Master thesis

Adapting the Engagement Level of the Growing Greener Card Game to Stimulate Climate-Friendly Behaviour for Elementary School Students

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Abstract

Serious games have the ability to foster climate-friendly behaviour. However, for them to do so these games need to be engaging. The level of engagement within a serious game can be increased by stimulating active participation. Active participation can be increased by, for example, giving people responsibility for a task, letting them explain their actions, and using problem-based learning or content creation. Little investigation has been done on the engagement level of elementary school students for the serious climate change game developed by Growing Greener. Therefore, this study investigated whether engagement could be increased by adding active participation through a self-developed card within the children's version of the Growing Greener card game, targeted at elementary school students, ages eight to twelve. The results were analysed through a quasi-experimental design, using a control group playing the regular card game, and an experimental group playing the game including the additional self-developed card. Thirty-one elementary school students of either grades six, seven, or eight participated. Analyses were made on the basis of three questionnaires. Results showed that there was no significant effect on the level of engagement due to the additional self-developed card. Next, no significant increase was found in game engagement between the conditions, and no correlation was found between game engagement and the execution of climate actions. The difference between the conditions in the execution of the climate actions was limited. Moreover, the experimental group did not execute their self-developed card more often than the card they choose from the original deck. These findings could be explained by, for example, a lack of game-like elements within the game, external factors like parental attitude and student cognition, and a lack of time to finish the self-developed card. Even though this study showed no enhanced engagement through the self-developed card, it contributed to the knowledge on the effectiveness of the Growing Greener card game for elementary school students.

Problem Statement

Climate change is a topic that impacts all of our lives. It is seen on the news, in the papers, and on television. The Intergovernmental Panel on Climate Change (IPCC, 2022) documented the visible effects of climate change and its life-threatening consequences such as extreme types of weather, droughts, fires, the rising ocean level, and its shift in pH levels worldwide. Next, they found a moderate increase in the spread of infectious diseases, hunger and a significant increase in mental health problems due to climate change.

Humans play a big part in the cause of climate change due to our extreme emission of CO_2 (National Research Council, 2012). Humans are able to decrease climate change by changing their consumer behaviour (National Research Council, 2012; Swim et al., 2011). Interventions on climate change can contribute to changing this consumer behaviour (Burke et al., 2018). However, behavioural change is unlikely to occur when participants are not engaged with climate change (Burke et al., 2018). A good starting point for increasing climate change engagement is through education (Ouariachi et al., 2018), as education is a way to create awareness and distribute knowledge on climate change into the world (IPCC, 2022; Monroe et al., 2019). Providing education on climate change can increase knowledge on the subject and reduce misconceptions (Whitmarsh et al., 2013). However, climate change can be difficult to teach, as especially young children are unfamiliar with the science behind the topic and because of the different misconceptions students can have (Monroe et al., 2017). Serious games can provide a good and easy way to implement the topic of climate change in education (Darwesh, 2016; Douglas & Brauer, 2021; Mazur-Stommen & Farley, 2016). Next to this, games can potentially change behaviour (Morganti et al., 2017). However, not all games are effective in doing so (Cojocariu & Boghian, 2014; Dele-Ajayi et al., 2016), as some games have low levels of game engagement (Burke et al., 2018). When a climate change game has low levels of game engagement, this leads to less engagement with climate

change itself (Ouariachi et al., 2018), which is needed to prompt behavioural change (Burke et al., 2018). Ouariachi et al. (2018) hypothesise that games that are engaging themselves lead to more engagement with climate change after playing, and have thus the potential to lead to behavioural change. The effectiveness of a game can therefore be increased by making sure the game has a high level of game engagement (Dele-Ajayi et al., 2016; de Freitas & Jarvis, 2006).

Therefore, this study aims at determining and increasing the level of game and climate change engagement of the climate change card game developed by Growing Greener, leading to a game that is possibly more effective in increasing behavioural change toward a sustainable way of living. Since a good starting point for increasing climate change engagement is through education and limited research was found on this topic among elementary school students, the focus in this study will be on students ages eight up to twelve.

Theoretical Framework

Nowadays, games are not only used for entertainment purposes but are also applied in education. Games that are specifically designed for education are called serious games (Ma et al., 2011). The main difference between serious games and regular games is that serious games do not have entertainment as their main purpose (Cojocariu & Boghian, 2014; Susi et al., 2017) but have the purpose of providing information (Wu & Lee, 2015). This ensures that serious games always include a teaching goal (Darwesh, 2016; Susi et al., 2007; Wu & Lee, 2015). Next to this, for something to qualify as a serious game, it should include rules (Georgieva-Tsaneva & Serbezova, 2021; Susi et al., 2007), competitive elements (Cojocariu & Boghian, 2014; Susi et al., 2007), strategic components, interactivity (Darwesh, 2016), and a scale to compare players or individual progress (Darwesh, 2016; Mazur-Stommen & Farley, 2016).

Serious climate change games are a sub-category in the field of serious games. These games illustrate the role humanity plays in climate change (Douglas & Brauer, 2021; Wu & Lee, 2015). Some of these climate change games increase climate-friendly behaviour, like recycling or reducing electric use (Li et al., 2019), in higher amounts than others and are thus more effective (Douglas & Brauer, 2021). A way to increase the effectiveness of a serious game, is by increasing its level of game engagement (Biercewicz et al., 2020; de Freitas & Jarvis, 2006), as this can increase climate change engagement (Ouariachi et al., 2018). This, in turn, can lead to more adaptive behaviour (Ouariachi et al., 2018).

Engagement

When looking at the definition of engagement itself, someone is considered engaged when focused on, captivated by, and attentive to what they are doing (Axelson & Flick, 2010). Engagement consists of three constructs; cognitive, behavioural, and emotional engagement (Axelson & Flick, 2010; Witkowski & Cornell, 2015). Cognitive engagement consists of the willingness to put time and energy into learning using necessary and appropriate strategies (Blumenfeld et al., 2006). This can be measured by testing students' knowledge (Alias et al., 2021). Behavioural engagement are all observable things done by a student, that are connected to showing involvement (Hart et al., 2011). Emotional engagement is the emotional connection a student has to their surroundings and other people (Hart et al., 2011), and underlying feelings, like believing in oneself, motivation, and passion for the work someone is doing (Alias et al., 2021).

Climate change engagement consists of the same three constructs as regular engagement but related to climate change (Whitmarsh et al., 2013). Whitmarsh et al. (2013) describe cognitive climate change engagement as thoughts related to climate change,

behavioural engagement as the actions someone takes to reduce climate change and emotional engagement as feelings someone has related to the topic of climate change.

The constructs of cognitive, behavioural, and emotional engagement are supported by four underlying attributes; *absorption*, *flow*, *presence* and *immersion*. These four attributes have the ability to operationalize the concept of engagement, especially in the field of serious games (Hookham & Nesbitt, 2019). When people are *absorbed* in a game, they are completely disconnected from the real world and fully immersed in the game (Funk et al., 2003). *Flow* can be defined as a state of mind when someone is drawn into an activity and has no concern for other things happening in their surroundings (Agrewal et al., 2020). *Presence* is defined as the experience of being transported into the environment of the game (Agrewal et al., 2020). *Immersion* is a combination of the concepts of flow, presence (Agrewal et al., 2020), and absorption (Funk et al., 2003; Nilsson et al., 2016). It is defined as being captivated by the game and it results in getting disconnected from the real surrounding, being absorbed by the game, and losing all feeling of time (Bouvier et al., 2014).

Engagement has many benefits for learning, for example, increased student performance, increased on-task behaviour (Hart et al., 2011; Tincani et al., 2016), students give more correct answers and are more connected to the assignment (Tincani et al., 2016).

Active Participation

As the intent of this study is to increase engagement, it is important to know what increases engagement and how this increase can be stimulated. As mentioned by Evans et al. (2015 as cited in Macfarlane & Tomlinson, 2017), a way to increase engagement is through active participation. Participation by itself can be defined as the physical attendance of a student in a class (Peterson, 2001). However, just attending class and passively absorbing knowledge is not the most effective way of learning (Chi & Wylie, 2014; Peterson, 2001), and

is not enough to be engaged (Seo et al., 2021). That is because someone can be doing something as a routine. Even though someone is performing behaviour that seems engaged this does not mean someone is learning (Seo et al., 2021). When students actively participate by investigating information in different ways, being involved in conversations, and having good collaboration (Peterson, 2001), they become engaged (Parsons et al., 2014).

An effective serious game uses active participation (Anolli et al., 2010; Pappa & Pannese, 2010) as this has the potential to increase the learning outcome (Anolli et al., 2010), and thus increases the quality of a serious game (Cojocariu & Boghian, 2014; Nousiainen, 2009; Yusoff, 2010). Active participation contributes to higher amounts of learning (Deslauriers et al., 2019), making a game more meaningful (Pappa & Pannese, 2010). This is because active participation contributes to an increase in the understanding of the learning material (Deslauriers et al., 2019; St. Onge & Eitel, 2017), increased learning outcome (Deslauriers et al., 2019; Witkowski & Cornell, 2015), and increased student involvement (Deslauriers et al., 2019).

Thus, to make a serious game more engaging, a good first step is to increasing the level of active participation. There are several ways to do so. For example, in regular classes, this is often achieved by making students responsible for their own part of an assignment (Witkowski & Cornell, 2015). Also, when students have to explain further what they did on their part, they are stimulated to participate more actively (Witkowski & Cornell, 2015). Next to this, incorporating problem-based learning can indirectly increase students' motivation and engagement and make students active participants in the learning process (Chang, 2017). Additionally, Nousiainen (2009) mentions that involving students in content creation can stimulate active participation. Lastly, when working in groups, the active participation of group members can positively impact the level of participation of others (Deslauriers et al., 2019).

