

**Development of an educational board game about climate change
and sustainability in primary education.**

Name: Nicole van Daalen

E-mail: n.vandaalen@student.utwente.nl

Student number: 2606399

Supervisor's name: Henny Leemkuil

E-mail: H.H.leemkuil@utwente.nl

Second supervisor's name: Johannes Steinrücke

Keywords: *Educational learning method, game-based learning, educational board game, active learning, climate change, sustainability*

Word count: 12.565

Abstract

Climate change education (CCE) could be helpful as a tool to tackle the problem of climate change; however, too little has been done to implement CCE. Pupils up to sixth grade primarily learn concepts about climate and sustainability. Therefore, learning about climate change and sustainability would fit well in seventh and eighth grade. Active learning is an instructional method that allows pupils to better understand climate change. In this design-based research, an educational instruction method about climate change and sustainability was developed using the ADDIE model, as supported by a literature study. In the analysis phase, a foundation for the educational instruction method was provided by analysing the audience, the task, existing learning material, and game-based learning. These analyses concluded that an educational game could be a beneficial instructional method. In the design chapter, some game features important to educational games are described. The game's features and design requirements were converted into practical design principles and subsequently into an educational board game about climate change and sustainability named Bewust Milieu. This prototype was then evaluated by teachers who currently teach or have taught grades six, seven and eight. Some adjustments were then made, and a revised prototype was tested by 30 pupils from the seventh and eighth grades. First, the board game was explained to the pupils. Next, the pupils played the game. Finally, the pupils participated in a focus group interview to elicit their feedback on areas that needed improvement. Based on these results, adjustments were made, leading to an adapted version of the educational board game Bewust Milieu.

Keywords: game-based learning, educational board game, climate change, sustainability, active learning

Table of Contents

Introduction.....	3
Problem Statement	3
The ADDIE Model.....	4
Goal of the Research	5
Analysis	6
Audience Analysis.....	6
Task Analysis	7
Existing Learning Materials About Climate Change and Sustainability	11
Game-based Learning	13
Conclusion of the Analysis Phase	14
Design.....	16
Game Features.....	16
Design Guidelines	21
Development	23
Goal of the Game	23
Role Division.....	23
Plastic Points	23
Gameboard	24
Dice	25
Pawn.....	25
Gameplay	25
Storyline	26
Question Cards	27
Did You Know Cards.....	29
Thinking Cards.....	29
Overview Materials	30
Prototype Evaluation.....	32
Respondents	32
Variables and Instruments	32
Procedure.....	32
Analysis.....	33
Results	33
Implementation and Evaluation of the Board Game.....	38
Variables and Instruments	38

Respondents	38
Procedure.....	38
Analysis	39
Results	39
Discussion and Conclusion.....	42
Conclusion.....	42
Discussion	42
Recommendation.....	43
References.....	45
Appendix A.....	51
Appendix B.....	52
Appendix C.....	61
Appendix D.....	64
Appendix E.....	67
Appendix F.....	68
Appendix G.....	73
Appendix H.....	75

Introduction

In this research, an educational learning method regarding climate change and sustainability in primary education in the Netherlands is developed. In the introduction, the problem statement for the research is provided. In the next section, the design model is explained. In the last section of the introduction, the goal of the research is articulated.

Problem Statement

There has been growing interest in climate change education (CCE), as it could raise awareness of climate change (UNESCO, 2015). The Dutch government's (Het groene brein, 2015) interest in CCE has also grown because it has been seen as a way to facilitate sustainable development in Dutch education. CCE is urgent since the climate has been changing, leading to consequences such as extreme weather, melting glaciers, and rising sea levels (D'Amato et al., 2015; Haines & Ebi, 2019). Climate change has become more noticeable because more extreme weather has been occurring more frequently. As the earth grows even warmer and the sea level is rising around the year 2100 (KNMI, 2021), the generations born around 2010–2030 may notice extreme weather even more but could contribute much to the solution.

