norm refers to the social pressure experienced to engage in behavior or not. Thirdly, perceived behavioral control indicates the perceived degree of ease or difficulty in executing the behavior. Intentions are an indicator of motivational components e.g. how hard people are willing to work. Therefore the stronger the intentions the more likely that they will adapt their behavior and make improvements. Additionally, the behavior is influenced by the perceived behavioral control which can change depending on the situation. If the person thinks a behavior is difficult to perform then with intentions alone there will be no change [11]. The theory of planned behavior in combination with the concept of storytelling could help to change their behavior by working on the attitude towards the behavior and the perceived subjective norms which in turn influence the intentions. Human is tempted to copy behavior they can reflect on. The story makes sure that the reader reflects on the desired behavior by letting the main character experience this behavior.
The experiential learning theory (ELT) states that we learn by transforming what happened in practice through reflection. This occurs in a cycle of four steps. the first step would be to take a concrete incident or operation. Second, based on the experience can be discussed and reflect on what was going on. The third step would be to formulate abstract guidelines and new insights out of these reflections. The last step would be to apply these guidelines and insights in practice and test their effectiveness. Based on the ELT, an effective learning method should build on four different learning abilities, namely 'concrete experience', 'reflective observation', 'abstract conceptualization' and 'active experimentation' [12].

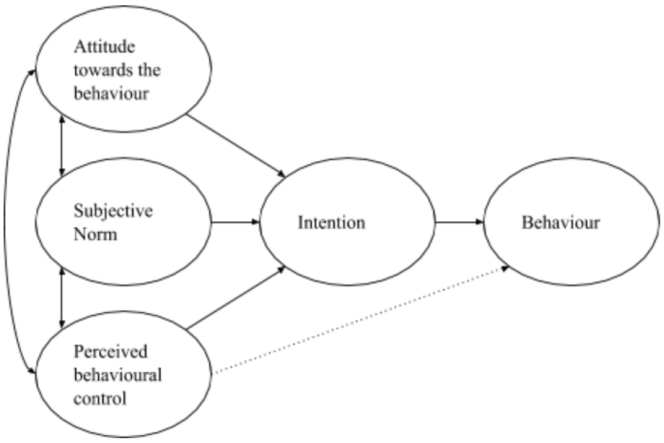

Fig. 4: Theory of planned behaviour [11]

3.4 *Storytelling*

To gain a better understanding of storytelling, this section will elaborate on Story and storytelling. There is a recognition that existence is inherently a story. The story is central to human understanding because, without a story, there is no identity [13].

3.4.a Shape of stories

Stories consist of simple shapes that can be visualized by using the graph in Figure 5. There is a good fortune (G) - Ill fortune (I) axis and the beginning (B) - Entropy (E) axis. The yellow line is the basic line and is repeated and repeated everywhere. it starts always being positive until someone gets into trouble and the line drops. Then the person gets out of trouble again so the line rises. Important by this part is that the line ends slightly higher than it started.

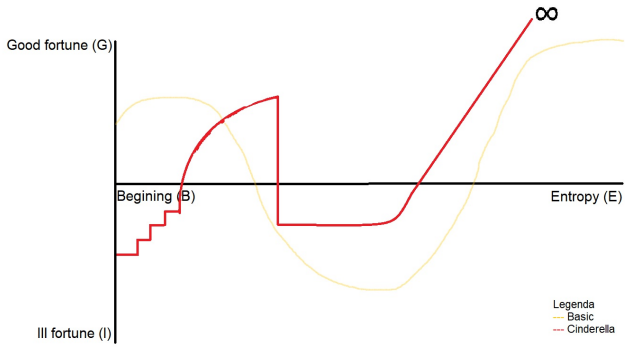

Fig. 5: Shape of Stories[14]

The red line is represented the fairy tale Cinderella. Cinderella's parents died and she have to live with her horrible stepmother and her two daughters. Then a party at the palace is announced and the fairy godmother helps Cinderella. She creates a carriage out of a pumpkin, Gives Cinderella a beautiful dress, and concludes with glass slippers. At the party the prince fell in love with her, but then the clock strikes midnight and everything is taken again, but she will remember this beautiful evening. Until the glass slipper fits and she becomes of scale happy [14].

4 EXPERIMENT

The knowledge from the literature research, as described in Section 3, is used to write six stories, see Fig 6. Each story represents a domain of the safety cube method. The stories can be read at: `https://safety.productions/?p=2110` [1]

A collaboration has been established with IKC De Tichelaar. They made sure that a test group was available with students from groups 7 and 8 of primary school at the two agreed moments. In the Netherlands, this is representative of the target group since these children are between the age of 10-12.

There were two moments to test the stories. At the first moment, 20 children were present. This was on a Friday afternoon just after the break. They have read the three stories: Formule 1, De Familie Eend, and Spaceshuttle 8. At the second moment, 33 children were present. Monday afternoon just after the break. They have read the three stories: TikTok, The HologramPhone, and Droom. During the two moments, different children participated in the research.