Current study

The theoretical framework leads to the conclusion that the level of active participation has the capacity to increase game engagement. Game engagement within climate change card games has the ability to increase climate change engagement and its underlying attributes; absorption, flow, presence, and immersion. Increasing this climate change engagement potentially leads to a game that is more effective in increasing behavioural change towards more climate-friendly behaviour than the original game. This information was used to adapt the children's version of the Growing Greener climate change card game to increase its level of engagement, by incorporating active participation through content creation (Nousiainen, 2009), problem-solving (Chang, 2017) and giving students responsibility for an individual part of the task (Witkowski & Cornell, 2015). These three stimulators of active participation were combined into an additional activity that was added to the Growing Greener card game, used in the experimental group. The added activity entailed students developing their own climate change action card before playing the game and incorporating it into the original deck.

To investigate whether the addition of a self-developed card had an impact on the effectiveness of the Growing Greener card game, the following research question was proposed: *To what extent did the addition of a self-developed action card affect the level of climate change engagement of elementary school students?*

Hypotheses

This research question was answered by testing several hypotheses. First, a baseline measure for climate change engagement was needed. The level of climate change engagement was measured before and after the intervention. Through the comparison of the pre- and post-test scores, it was measured whether or not the game increased students' engagement with

climate change. It was expected that both groups would increase their climate change engagement due to the game. However, the increase for the experimental group was expected to be larger. This led to the first two hypotheses:

Hypothesis 1: Elementary school students showed an increase in their level of engagement with the topic of climate change after playing the climate change card game.

Hypothesis 2: Elementary school students in the experimental group, who developed their own action card, showed a larger increase in engagement with the topic of climate change after playing the climate change card game compared to the control group.

The level of game engagement was measured by using the underlying attributes absorption, flow, presence, and immersion as variables, as these attributes made the concept of engagement easier to measure (Hookham & Nesbitt, 2019). As the Game Engagement Questionnaire (GEQ) was the only questionnaire found on game engagement, and considered these attributes, this questionnaire was used. The experimental group was expected to have higher levels of game engagement due to the addition of active participation. This led to the third hypothesis:

Hypothesis 3: Elementary school students that played the climate change card game in the experimental condition including the self-developed card were more engaged with the game and had higher levels of absorption, flow, presence, and immersion than students who played the game as intended in the control condition.

Through a follow-up questionnaire (see Appendix A), three weeks after the intervention, it was measured whether behavioural change occurred. This questionnaire gathered information on whether or not students executed their action cards and the number of times they did so. It was expected that the experimental group would execute their chosen action cards more often than the control group. Next to this, they were expected to execute their self-developed card more often than the card they chose from the original deck.

Additionally, a comparison was made between the level of engagement with the game and the actual execution of the climate action. By doing so, it was measured if engagement was related to, and had an impact on the execution of the climate actions. This led to the last three hypotheses:

Hypothesis 4: Three weeks after playing the climate change card game, a larger amount of elementary school students of the experimental group executed their chosen action cards, and did this more frequently than the control group.

Hypothesis 5: Elementary school students who had higher levels of game engagement, during the game, executed their chosen action cards more frequently in the three weeks after the intervention.

Hypothesis 6: Three weeks after playing the climate change card game, elementary school students of the experimental group executed the self-developed action card more often the chosen action card of the original deck.

Method

Participants

Before the start of this study, the research plan was approved by the BMS Ethics Committee of the University of Twente. In total, 173 students from eight different classrooms of three elementary schools in the Netherlands, gathered through convenience sampling, participated in this study. The parents of 34 students gave informed consent to use the data of their child for the purpose of this study. This informed consent was obtained using a written form. Due to missing data, three of the students with informed consent were excluded from this study, resulting in a total of 31 students (12 female, 17 male, 2 other). The age of the students ranged from 8 to 12 (M = 10.29, SD = 1.04). Students were either from grade six (9 students), seven (9 students), or eight (13 students). All students were randomly assigned to

either the control group or the experimental group by splitting the classes in half resulting in a control group consisting of 17 students (7 female, 10 male) with an age ranging from 8 to 12 (*M* age = 10.29, *SD* = 1.04). The experimental group consisted of 14 students (4 female, 8 male, 2 other) with an age ranging from 9 to 11 (*M* = 10.29, *SD* = 1.04).

Materials

The Climate Change Card Game

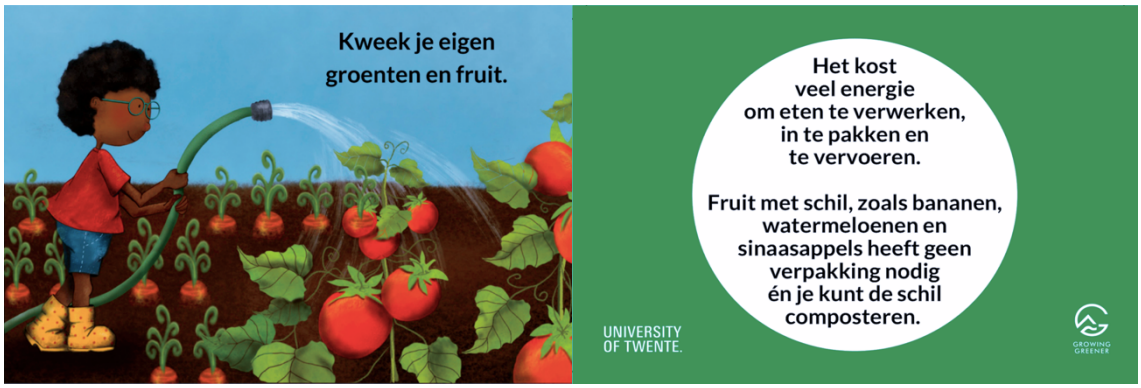
The original Growing Greener climate change card game (Growing Greener, 2023a) is developed for adults. More recently, a children deck was developed (Growing Greener, 2023b), of which the adapted and in Dutch translated version is used in this study (see Figure 1). The adapted version of the game consists of 26 cards (see Appendix B). Each card contains a drawing of a climate change action on the front, stating, for example, “Walking to places instead of riding in a car”, “Using public transportation”, or “Using LED light bulbs”. The cards contain additional information on the back, for example for the card, “Use public transportation”, the back said, “Using buses and trains means fewer cars, less traffic, and much less air pollution”. Every deck includes three separate category cards stating: “I already do this”, “I could do this”, and “I cannot do this”. These cards are used to split the action cards into piles of how they apply to the player in their day-to-day life. All action cards of the children deck are translated from English into Dutch. In addition, two cards are adapted to a more Dutch culturally appropriate statement (e.g. “Going to school by using the school bus” is replaced by “Cycle to places nearby").

The Growing Greener card game belongs to the category of card a board games (Wu and Lee, 2015). This type of games is often low time-consuming and played in small groups. These games are mostly easy to produce and low in manufacturing costs but difficult to play in larger group settings. However, when looking more closely at the card game and

comparing it to the five criteria for serious games as mentioned before (by Cojocariu & Boghian, 2014; Darwesh, 2016; Georgieva-Tsaneva & Serbezova, 2021; Mazur-Stommen & Farley, 2016; Susi et al., 2007), the Growing Greener card game only includes the criteria rules and interactivity. Even though the game does not include all criteria to be considered a serious game, for this study, it is considered as such.

Figure 1

Front and Back of a Translated Card from the Growing Greener Children Deck



The rules of the game. The goal of the Growing Greener card game is to make players aware of their contribution to climate change and how to reduce their impact on the climate. The game is played in small groups of two to four players. Every player receives their own deck, containing the same action cards, in the same order. The game starts by the players taking the first action card from their deck, reading it (out loud), and discussing whether or not they already do this action, are willing to implement it in their lives, or are not willing or able to do so. After discussing the card, they place it on top of either of the three category cards, fitting to their personal choice. For example, if a player already closes the door whenever they leave a room, they put the action card in the “I already do this” pile. Another player would like to start doing this, and puts it in the “I could do this” pile. A third player is unwilling to do so, and puts it in the “I cannot do this” pile.

The Worksheet

Growing Greener developed a worksheet to assist students in implementing actions from the card game into their day-to-day life (see Appendix C). Before filling out the worksheet, students had to choose two cards from their individual pile of things they would like to do. Based on these two cards, they filled out the worksheet. The experimental group was obligated to choose their self-developed card and a card from the original deck. The control group could pick any two cards from original deck. The worksheet provided guiding questions like, whom the students would tell about their actions, when they would start executing the action, and what the consequences would be when they did not execute it.

The Intervention

The intervention consisted of three parts: (1) an introduction and workshop connected to climate change, (2) playing the card game, and (3) filling out the worksheet and reflecting on the whole intervention.

The intervention was guided by a PowerPoint presentation (see Appendix D). The intervention started with an introduction of the researcher, a video, and a discussion on climate change followed by a workshop. In this workshop, students were asked to imagine a place they love, this place after a natural hazard that led to a disaster, and the same place in fifty years. Students were asked to draw the place in all three situations in one minute. After the minute of drawing, students were asked to reflect on their drawing.