Thus, CCE could be helpful to address climate change. However, in the Netherlands, little has been done about the implementation of CCE (Wals, as cited in Aarnoudse, 2019). Wals (in Aarnoudse, 2019) stated that teaching about sustainability could start from the age of four. In Dutch primary education, from sixth grade onwards, pupils learn about the disturbance of equilibrium in the world (SLO, n.d.-a). In prior grades, pupils learn concepts about climate and sustainability, including air pollution and the greenhouse effect. This provides a foundation for them to learn about climate change and sustainability in their seventh and eighth grade curricula.

To identify how CCE can be implemented in the curriculum, it is necessary to determine what kinds of educational methods are suitable for pupils in primary school. One approach to improving children's understanding of climate change is active learning (Wals, as cited in Aarnoudse, 2019; Porter et al., 2012), which can be defined as engaging learners in the learning process (Bonwell & Eison, 1991) to attain maximum learning outcomes (Setiawan et al., 2018). Active learning in education includes problem-solving, collaborative work on projects, discussions, laboratory experiments and group work (Dicheva & Dichev, 2016).

The benefits of an active learning approach include improving learners' autonomy, cultivating creativity and promoting personal development (Daellenbach, 2018). Furthermore, learners can identify relationships between the learning material and everyday

life to solve real-life problems (Setiawan et al., 2018). This final benefit is also important in CCE. When a lesson or material is not perceived as engaging, fun active learning methods may satisfy learners and motivate them to master the topic (Silberman, cite in Setiawan et al., 2018).

Therefore, the aim of this paper is to design an educational learning method where pupils from seventh and eighth grades in primary schools in the Netherlands learn about climate change and sustainability. The ADDIE model is used to design a learning method about climate change and sustainability (Morison, 2017).

The ADDIE Model

To design a successful learning method, it is essential to analyse which learning method is effective for the target group, how to design the content of the learning method, what the context of the method is and how it allows for the interaction with the pupils. In the design phases of this research, the ADDIE model is a colloquial expression describing a systematic approach to instructional development. It is not strict, but rather serves as an outline for developing an instructional method.

Analysis Phase

During the analysis phase, the problem, a potential solution and the desired situation are identified. During this phase, objectives, prior knowledge of the target group and available resources must be researched. The last part of the analysis determines which learning method is suitable for the target group. The analyses in this study focus on audience, task, existing instructional methods and game-based learning.

Design Phase

In the design phase, knowledge gained from the analysis phase is used to turn it into design principles, which serve as the foundation for the development of the educational method.

Development Phases

In the third phase, the design principles are converted into a proposal for a practical educational learning method. The last step is to transform the proposal into a prototype.

Implementation and Evaluation Phases

In this research, this phase is divided into two parts.

Evaluation Prototype. First, teachers evaluate the prototype. After some adjustments are made to the prototype based on the feedback, a revised prototype is designed.

Implementation and Evaluation of the Board Game. Next, the revised prototype is implemented during the implementation phase, which partly coincides with the evaluation

phase. This revised prototype is again evaluated. Based on this second evaluation, additional adjustments are also made to the prototype. This iterative process continues until the result is satisfactory.

Goal of the Research

The goal of the study is to develop an educational learning method about climate change and sustainability for primary education, specifically for the seventh and eighth grades. The learning method developed is based on the analyses. If the development of the learning method is successful, it could serve as a solution for implementing more CCE in primary education.

Analysis

The first step of the ADDIE model is to perform an analysis. In this research, several analyses were conducted – namely, an audience analysis, a task analysis, analyses on existing instructional methods, and an analysis on game-based learning.

Audience Analysis

During the audience analysis, information about the specific learners participating in the study is gathered. In this research, the learners are pupils in seventh and eighth grade in Dutch primary education, meaning that the pupils are 10, 11 and 12 years old. Based on a questionnaire answered by a teacher who teaches seventh and eighth grades, these pupils are expected to have an attention span of 45 minutes. Consequently, consideration should be given to the duration of the game.

Another challenge is that there are different types of students in seventh and eighth grade, as the pupils may have different levels of development with regard to both social and cognitive skills. In developing the board game, these differences are considered to make the learning method as accessible as possible to every pupil.

As described, Wals (in Aarnoudse, 2019) and Porter et al. (2012) indicated that children's understanding of climate change can improve through active learning. Active learning is an instructional method that engages the learners in the learning process (Bonwell & Eison, 1991), engaging learners in meaningful activities and encouraging them to think about what they are doing.