The session started with a short introduction by their teacher. At that moment, the children got the opportunity to ask some questions to the researcher. After this, it is ensured that the students know what to expect by telling the schedule and purpose. In addition, during this moment it was explained how the students had to fill in the questionnaire. Since the questionnaire was online. The children had to use the Chromebooks provided by the primary school.

The stories are randomly distributed across the classroom. After conducting reading one of the stories the students anonymously filled in a questionnaire via socrative.com. Socrative is normally used as a classroom app for fun, effective engagement, and on-the-fly assessments. It is ideal for engaging students as learning happens. Different activity types are available. For this research quick questions for instant feedback are designed beforehand and saved in a personal socrative account. It is possible to review student understanding at the class, individual students, or question-level. And, because each socrative report is saved it is possible to quickly download the results [15].

This was followed by a class discussion guided by the researcher, where the students first took a moment to think for themselves about what they had read, then shared it with the class. In this way, the children were reorganizing their knowledge after reading. This is a part of the brain principle building on.

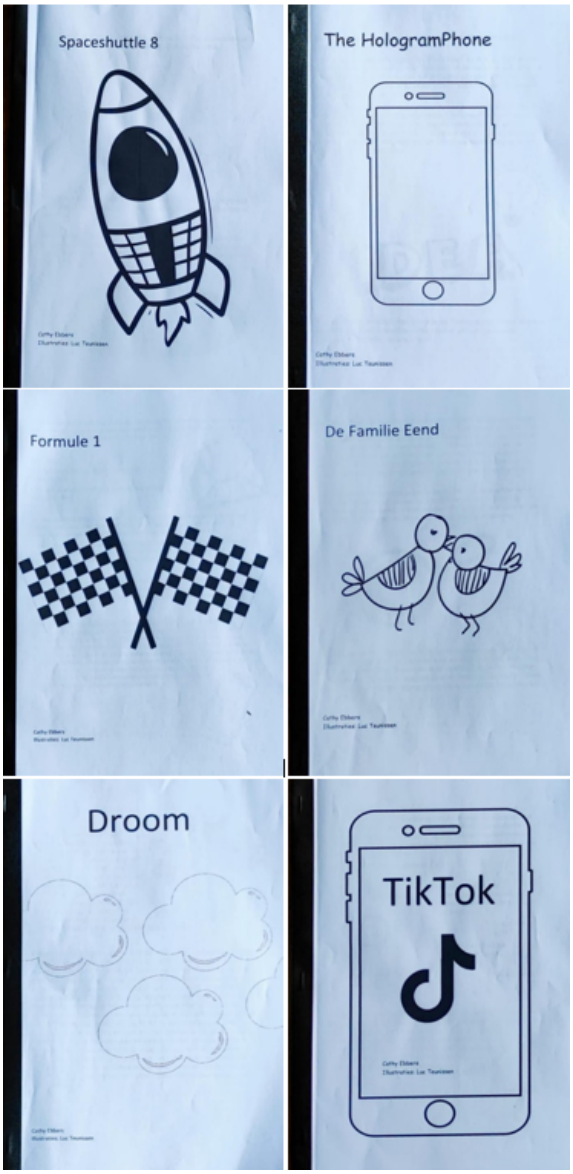

Fig. 6: The Six Stories with each representing another domain of the safety cube method

[1] `https://safety.productions/?p=2110`

5 RESULTS AND DISCUSSION

In this section, the results of the outcome of the test on the target group will be discussed. In Table 1, the results of the experiment can be found. These results are based on the answers that are given in the questionnaire. The first question was an open question to measure their understanding of the goal. In other words; What did the student learn in the context of the story about the domain that is central. This is followed by three multiple-choice questions where the students had to rate the story, the illustrations, and which gender. The gender question can give some mixed feelings, It also can provide insight into the interest differences between boys and girls. Therefore, the option: 'I'd rather not say' was included.

Most children liked the stories and illustrations. The children who rated the story positive indicated that they wanted to read the other stories as well. What was striking is that the stories Formula 1 and Spaceshuttle 8 were generally appreciated more by boys than girls.

The reading time of the stories was between 5 and 8 minutes which was doable for the children. Some thought the stories were boring and they suggested deleting some details to make the stories shorter. The students indicated that they found it a nice experience that they were allowed to participate in the research.

Table 1: The results of the questionnaire completed by the test audience

Story	Domain	participants	Understood (%)
Formule 1	S	7	71,4
TikTok	H	13	84,6
De Familie Eend	E	7	85,7
Spaceshuttle 8	S-E	6	66.7
The HologramPhone	H-S	10	100
Droom	H-E	10	90

During the research, it emerged that the stories are provided with font and size that is suitable for the target group. This is also determined in consultation with a teacher of group 7/8. In addition, according to the students, the stories were at the right level. Before reading, the stories were too long according to the students, but they indicated after reading that it was not that bad. The reading time of 5 to 8 minutes for the stories is therefore suitable for the target group.