After a short explanation, the students of the control group started playing the climate change card game, where the experimental group received a blank action card. They were asked to draw something they thought would be beneficial in reducing climate change, as an additional card to the climate change action deck. Students were completely free in what they wanted to draw. Next to this, they could view some examples of the original deck so they had

some idea of what a climate change action card should look like. The students were asked to only make a front card, as they did not have to support what effect their action had on climate change (examples of self-developed cards can be found in Appendix E). After the experimental group finished drawing their card, they were instructed to put their self-developed card into the original deck and play the game as intended. When all students finished the card game, they were asked to fill out the worksheet. The intervention was concluded by a plenary discussion on what cards the students put in which of the three categories.

The Climate Change Engagement Questionnaire

In this study the climate change engagement questionnaire (see questions 9 – 14 in the pre-test, see Appendix F, and questions 6 – 11 in the post-test, see Appendix G), developed by Morrison et al. (2019) was used, as its aim was closely linked to this study. The questionnaire aimed at measuring the level of engagement with climate change. It was originally developed for measuring engagement in educational activities related to climate change that differed from regular lectures on this topic. The goal of Morrison et al. (2019) was to examine whether adding active learning in education, which contribute to active participation (Matsushita, 2021; Peterson, 2001), would increase the level of engagement with climate change.

The climate change engagement questionnaire focused on students' knowledge of and feelings toward (the effects of) climate change. The questionnaire, as used in this study, consisted of six items. It included items like "Are you interested in the topic of climate change?" and "Are you worried about climate change?" (Morrison et al., 2019, p. 22). All items were answered on a three-point scale (i.e., *Yes, Somewhat, No*). Due to the phrasing of the items, these three answer options were slightly adapted for two items to make the answers fit them grammatically. For example, on the item "How well informed do you feel you are

about how the Earth's climate system works?" the answer options were adapted to; *Much, A little, Not much*. The questionnaire originally consisted of eight items. However, for this study, two items were excluded. The item "How sure are you that climate change is happening?" was excluded from the questionnaire due to the assumption that students participating in this study were sure climate change is happening. The item "How often do you talk to friends and family about climate change" was also excluded as the answer to this question was unable to change during the intervention, and did thus not provide any information on the effect of the intervention.

The reliability of the climate change engagement questionnaire was measured through the use of Cronbach's alpha. A value above 0.6 was considered reliable. The climate change engagement questionnaire was administered both in the pre- and post-test, and showed moderate reliability for the pre-test (see Appendix F) (6 items; $\alpha = 0.639$) and acceptable reliability for the post-test (see Appendix G) (6 items; $\alpha = 0.757$).

The Game Engagement Questionnaire

The GEQ (Game Engagement Questionnaire; all statements presented after question 11 in the post-test, see Appendix G) aimed to measure the level of engagement experienced within a game (Brockmyer et al., 2009). The GEQ was the only questionnaire found that measured engagement within games. However, the GEQ was focused on regular games instead of serious games.

Originally the questionnaire consisted of 19 items divided into the four attributes of engagement, including five items on absorption, nine on flow, four on presence, and one on immersion. For this study, the item "I feel scared", which was part of absorption, was excluded from the questionnaire because it was considered irrelevant for this game. Next to this, another item was rephrased from "I played longer than I meant to" to "I would have

wanted to play for a longer time" as students were unable to play for an unlimited amount of time during the intervention. All items were translated into Dutch and answered on a five-point scale (i.e., *Yes, A lot, Sort of, A little, No*).

The reliability of the GEQ was measured by Cronbach's alpha. The GEQ showed solid reliability (18 items; $\alpha = 0.886$).

The Follow-Up Test

The follow-up test (see Appendix A) aimed to retrieve quantitative information on how often students had executed their climate action. All items were developed by the researcher, as there was no questionnaire found that was developed to specifically target climate change actions performed due to a serious climate change game. In the construction of the items of the follow-up test, the fourth, fifth and sixth hypotheses were leading; these hypotheses were about the execution of the climate actions, the relation between the game engagement and the difference in execution of the self-developed and original action cards, respectively. As for this questionnaire no pilot test was conducted, no validity or reliability check could be performed.

The questionnaire consisted of thirteen items. Three items were open-ended questions on demographics (e.g. "What is your name?"). Four items focused on the specific climate action that was chosen (e.g. "Did you develop the climate change action card yourself?"), with two open-ended and two *yes/no* questions. Four items addressed the frequency of execution (e.g. "How often did you execute the climate change action card in the first week after the intervention?"), with two questions on a five-point scale (i.e. *the same day/1-2 days/3-4 days/5-6 days/more than a week*) and two on a six-point scale (i.e. *0 times/ 1-5 times/6-10 times/11-15 times/16-20 times/more than 21 times*). Finally, two items were

focused on enjoyment (e.g. “Did you enjoy executing the climate change action cards”) on a ten-point scale.

Procedure

The full procedure of the intervention consisted of three components, each executed on a separate day, with a total duration of 1 hour and 45 minutes. The first component consisted of the pre-test, which took about 15 minutes. The second component was the intervention itself, which took about 75 minutes, and lastly, the third component consisting of the follow-up questionnaire, which took about 15 minutes. The pre-, post-, and follow-up test were taken either on a digital device or on paper, dependent on the choice of the teacher.

Before the intervention started, students were asked to complete the pre-test to measure their general climate change engagement. The teachers of the class administered the test without the researcher's attendance. The questionnaire was conducted at a time convenient for the teacher, at least one day before the intervention.

The starting introduction and workshop, as part of the intervention, took approximately 25 minutes. Next, the class was divided into the control and experimental groups, by splitting the class into a left (control group) and a right side (experimental group). Subsequently, all students received an individual card game deck and started the game, playing in groups of two to four students. The control group started playing immediately. The experimental group had five minutes to make a self-developed card, included this card into their individual deck, and started the game either when they finished their self-developed card or when they exceeded the five minutes. It took the students approximately 20 minutes to play the game. When the students went through all the cards and thus finished the game, they filled out the action plan worksheet, which took about 5 minutes. Students who finished the worksheet early were asked to draw freely or finish their action cards by for example

colouring them in. After a small plenary discussion on the action cards students chose, they were asked to fill in the post-test.

Three weeks after the intervention, the teachers of the participating classes were asked to let the students fill out the follow-up questionnaire. The teachers were again free to choose a time and day which was convenient for them, as the researcher was not present when the test was administered.

Analysis

The Climate Change Engagement Questionnaire

The climate change engagement questionnaire was scored by assigning points to the given answers. The answer *yes* was given 3 points, *somewhat* 2 points, and *no* 1 point. Questions 10 and 13, in the pre-test, and questions 7 and 10, in the post-test, were reversed, so answering *yes* received 1 point and answering *no* 3 points. The sum scores were calculated by adding all individual points, resulting in a maximum score of 18 points and a minimum score of 6 points.

Hypotheses Testing. The first and second hypotheses could be tested using the climate change engagement questionnaire. For the first hypothesis, the increase in climate change engagement was determined by using a paired sample t-test, using the scores from the pre- and post-test as variables. The full dataset was used as the sample, as no distinction was made between the two conditions. Next, a within-group analysis was conducted to examine whether the control or experimental group independently showed a significant in- or decrease in their climate change engagement level. To do so, the conditions were analysed, using a paired sample t-test using the pre- and post-test as separate variables.

For the second hypothesis, to investigate if the experimental group increased their climate change engagement score significantly more than the control group, an independent

one-way ANOVA was used. The difference between the pre- and post-test was used as the dependent variable (depended list) and the two conditions as factors.

The Game Engagement Questionnaire

The GEQ was scored similarly to the climate change engagement questionnaire by assigning points to the given answers. All answers of *not at all* were scored 1 point, *almost never* 2 points, *sometimes* 3 points, *often* 4 points, and *all the time* 5 points. All scores were added up, resulting in a sum GEQ score ranging between 18 as the lowest and 90 as the highest.

Hypothesis Testing. For the third hypothesis, to determine whether the experimental group had a significantly higher game engagement than the control group, an independent-sample t-test was used. The overall GEQ scores were used as the dependent variables (test variable), and the two conditions as independent variables (group variable). Additionally, an analysis was made of the separate constructs, absorption, flow, presence and immersion, through an independent-sample t-test. The four individual constructs were analysed separately, using the sum score for the individual construct as the dependent variable (test variable) and the two conditions as the independent variable (group variable).

The Follow-Up Test

The follow-up questionnaire was analysed based on the number of times the students executed their climate actions per week, as indicated on the questionnaire. Additionally, students were divided into two categories, labelled *yes* and *no*. Students were categorised in the category *yes* if they executed either of their action cards at least once. Students were categorised in the category *no* if they executed neither of their action cards. This information was used for the fifth hypothesis.

Hypotheses Testing. The fourth, fifth, and sixth hypotheses were tested using the follow-up questionnaire. For the fourth hypothesis, to investigate whether the experimental group executed their action cards more often than the control group, a descriptive analysis was conducted. A descriptive analysis was chosen as the sample was relatively small.

For the fifth hypothesis, to test whether there was a correlation between game engagement and the execution of the climate change actions, a Spearman rank correlation was used. As variables the GEQ scores were used as indication for the game engagement, and the categorisations *yes* or *no* (dichotomous variable) indicating whether students executed any actions.

For the sixth hypothesis, to investigate whether the self-developed card would be executed more often by the experimental group than the card they picked from the original deck, a descriptive analysis was used, similar to hypothesis four.