Current Knowledge

During the design process, it is important to consider the target group for which CCE is being developed. To ensure that the content matches the appropriate level, it is necessary to identify what kind of knowledge about sustainability and climate change students in seventh and eighth grade have already acquired.

In Dutch primary education system, the concepts of climate and sustainability are described in Core Goal 39, which states that 'The pupils learn to treat the environment with care' (SLO, n.d.-a). Core goals indicate what pupils should know and be able to do in a certain part of their primary education (SLO, 2021). This core goal also describes what information should be learned about climate change and sustainability for different school grades.

According to the SLO (n.d.-b), the environment is everything that is part of people's surroundings. This environment includes nature, which consists of flora, fauna, rocks, weather, climate and cycles. It also involves (material) culture, which consists of everything

made by people, such as buildings, infrastructure, fields and meadows. Table 1 provides an overview of the elaboration of Core Goal 39 on the environment (SLO, n.d.-a). It shows which concepts primary school pupils should learn about the environment in the first six years. This concerns the topics of environmental significance, human intervention, making choices and sustainable development. For seventh and eighth grades, there are no additional concepts or themes to be addressed in the core objectives.

Table 1

Overview of the Elaboration of Core Goal 39

Concept	Grade 1 and 2	Grade 3 and 4	Grade 5 and 6
Environmental significance	<ul style="list-style-type: none"> • Wonder • Beauty (nature is beautiful) 		
Human interventions	<ul style="list-style-type: none"> • Add something: waste, stench, noise, asphalt • Remove something: forest (felling), animals (hunting, fishing) • Intervene with care 	<ul style="list-style-type: none"> • Imbalance in the Netherlands: • Manure surplus • Air pollution (from traffic, factories, intensive livestock farming) 	<ul style="list-style-type: none"> • Global imbalance: • Deforestation in the tropics • Greenhouse effect
Making choices	<ul style="list-style-type: none"> • Readiness to care 	<ul style="list-style-type: none"> • Consequences of interventions (from different perspectives) 	
Sustainable development			<ul style="list-style-type: none"> • Responsibility for the environment • Justice

Task Analysis

Task analysis concerns the learning needs and goals of the game. The learning needs and goals can provide a focus for designers throughout the design process, helping them to understand the breadth of the project and what needs to be analysed. In this study, Dutch primary education's core goals about the climate need to be investigated so that these goals can be incorporated when designing and developing learning content.

Furthermore, it is also necessary to identify the instructional content or the specific skills related to the task. It is necessary to consider which facts, concepts and information are to be covered. This is done in the following sections.

Instructional Goals

The purpose of the task is to allow pupils to learn something about climate change and sustainability; therefore, learning goals were formulated. These learning goals help in the design process and aid designers in determining whether the intended goal of a task has been achieved.

As the core goals are very general, content lines have been provided to give the various core goals a framework (SLO, n.d.-c); these provide a more complete overview of what is offered in the core objectives of the different learning areas. The content lines serve as an example and can be used in the development of educational curricula to further develop learning goals and to build up a school curriculum. Nevertheless, the core goals are officially regulated, and the content lines are supplementary.

Three different phases are described in the content lines, but only Phase 3 is relevant to this research. Phase 3 was written for the second half of sixth grade, as well as for seventh and eighth grades. The content lines relevant to the development of the educational instruction method and related to climate change and sustainability are