The illustrations accompanying the story are seen as an addition by the students. It made the story more fun and in some cases, it was also a clarification. For example, in the story of the Space Shuttle 8, the illustration gave a better idea of what the story was about. The illustrations are in black and white, some students indicated that the stories would be extra entertainment if the illustrations were in color. According to the brain principle sensory. It is important to engage multiple senses. At such a moment many neural networks in multiple lobes are active at the same time. The more senses are used during learning, the easier it is to access what has been learned later. An extensive neural network is formed [4]. This could explain why students indicate this, but smell and feel illustrations could also be used for the use of even more senses.

In table 1, it can be seen that most of the students understood what the story was about after reading and were able to extract the most important message from it. During the discussion, the students also showed that they could reflect on it. This can also be explained by the fact that the students indicated that the stories were fun to read and that the topics were interesting. This ensures that the focus of the student is greater which is one of the brain principles. Focused attention is very important when acquiring new knowledge and learning skills [4]. As a result, the students followed the first steps or TBP. The students were able to indicate whether the situation was positive or not. In addition, it was clear that there was social pressure in the classroom to form an opinion that stimulated positive behavior.

The students have all read and rated a story. In the class discussion, it was first made sure that everyone was aware of the different storylines. During this discussion, it emerged that the students did not see the connection between the different stories. For them, each story had its problem that had to be solved. They did not understand that every story was about some form of safety. The stories were therefore made up of different characters and subjects. The storylines had nothing to do with each other. What was striking was that the students were unable to get to the core of the story. Also labeled the story not fun. Students who appreciated the story also understood it better.

In addition, some students indicated that the story was boring and suggested that some details be removed. Some details also had no added value to understand-

ing the story. In addition, many details added nothing to the ultimate goal of the story.
Initially, the current stories can be improved by critically reviewing the details of the stories. The two questions: Do these details matter to the story? and Do these details add to the ultimate goal? Based on this, the stories can be adapted to create a situation in which the student achieves a higher learning efficiency.
To reach more students, you can choose to write more stories about one domain. These stories can then all have a different storyline. There is a greater chance that there will be a story for every student that they like. The research has shown that if the students like the story, they learn more from it. In addition, multiple stories can have a positive effect on the learning effects of students. As described under 3.2.a new, strong, and comprehensive neural network or brain cells are formed for learning. When this pattern of connecting brain cells is repeated many times, something changes in the connection of those brain cells. All kinds of changes occur that make this contact easier: the signals between the brain cells can be passed on more efficiently and the connections between the brain cells become stronger.

6 CONCLUSION

It can be concluded that the student's interest in the story affects the learning curve. Children who enjoy reading the story are better able to explain and reflect on what the story is about. The more the student can recognize himself in the story, the better the TBP works. After reading one story, the children are unable to attach the problem to more general terms. In addition, they can not link the different domains that can be found in the stories based on these stories.
Currently, the stories have been updated based on the feedback obtained during the research. Details that do not add value to the story or the end goal, can be removed or modified to promote a better learning process. For the most ideal situation, the stories should now be tested again to see if the stories have improved as expected.
In addition, more short stories can be written with different topics that represent the six domains. This increases the chance that there is a story that the student likes, which positively influences the learning process [4]. In addition, the brain principle repeat brain describes that repetition and practice are crucial to forming and strengthening a neutral path. So when more stories are read with the same theme. The brain is triggered to make stronger connections. What then lays a stronger foundation for learning about safety in the future.
At the moment it is still a problem that the children are not able to recognize the overlapping theme of the different stories. It is expected that this can be improved by linking the stories themselves more clearly. This could be created by using the same characters in every story. another option is to make a collection of short stories. The effectiveness of this could be further investigated in the future.
The research has now focused on the six principles of safety. It is beneficial for future technicians if they already understand how safety can be integrated during the design process. Therefore, it could be investigated how safety by design could be integrated into the curriculum of primary schools.
Research has now been conducted on implementing safety as part of the curriculum in primary schools. Here the learning experience must be mainly fun. To create an ideal learning situation where there is a lot of repetition. Everything that happens more often or is important enough is preferably automated. This costs less energy and that is a good thing because we only have a small capacity for conscious attention. In addition, in this way, you build on existing knowledge, experience, and thought patterns [4]. Therefore, it is also possible to investigate how safety can be included in the curriculum for other target groups. The focus is now on the oldest pupils of a primary school. It would have a positive influence on the learning process if safety is also seen as a learning element for the youngest children in primary school. Perhaps even more important is that in the future safety in secondary schools will also be integrated into the curriculum. To complete the circle, it is still possible to investigate how students from mbo, HBO, and university can learn about safety. Al these target groups are used to formal learning, which is a form of structured learning that typically takes place in classroom-based formal educational settings [6]. Therefore, it could be possible to compare the results.
For the students from mbo, HBO, and university it could be interesting to dive into ELT. This theory could be implemented by an interactive story. There is a certain beginning and from there the students get choices, based on the choices made a personal story is

created with a certain outcome.

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