Results

Differences in Climate Change Engagement Level

As an effective climate change game can increase climate change engagement, it was expected to see an increase in climate change engagement for all participating students. However, the results (see Table 1) showed no significant difference between the pre- and post-test scores for climate change engagement ($t(29) = 0.69$; $p = .495$). When looking at the individual groups, neither the experimental group ($t(13) = 0.55$; $p = .592$) nor the control group ($t(16) = 0.69$; $p = .495$) increased their climate change engagement scores significantly.

The addition of a self-developed card was expected to increase the level of engagement with the game and, indirectly thus, increase climate change engagement. Given this statement, it was investigated whether the experimental group increased their scores significantly more than the control group. However, the difference in the level of climate

change engagement of the two groups was insignificant ($F = 0.001$; $p = .979$). Both groups scored similarly on both the pre- and the post-test.

Table 1

Scores of the Climate Change Engagement Questionnaire

		Pre-test		Post-test		Difference	
	N	M	SD	M	SD	M	SD
Experimental group	14	12.31	1.80	12.00	2.48	-0.31	2.02
Control group	17	13.44	2.87	13.11	3.41	-0.33	3.01

Note. The mean (M) ranged between 6 and 18, where 6 corresponds to low engagement, and 18 to high engagement with climate change. The last column shows the difference between the pre- and post-test.

Differences in Game Engagement, Absorption, Flow, Presence, and Immersion

High levels of game engagement were assumed to increase climate change engagement, which was why a high level of game engagement could contribute to a more effective game. Consequently, it was expected that students who played the game including the addition of a self-developed card would score higher on game engagement (i.e., GEQ). However, no significant difference between the two groups (see Table 2) in their overall GEQ score ($t(28) = 0.40$; $p = .693$) was found. When looking at the separate underlying constructs (i.e., absorption, flow, presence, and immersion), neither the scores for absorption ($t(28) = 0.38$; $p = .711$), flow ($t(28) = 0.33$; $p = .741$), presence ($t(28) = 0.41$; $p = .683$), nor immersion ($t(28) = 0.79$; $p = .437$) were found to be significantly different.

Table 2

Scores of the Game Engagement Questionnaire

		Overall		Absorption		Flow		Presence		Immersion	
	N	M	SD	M	SD	M	SD	M	SD	M	SD
Experimental group	13	1.92	0.73	1.50	0.61	1.97	0.79	2.06	1.17	2.31	1.65
Control group	16	2.05	0.92	1.59	0.71	2.08	0.94	2.25	1.30	2.81	1.76

Note. The mean (M) scores varied between one and five, one meaning not engaged, and five meaning completely engaged with the game.

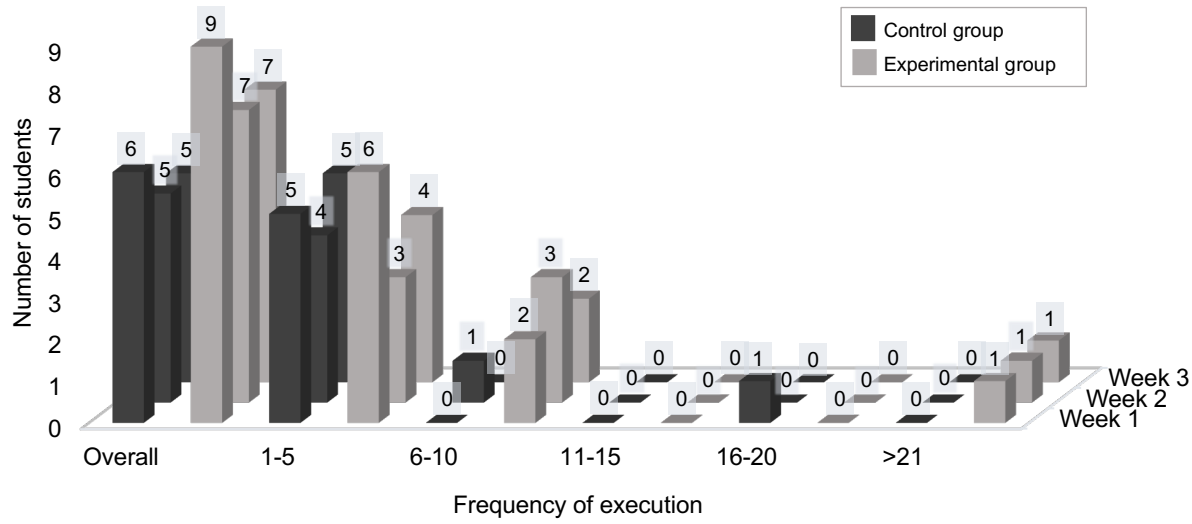
Differences in the Execution of Climate Actions

Next, it was hypothesised that the experimental group would execute their climate change actions more often than the control group and perform them at a higher frequency. Because of limited data, this analysis was presented descriptively. When looking at the data (see Figure 2), a small difference in the number of executions could be seen between the two groups. Throughout all three weeks after the intervention, the experimental group had a higher overall number of students executing their action cards compared to the control group. However, this difference was relatively small with a difference of three executions in the first week and two executions in the second and third week. Next to this, it was expected that the number of executions would decrease every week. In both groups, a decrease was visible between weeks one and two but did not continue into the third week. The decrease between weeks one and two was one person for the control group and two persons for the experimental group.

When looking at the frequency of the executions, the experimental group had a higher frequency of execution than the control group, especially for the frequency of 6 – 10 times per week. Students seemed to be more likely to execute their actions in low frequencies, as most students performed their actions either 1 – 5 times or 6 – 10 times per week.

Figure 2

Frequency of the Execution of the Action Cards over the Course of Three Weeks



Correlation Between Game Engagement and the Execution of the Action c=Cards

Next, it was expected there would be a positive correlation between the number of points scored on the GEQ, an indication for game engagement and whether students executed their chosen climate change actions. However, the Spearman rank correlation showed an insignificant correlation between these two variables ($N = 23$; $r = .15$; $p = .509$).

Differences in the Execution of the Self-Developed and Original Cards

It was also expected that the experimental group would be more likely to execute their self-developed card than the card they picked from the original deck, as they created this card themselves. In total, 12 students stated they executed either of their two cards (self-developed and/or original deck card). As these 12 students all picked two cards to execute, data was available for 24 cards (see Table 3), of which 12 were self-developed, and 12 were from the original deck. Some of the students could not remember the action that was on both or one of their cards, and whether the card was from the original deck or self-developed; thus, these students were excluded from the sample, resulting in a total of 17 cards. In total, six students stated they executed their self-develop action card, and three did not execute their self-developed action card. Of the cards picked from the original deck, five students executed this card, and three students did not. Relatively no difference could be seen between the execution of the self-developed card and the card chosen from the original deck.

Table 3

Difference in Execution of the Self-Developed and Original-Cards in the Experimental Group

		Executed	Not executed
	N	N	N
Self-developed	9	6	3
Deck card	8	5	3

Discussion

Studies showed that the effect of serious games on behavioural change depends on their level of engagement (Biercewicz et al., 2020; de Freitas & Jarvis, 2006; Ouariachi et al., 2018). This study aimed to assess the effect a self-developed card had on the level of engagement of students playing the Growing Greener children deck card game.

Differences in Climate Change Engagement Level

It was expected that the overall level of climate change engagement of all students would increase due to the card game, as engaging games have the ability to increase climate change engagement (Ouariachi et al., 2018). However, this study showed no significant effect for both the control and experimental condition on the engagement students had with climate change. Which was contrary to the findings of for example, Galeote et al. (2021) and Wu and Lee (2015) who state that usually games have the ability to increase climate change engagement. Geleote et al. (2021) mention three reasons a game could be less effective in increasing climate change engagement. First, if students are uninterested in the topic this could impact student's climate change engagement in a negative way. The interest in climate change of students participating in this study could have played a role in the lack of increase in climate change engagement, as the engagement in climate change was moderate as shown by the means in Table 1. Second, games for young students are more effective in increasing climate change engagement when they are technology based. As the Growing Greener game is a card game, it could be expected less effective. Lastly, interventions to improve climate change engagement are often limited to only one class, like in this study, which decreases their potential impact.

Next, this increase in climate change engagement was expected to be larger for the experimental group than for the control group. This was based on the ability of active participation, which was increased through the self-developed card, to increase engagement (Evans et al., 2015) within the game. Game engagement was then expected to increase climate change engagement (Ouariachi et al., 2018). As the students in the experimental group played the game including the additional card, which was intended to increase active participation, they were expected to have a larger increase in climate change engagement than the control group. However, there were no significant results to prove this hypothesis,

meaning the self-developed card had no significant impact on the climate change engagement of the students. This could be explained by the low level of game engagement as students scored below two on a scale of one to five for game engagement (see Table 2). The potential reasons for this low level of game engagement will be discussed further in the following section.

Differences in Game Engagement, Absorption, Flow, Presence, and Immersion

It was expected that the experimental group had a higher level of game engagement and higher scores on its underlying attributes compared to the control group. This was expected, as the self-developed card was thought to increase active participation through the implementation of content creation (Nousiainen, 2009), responsibility for a task (Witkowski & Cornell, 2015), and problem-based learning (Chang, 2017). As active participation has the ability to increase engagement (Evans et al., 2015), the experimental group was expected to have a higher level of game engagement than the control group. However, as the scores of the experimental group on the GEQ were not significantly different from those of the control group, the addition of the self-developed card did neither increase nor decrease the level of engagement with the game. Auman (2011) mentions that students participate less actively during games if they are unfamiliar with or uncertain about what to do. During the intervention students might have been unclear on how to develop their self-developed action card, decreasing the impact of the elements of active participation.

Next to this, the level of game engagement was relatively low for both groups, which was in contrast to the finding of Przybylski et al. (2010) who concluded that games often have high game engagement. There are five components that contribute to engagement of a game: *rules, goals and objectives, outcomes and feedback, conflict/competition/challenge/opposition, interaction, and representation or story* (Prensky,

2001, p. 11). Prensky (2001) mentions that engaging games use (almost) all these elements, however, the game used in this study only incorporated some of these components. These five components of game engagement are similar to the criteria to qualify as a serious game, as mentioned in the theoretical framework (by Cojocariu & Boghian, 2014; Darwesh, 2016; Georgieva-Tsaneva & Serbezova, 2021; Mazur-Stommen & Farley, 2016; Susi et al., 2007). From these inclusion criteria, the Growing Greener card game missed competitive elements (Cojocariu & Boghian, 2014; Susi et al., 2007), strategic components (Darwesh, 2016), and a scale to assess progress (Darwesh, 2016; Mazur-Stommen & Farley, 2016). On this basis, the card game cannot be classified as a serious game which might explain the low levels of game engagement.

Differences in the Execution of Climate Actions

It was expected that the experimental group would execute their climate change action cards more often and with higher frequency than the control group. As climate change engagement has the ability to increase behavioural change (Biercewicz et al., 2020; de Freitas & Jarvis, 2006; Ouariachi et al., 2018), and the experimental group was expected to have higher levels of game engagement and therefore climate change engagement, it was anticipated that they would execute more climate change actions than the control group. As less data was available to answer this hypothesis, it was chosen to present this data in a descriptive way, leading to no hard conclusions. What could be seen is that the execution of action cards was slightly higher (three students in the first week, and two in the second and third week) within the experimental group. The experimental group executed their actions moderately more frequent than the control group. Even though there were some differences between the two groups, the results were relatively close to one another, meaning the self-developed card was less impactful than expected regarding behavioural change. This finding

could be related to the first hypothesis, about the increase in climate change engagement in the experimental group. Research states that climate change engagement has the ability to increase behavioural change (Burke et al., 2018), however, no increase was shown in the level of climate change engagement within this study. Possibly explaining the low amount of climate action executions.

There might also be other explanations for the low number of executions of action cards. There is the possibility of an external factor that makes students unwilling or unable to execute their actions. Stern (2020) mentions several factors that can contribute to a lack of change toward more climate-friendly behaviour. He mentions, for example, "*physical, institutional, economic, cognitive, attitudinal*" (Stern, 2020 p. 2) factors that can withhold people from changing their behaviour. In the case of this study, restricting factors could be, for example, cognition and attitude. Regarding cognition, students could simply have forgotten about the climate action. This means the intervention might not be compelling enough, what could be connected to the lower levels of game engagement. Another aspect of cognition might be whether young children are able to grasp the concept of climate change. As mentioned by Fauville et al. (2020) and also stated by Takahashi (2021), knowledge of climate change is the first step towards more climate-friendly behaviour. So, if students do not fully comprehend this subject, they do not understand the impact of their actions and may therefore be more reluctant. When looking at the factor of attitude, this is something particularly relevant for young children. As young children are often restricted by the willingness, and thus attitude, of their parents (Ojala, 2013). Even though students might be willing to change their behaviour, parents can be less supportive or not have the economic recourses, potentially leading to the students not executing their action cards. Next to this, parents play a big role in how children handle climate change and the information they possess on this subject (Sanson et al., 2018).

Correlation Between Game Engagement and the Execution of the Action Cards

Next, it was expected that the higher the engagement score on the GEQ, the more likely students would be to execute their action card. This was expected as engaging games have an impact on engagement with climate change (Ouariachi et al., 2018), and higher levels of climate change engagement can lead to a behavioural change (Burke et al., 2018; Dele-Ajayi et al., 2016; de Freitas & Jarvis, 2006; Whitmarsh et al., 2013). However, the results of this study showed no proof of a correlation between game engagement and behavioural change in the execution of action cards. Although Galeote et al. (2021) found that games with low game engagement were less effective in increasing behavioural change, this study could not confirm this. The reason for this lack of correlation was unclear, however, the small sample size could contribute to this result.

Differences in the Execution of the Self-Developed and Original Cards

It was also expected that students of the experimental condition would execute their self-developed cards more often than the card they picked from the original deck. This was expected as the self-developed card potentially increased active participation by incorporating content creation (Nousiainen, 2009), problem-solving (Chang, 2017), and giving students responsibility for a task (Witkowski & Cornell, 2015). As active participation has the ability to increase game engagement (Evans et al., 2015) and game engagement can increase climate change engagement (Ouariachi et al., 2018), the self-developed card was expected to impact climate change engagement, leading to increased behavioural change (Biercewicz et al., 2020; de Freitas & Jarvis, 2006; Ouariachi et al., 2018). However, the data showed no difference between the execution of the self-developed cards and the cards picked from the original deck within the experimental group. The IKEA effect might explain this result; this effect states that when someone develops something themselves, they feel a stronger connection to this

object (Norton et al., 2012). However, Norton et al. (2012) mention that when people cannot finish their self-developed product, they lose this connection. As most students could not finish their self-developed card during the intervention, due to a limitation in time, they potentially lost the connection with their self-developed card. This might be a plausible reason why they did not execute their self-developed card more often than the card they picked from the deck. Another reason might be that the requirements for a good climate change action card were unclear to some students. This was visible as some of the developed cards could not be executed, for example: “becoming a god and fixing all climate change problems” or “developing a gun to shoot trees into the ground, and plant a forest very quickly”. These ideas were within the freedom of the assignment, but the student was unable to execute these actions. This potentially led to fewer executions of the self-developed action cards than expected.

Limitations

This study had two main limitations. First, the sample size of this study was smaller than intended due to some difficulties receiving informed consent from parents, resulting in only 31 usable samples, or less, per hypothesis. This led to the choice of analysing some data in a descriptive way, which resulted in no hard conclusions.

Second, was the lack of consistency in the answers the students gave on the follow-up test. Specifically, the answers to the questions related to the execution of their action cards were inconsistent. In many cases, the answers to "After how many days did you start executing your action card?" and "How often did you execute your action card in the first/second/third week?" were unrelated. For example, some students answered "Longer than a week" on the first question but stated they had executed their card already in the first week on the second question. Other students reversed this and answered, for example, "The same

day" on the first question but stated they never executed their action card on the second question. Through this inconsistency, the interpretation of the data became more difficult, and conclusions were less reliable even though this data was still used for answering the fourth, fifth, and sixth hypotheses but should be viewed in light of these inconsistencies.

Implications

First and foremost, this study provided insight into the effectiveness of the children's version of the Growing Greener card game. Through the recommendations of this study, the Growing Greener card game could be improved to increase students' engagement with the game and climate change. This could contribute to the effective use of this card game in elementary schools, changing the behaviour of students in favour of a better climate. This research also contributed to the body of literature on the Growing Greener card game and the engagement and behaviour of student through climate change games, especially applied to young children.

Recommendations

Based on the findings of this study, several recommendations can be made for future research. Within this study, game and climate change engagement did not increase significantly for either condition. As these aspects are important in the game's effectiveness and stimulate behavioural change, it is recommended to investigate how to increase these levels. This can be done by providing several interventions and digitalising the game, to increase climate change engagement. Next to this, the game can most likely be improved by implementing more game-like elements to increase game and climate change engagement. Future research should focus on what elements make the game most engaging; based on this study, the best starting point would be by implementing competitive elements, strategic

components, and a scale to assess progress. Lastly, to increase the effectiveness of the game, it would be interesting for future research to determine if there are external factors, like attitude or cognition, that have an effect on the execution of action cards by students. Researching this can provide a more in-depth understanding of the cause of the lack of behavioural change due to the game.

Considering the limited impact of the self-developed card on engagement and behavioural change, it is recommended to pursue future research in a different direction. The implication of additional game-like elements is expected to contribute more to climate change engagement within the Growing Greener card game than the optimisation of the additional self-developed card.

Conclusion

Within this study, it was explored whether the addition of a self-developed card would increase the engagement level of the Growing Greener card game. No significant results were found on the level of engagement and almost no difference was found between the execution of the self-developed and original cards, which supports the conclusion that the self-developed card as implemented in this study had no significant effect on engagement or behavioural change. Even though the addition of the self-developed card to the game was not effective, this study does give an interesting insight into the effectiveness and engagement level of the Growing Greener card game among elementary school students. This study is a valuable addition to the literature, as no research could be found on the effectiveness and engagement of this version of the game and little research on climate change games for elementary school students. Further research is needed to investigate how to increase the effectiveness of the game, for example, by increasing the number of game-like elements, digitalising the game, extending the intervention and focusing on what factors raise barriers

for students to actually execute their climate action. As there were no positive results found for the self-developed card it is recommended to focus on other game-like elements to increase the effectiveness of the game. Finally, this study provides information and a starting point to re-evaluate, adjust and increase the effectiveness of the Growing Greener card game. By continuing the development and distribution of this game, hopefully, all children will have the chance to learn about climate change and the way in which they can contribute to a greener world.

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Appendix A

Follow-up test

In the following appendix, the follow-up test can be found. Data was collected in collaboration with R. Hurenkamp, who is doing a related study. Questions 1 to 13 were used for the purpose of this study. Questions 14 to 16 were not used for this study but were part of the study of R. Hurenkamp.

Hoi,

Een tijdje geleden hebben wij, Rochelle en Else, bij jullie op school een les gegeven over het klimaat, en hebben jullie samen het klimaatspel gespeeld. Na het spel heb je twee kaartjes gekozen (klimaatacties) die je wel zou willen uitvoeren.

We willen graag weten of je je klimaatactie hebt uitgevoerd en wat je hier van vond. Ook willen we je vragen hoe je na het spel denkt over het klimaat, wat je voor het klimaat doet en hoeveel je erover praat. Daarom vragen we je om de volgende vragen in te vullen.

Dankjewel voor het invullen!

Je krijgt eerst een paar korte vragen over **wie jij bent**. We gebruiken dit alleen om te weten welke vragenlijst bij wie hoort.

1. Wat is je naam?

_____

2. Op welke school zit je?

_____

3. In welke klas zit je?

   □ Groep 6

   □ Groep 7

   □ Groep 8

4. Je hebt tijdens het spel 2 kaartjes (klimaatacties) gekozen. Schrijf hieronder op wat er op je 1e kaartje stond:

_____

5. Heb je dit kaartje met de klimaatactie zelf gemaakt?

   □ Ja

   □ Nee

Vul de volgende vragen in voor de klimaatactie die je hierboven hebt opgeschreven.

6. Hoeveel dagen na het spel ben je begonnen met het uitvoeren van je 1e kaartje (klimaatactie)?

   □ Dezelfde dag

   □ 1 - 2 dagen

   □ 3 - 4 dagen

   □ 5 - 6 dagen

   □ Langer dan een week

7. Hoe vaak heb je je klimaatactie gedaan?

	0 keer	**1 - 5 keer**	**6 - 10 keer**	**11 - 15 keer**	**16 - 20 keer**	**Meer dan 21 keer**
In de **1e** week na het spel						
In de **2e** week na het spel						
In de **3e** week na het spel						

8. Welke klimaatactie stond er op je **2e** kaartje?

_____

9. Heb je dit kaartje zelf gemaakt?

   □ Ja

   □ Nee

10. Hoeveel dagen na het spel ben je begonnen met het uitvoeren van je **2e** kaartje (klimaatactie)?

    □ Dezelfde dag

    □ 1 - 2 dagen

    □ 3 - 4 dagen

    □ 5 - 6 dagen

    □ Langer dan een week

11. Hoe vaak heb je je klimaatactie gedaan?

	0 keer	**1 - 5 keer**	**6 - 10 keer**	**11 - 15 keer**	**16 - 20 keer**	**Meer dan 21 keer**
In de **1e** week na het spel						
In de **2e** week na het spel						
In de **3e** week na het spel						

12. Hoe leuk vond je het om je klimaatactie uit te voeren?

- ☐ Niet leuk
- ☐ Soms niet leuk
- ☐ Soms leuk en soms niet leuk
- ☐ Best leuk
- ☐ Heel leuk

13. Hoe leuk vond je het om je klimaatactie uit te voeren in week 1, 2 en 3? Een 10 is super leuk en een 0 is helemaal niet leuk.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Week 1										
Week 2										
Week 3										

Op de volgende bladzijde vind je een aantal stellingen. De stellingen gaan over jouw **mening**, wat je **doet** en of je over het klimaat **praat**.

Let op: er zijn geen goede of foute antwoorden!

14. Deze vragen gaan over jouw **mening** over het klimaat. Wat vind je van de stellingen op de volgende bladzijde?

	Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
Mensen zouden meer moeten geven om het klimaat.					
Het klimaat is het allerbelangrijkste.					
Ik vind het vervelend als mensen niets doen aan klimaatverandering.					
Mensen maken zich teveel zorgen om klimaatverandering.					
Hoe serieus we klimaatverandering nemen is overdreven.					
Klimaatverandering is een bedreiging voor de wereld.					

15. Deze vragen gaan over wat je **doet** voor het klimaat.

	Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
Ik probeer geen water te verspillen.					
Ik probeer geen eten te verspillen.					
Ik scheid mijn afval.					
Als het kan, gaat mijn gezin met de fiets of het OV in plaats van de auto.					
Ik doe altijd de lichten uit als ik een kamer uit ga.					
Ik probeer energie te besparen.					
Ik vind het belangrijk om goed voor het milieu te zorgen.					

16. Deze vragen gaan over hoeveel en met wie je over het klimaat **praat**.

	Nooit	Bijna nooit	Af en toe	Vaak	Heel vaak
Ik praat thuis over het klimaat.					
Ik praat op school over het klimaat.					
Ik praat met vriend(innet)jes over het klimaat.					

Dit waren de laatste vragen. Dankjewel!

Appendix B

Overview of the cards in the card game

Within this appendix all 26 translated cards of the Growing Greener children deck can be found.

Table B1

Overview of the Cards in the Card Game

	Front of the cards	Back of the cards
1.	Ga bij een klimaatveranderingsclub op school of in je buurt, of start er zelf één!	Vind vrienden die ook de aarde willen helpen. Bedenk een naam voor je club. Bedenk doelen voor je club. Deze kaartjes geven je al wat ideeën, maar wat kan je samen nog meer doen?
2.	Let op lekkende kranen	Een lekkende kraan verspilt meer dan 1100 liter water per jaar. Daarmee kun je 180 keer douchen!
3.	Recycle!	Wees een superrecycler door papier, blikjes, glazen flessen, karton, plastic zakjes en flesjes te recyclen!
4.	Houd je huis warm in de winter en koel in de zomer door de deuren dicht te houden.	Als je 8 uur lang één schuifdeur een klein beetje openlaat, kan dat je energierekening tot wel 30% verhogen.
5.	Schrijf een brief naar mensen die het klimaat kunnen helpen.	Jouw mening doet ertoe! Het schoolbestuur, burgemeesters, leden van de tweede kamer, en zelfs de koning willen weten wat kinderen denken!
6.	Loop naar plekken toe in plaats van de auto te nemen.	Als de plek waar je heen wil dichtbij is, kun je lopen in plaats van met de auto gaan. Zo krijg je beweging en bespaar je energie. Dat is altijd goed voor de aarde.

7.	Gebruik koud water als je helpt met de was.	Het opwarmen van het water kost energie. De kleren worden net zo schoon in kouder water.
8.	Haal de stekker uit elektrische apparaten als je ze niet gebruikt.	Heb jij ‘energievampieren’? Dat zijn apparaten en elektronica die kleine hoeveelheden elektriciteit slurpen, zelfs als ze uitstaan. Als je de stekker eruit trekt bespaar je elektriciteit en geld!
9.	Doe de kraan uit terwijl je je tandenpoetst.	Als je twee minuten je tandenpoetst, spoel je meer dan 40 liter water per keer door de gootsteen. Door de kraan dicht te draaien, bespaar je enorme hoeveelheden water. Dat water kan onze planeet goed gebruiken!
10.	Doe de lichten uit als je een kamer verlaat.	Door het licht uit te doen, bespaar je elektriciteit en de brandstof die nodig is om elektriciteit te maken. Minder brandstof gebruiken betekent dat er minder koolmonoxide en andere broeikasgassen ontstaan.
11.	Praat met vrienden en familie over klimaatverandering en zorgen voor de planeet.	Kinderen hebben een superkracht: als je je ouders of opa en oma vraagt om over klimaatverandering te praten doen ze dat!
12.	Deel wat je weet over klimaatveradering met familie en vrienden.	De meeste mensen praten nooit met hun familie of vrienden over klimaatverandering. Blijf niet stil. Deel wat je weet!
13.	Ga met de fiets naar plekken die niet ver weg zijn.	Fietsen is een leuke manier om beweging te krijgen. Het is goed voor jou en de aarde!

14.	Hergebruik. Maak dingen van gerecyclede materialen.	1. Weiger wat je niet nodig hebt. 2. Verminder wat je weggooit. 3. Hergebruik wat je kunt 4. Recycle wanner je klaar bent.
15.	Lees over klimaatverandering	Lezers zijn leiders. Kennis is macht. Hoe meer je leert over klimaatverandering, hoe meer je kunt doen om de aarde te helpen.
16.	Maak gebruik van het openbaar vervoer.	Door met de bus of trein te gaan zijn er minder auto's nodig, waardoor er minder file en luchtvervuiling ontstaat.
17.	Zeg nee tegen wegwerpbekers. Gebruik een herbruikbare beker.	In nedernad kopen we gemiddeld 900 miljoen kleine plastic flesjes per jaar. Door een herbruikbare beker te gebruiken, houd je deze plastic flessen weg van de vuilnisbelt of de oceaan.
18.	Maak een wandeling in de natuur of bezoek een natuurcentrum om te leren over klimaatverandering.	Er zijn verschillende natuurcentra in Nederland. Zoek eens naar een natuurcentrum bij jou in de buurt!
19.	Eet minder vlees	Het produceren van één hamburger kost evenveel energie als een kleine auto die 32 kilometer rijdt.
20.	Gebruik LED lampjes.	LED-lampjes geven veel licht, maar gebruiken weinig elektriciteit. Omdat er geen kwik in zit zijn ze veel beter voor het milieu. En ze gaan ook nog eens heel lang mee!

21.	Han kleding binnen of buiten te drogen.	Als je je kleding binnen of buiten te drogen hangt, bespaar je de elektricteit van de droger. Ook zullen je kleren lekker ruiken en maakt de zon witte kleren nog witter!
22.	Kweek je eigen groeten en fruit.	Het kost veel energie om eten te verpakken en naar winkels te brengen. Als je zelf groenten en fruit kweekt bespaar je die energie.
23.	Eet vers voedsel	Het kost veel energie om eten te verwerken, in te pakken en te vervoeren. Fruit met schil, zoals banenen, watermeloenen en sinaasappels heeft geen verpakking nodig en je kunt de schil composteren.
24.	Doneer kleren en speelgoed dat je niet meer gebruikt.	Het maken van kleding en speelgoed kost veel water en stroom. Je kleding en speelgoed kunnen vaak nog lager mee, dus geef ze door aan iemand die het kan gebruiken.
25.	Gebruik beide kanten van het papier en recycle oud schoolwerk.	Als je beide kanten van het papier gebruikt, heb je minder papier nodig, en hoeven er minder bomen omgekapt te worden. Bomen geven dieren een thuis, absorberen slecthe dingen uit de lucht en geven ons zuurstof. Eén grote boom zorgt voor genoeg zuurstof voor vier mensen, voor een hele dag!

26.	Composteer restjes uit de keuken.	Door te composteren kun je goede mest maken, waardoor andere planten kunnen groeien! Ook zrog je zo niet voor meer afval op de vuilnisbelt.

Appendix C

Worksheet

Within this appendix the the translated worksheet can be found, as used during the intervention.

Actieblad:
Mijn klimaat actie!

1. **Welke actie ga je DOEN?**

2. **Wie ga je vertellen over het uitvoeren van je klimaat actie?**

3. **Hoelang denk je dat het duurt voordat je begint met het uitvoeren van je klimaatactie**

4. **Wat is jouw consequentie als je je klimaat actie niet uitvoert?**

Appendix D

PowerPoint slides

Within this appendix the slides of the PowerPoint presentation can be found, as used during the intervention.

Figure G1

Slide 1

Figure G2

Slide 2

Figure G3

Slide 3

Note. Link to the video presented in slide 3: https://www.youtube.com/watch?v=dvN53e3BUS4

Figure G4

Slide 4

Figure G5

Slide 5

Figure G6

Slide 6

Figure G7

Slide 7

Figure G8

Slide 8

Appendix E

Examples of cards made by the students

In this appendix some examples can be found of self-developed climate change action cards, made during the intervention by students of one of the elementary schools.

Figure C1

Self-developed Card on Climate-Cleaning Robot

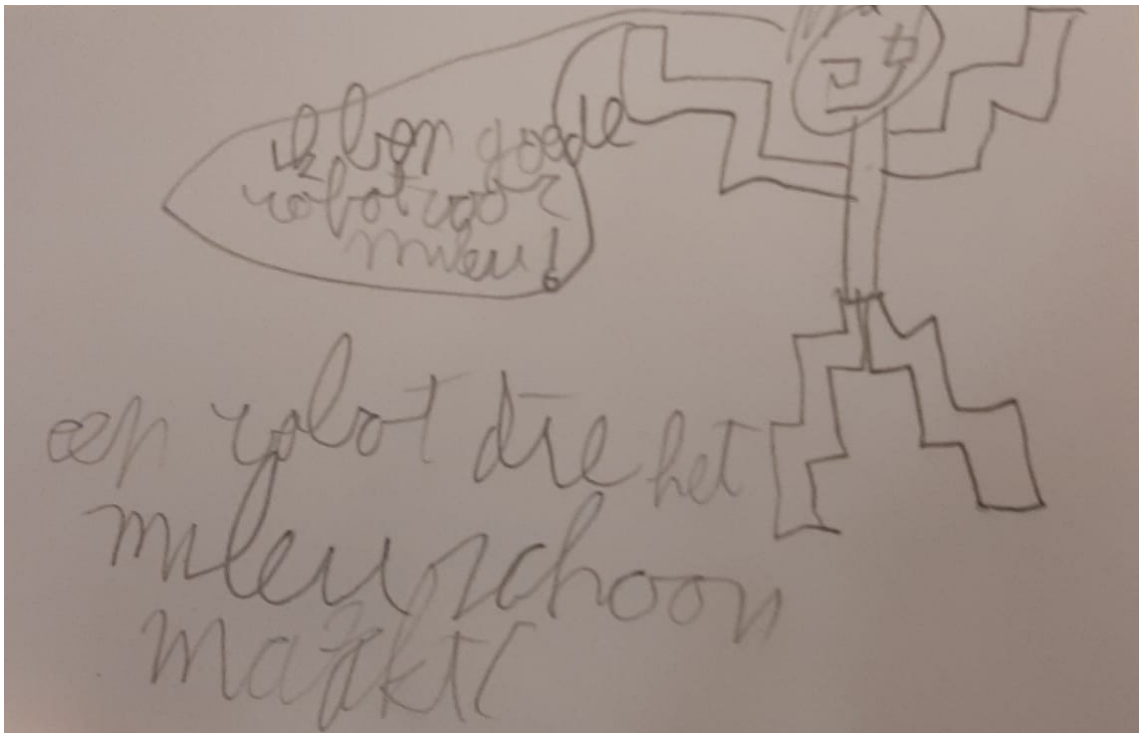

Figure C2

Self-developed card on Solar Panel Car

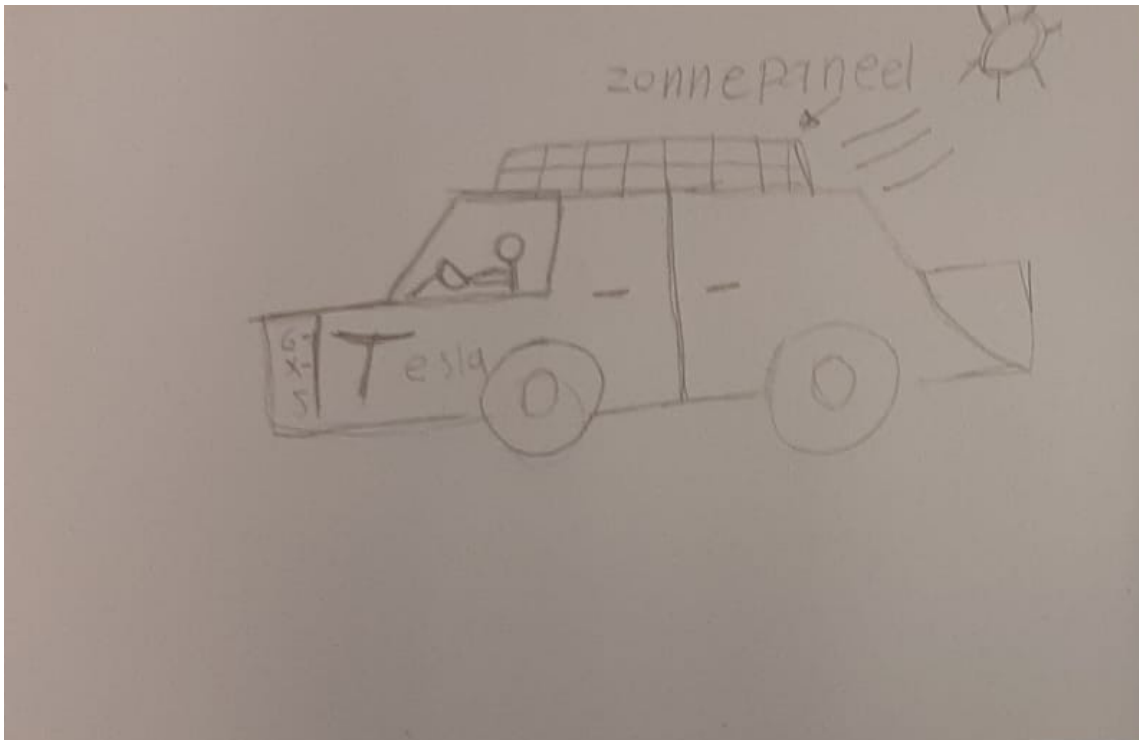

Figure C3

Self-developed Card on Producing Water

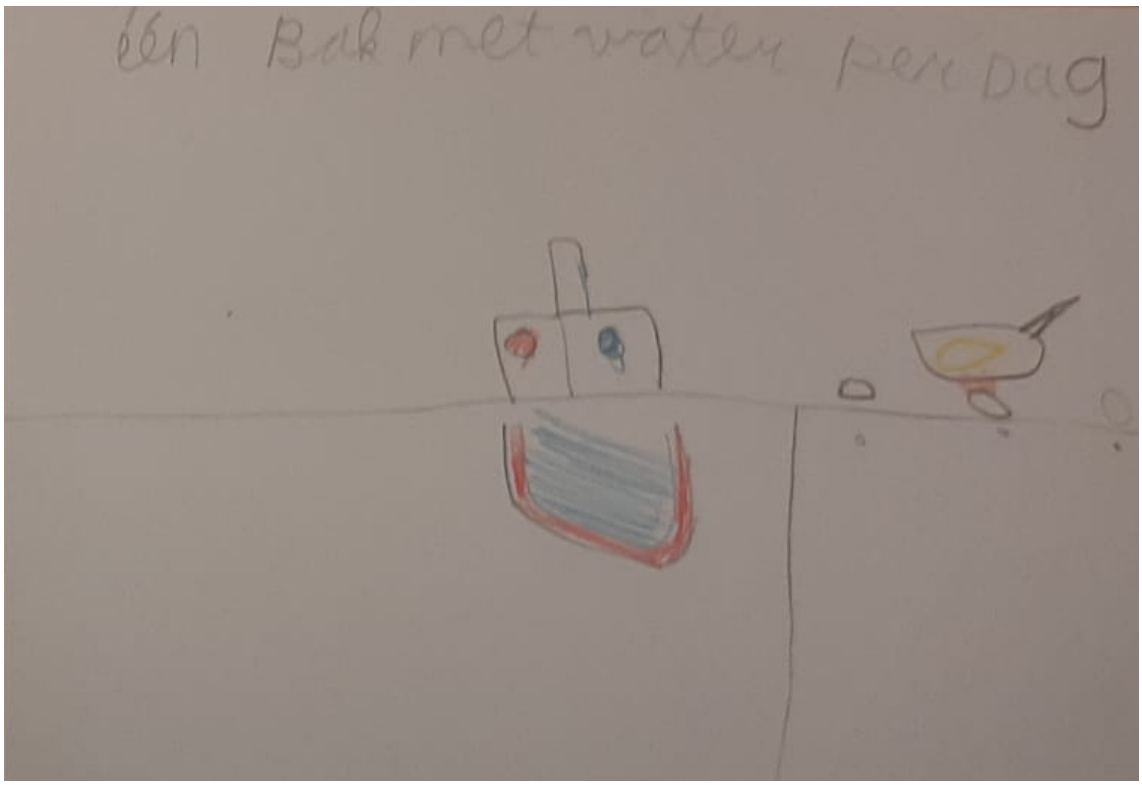

Figure C4

Self-developed Card on Taking a Bicycle Instead of a Car

Appendix F

Pre-test

In the following appendix, the pre-test test can be found. Data was collected in collaboration with R. Hurenkamp, who is doing a related study. Questions 1 to 5 and 9 to 14 were used for the purpose of this study. Questions 6 to 8 and 15 to 17 were not used for this study but were part of the study of R. Hurenkamp.

Hoi,

Fijn dat je meedoet aan ons onderzoek! Wij zijn Rochelle en Else, studenten aan de Universiteit Twente. Wij doen onderzoek naar een klimaatkaartspel.

Je gaat binnenkort op school dit kaartspel spelen. Daarbij krijg je ook een les over klimaatverandering. We gaan het hebben over wat jij kunt doen voor het klimaat en een actieplan maken. Voordat je het spel gaat spelen, willen we graag weten wat jouw mening is over het klimaat, wat je doet, en hoe vaak je erover praat.

Dankjewel voor het invullen van de vragenlijst.

Je krijgt eerst een paar korte vragen over wie jij bent. We gebruiken dit alleen om te weten welke vragenlijst bij wie hoort.

1. Wat is je naam?

_____

2. Op welke school zit je?

_____

3. In welke klas zit je?

   □ Groep 6

   □ Groep 7

   □ Groep 8

4. Ik ben een...

   □ jongen

   □ meisje

   □ anders

   □ zeg ik liever niet

5. Hoe oud ben je?

_____

De volgende twee vragen gaan over wat je vindt van **natuur en techniek**-vakken.

6. Ik vind vakken over natuur en techniek …

   □ Makkelijk

   □ Gemiddeld

   □ Moeilijk

7. Ik vind vakken over natuur en techniek …

   □ Leuk

   □ Gemiddeld

   □ Stom

8. Hoe vaak doe jij een **experiment** in de klas?

   □ Meer dan 1 keer per week

   □ Meerdere keren per maand

   □ Bijna nooit

De volgende zeven vragen gaan over je **interesse** in het klimaat.

9. Hoeveel weet je over het klimaat van de aarde?

   □ Veel

   □ Een beetje

   □ Bijna niets

10. Voel je je hulpeloos als je denkt aan klimaatverandering?

    □ Heel erg

    □ Een beetje

    □ Bijna niet

11. Maak je je veel zorgen over klimaatverandering?

□ Ja

□ Af en toe

□ Nee

12. Ben je geïnteresseerd in het onderwerp klimaatverandering?

□ Ja

□ Een beetje

□ Nee

13. Als je aan klimaatverandering denkt, heb je dan het gevoel dat je er **niks** aan kunt doen?

□ Ja

□ Een beetje

□ Nee

14. Als je aan klimaatverandering denkt, heb je dan het gevoel dat je er **iets** aan kunt doen?

□ Ja

□ Een beetje

□ Nee

Hieronder zie je een aantal stellingen. De stellingen gaan over jouw **mening**, wat je **doet** en of je over het klimaat **praat**. **Let op:** er zijn geen goede of foute antwoorden!

15. Deze vragen gaan over jouw **mening** over het klimaat. Wat vind je van de volgende stellingen?

	Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
Mensen zouden meer moeten geven om het klimaat.					
Het klimaat is het allerbelangrijkste.					
Ik vind het vervelend als mensen niets doen aan klimaatverandering.					
Mensen maken zich teveel zorgen om klimaatverandering.					
Hoe serieus we klimaatverandering nemen is overdreven.					
Klimaatverandering is een bedreiging voor de wereld.					

16. Deze vragen gaan over wat je **doet** voor het klimaat.

	Helemaal niet mee eens	Niet mee eens	Neutraal	Mee eens	Helemaal mee eens
Ik probeer geen water te verspillen.					
Ik probeer geen eten te verspillen.					
Ik scheid mijn afval.					
Als het kan, gaat mijn gezin met de fiets of het OV in plaats van de auto.					
Ik doe altijd de lichten uit als ik een kamer uit ga.					
Ik doe mijn computer uit als ik hem niet gebruik.					
Ik probeer energie te besparen.					
Ik vind het belangrijk om goed					

voor het milieu te zorgen.					

17. Deze vragen gaan over hoeveel en met wie je over het klimaat **praat**.

	Nooit	Bijna nooit	Af en toe	Vaak	Heel vaak
Ik praat thuis over het klimaat.					
Ik praat op school over het klimaat.					
Ik praat met vriend(innet)jes over het klimaat.					

Dit waren de laatste vragen. Dankjewel!

Appendix G

Post-test

For the post-test all questions were asked for the purpose of this study, and none of the questions were asked for the use of the study of R. Hurenkamp.

Hoi,

Fijn dat je meedoet aan ons onderzoek! Je hebt net een les gekregen over het klimaat en het klimaatspel gespeeld. We willen graag weten wat je van het spel vindt. Daarom vragen we je om de volgende vragenlijst in te vullen.

Dankjewel voor het invullen!

Je krijgt eerst een paar korte vragen over **wie jij bent**. We gebruiken dit alleen om te weten welke vragenlijst bij wie hoort. Daarna krijg je vragen over jouw **gevoel bij het klimaat**. Dit zijn dezelfde vragen als de vragen die je al eerder hebt ingevuld. Als laatste vragen we je **hoe je het vond om het spel te spelen**.

1. Wat is je naam?

   _____

2. Op welke school zit je?

   _____

3. In welke klas zit je?

   □ 6

   □ 7

   □ 8

4. In welke groep was je ingedeeld tijdens het spel?

   □ Groep A

   □ Groep B

5. Welke 2 klimaat acties heb je gekozen om te gebruiken in het doelenblad?

   1. _____

      _____

   2. _____

      _____

De volgende vragen gaan over jouw **gevoel bij het klimaat**.

6. Hoeveel weet je over het klimaat van de aarde?

   □ Veel

   □ Een beetje

   □ Bijna niets

7. Voel je je hulpeloos als je denkt aan klimaatverandering?

   □ Heel erg

   □ Een beetje

   □ Bijna niet

8. Maak je je veel zorgen over de klimaatverandering?

   □ Ja

   □ Af en toe

   □ Nee

9. Ben je geïnteresseerd in het onderwerp klimaatverandering?

   □ Ja

   □ Een beetje

   □ Nee

10. Als je aan klimaatverandering denkt, heb je dan het gevoel dat je er **niks** aan kunt doen?

    □ Ja

    □ Een beetje

    □ Nee

11. Als je aan klimaatverandering denkt, heb je dan het gevoel dat je er **iets** aan kunt doen?

    □ Ja

    □ Een beetje

    □ Nee

De volgende vragen gaan over **hoe je het vond om het spel te spelen**, en **hoe jij je daarbij voelde**. Zet een kruisje in het vakje wat voor jou van toepassing is.

	Helemaal niet	**Bijna niet**	**Af en toe**	**Vaak**	**De hele tijd**
Ik voel me anders na het spelen van het spel.					
De tijd leek stil te staan tijdens het spel.					
Het voelde alsof ik niet meer in de echte wereld was.					
Ik vergat waar ik was.					
Het spel voelde echt.					
Als er iemand tegen me praatte, hoorde ik hen niet.					
Ik werd enthousiast van het spel.					

Ik antwoordde niet als iemand iets tegen mij zei.					
Ik voelde niet dat ik moe werd.					
Het spelen van het spel ging automatisch.					

	Helemaal niet	**Bijna niet**	**Af en toe**	**Vaak**	**De hele tijd**
Ik hoefde niet na te denken over hoe ik het spel moest spelen.					
Het spel spelen maakte me rustig.					
Ik had het gevoel alsof ik niet meer kon stoppen met spelen.					
Ik vergat de tijd tijdens het spel.					
Alles wat ik deed ging automatisch.					
Mijn gedachten gingen snel tijdens het spel.					
Ik had langer door willen spelen.					

Ik zat helemaal in het spel.					

Dit waren de laatste vragen. Dankjewel!