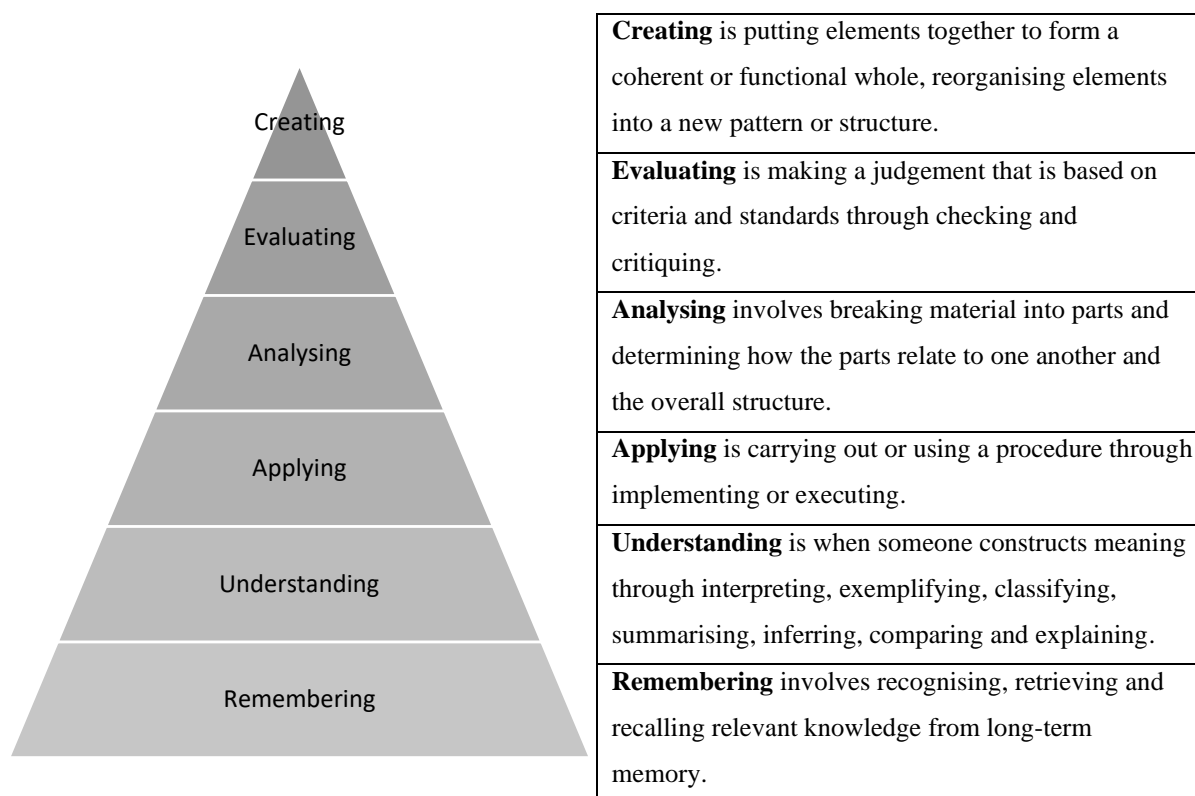
- Exploring causes and effects of climate change,
- Examining the impact of human consumption patterns on the environment (e.g., the problem of waste),
- Realising the importance of preserving nature,
- Exploring the possibilities of humans contributing to preserving and restoring the natural balance (e.g., water management),
- Caring for the environment and
- Obtaining an elementary understanding of ecology (sustainable development).

Since these are several content lines to focus on, the following content lines were chosen as the focus for this task: 1) examining the impact of human consumption patterns on the environment (e.g., the problem of waste and sustainability), 2) obtaining an elementary understanding of ecology (sustainable development) and 3) exploring causes and effects of climate change. In addition, van Graft et al. (2020) released a document elaborating on the knowledge topics for the content lines of 'Orientation to yourself and the world'. This document contains brief descriptions of the content and the keywords regarding climate change and sustainability (see Appendix A). Thus, these content lines and the document of SLO serve as starting points for developing learning objectives.

As described in the previous section, the learning goal of the game developed in this study is to learn about sustainability and climate change. Children are required to remember and understand concepts and information about climate change and sustainability. The final goal of the task is to empower pupils to apply these concepts and information in different situations and contexts. The idea of remembering, understanding and applying is based on the lowest layers of Bloom's revised taxonomy (Forehand, 2005), which is illustrated in Figure 1. Remembering, understanding and applying constitute lower-order thinking and analysing, while evaluating and creating are mentioned as forms higher-order thinking (Forehand, 2005). In this research, only remembering, understanding and evaluating are relevant.

Figure 1

Revised Taxonomy of Bloom



Note. Adapted version taken from Bloom's taxonomy: Original and revised. Emerging perspectives on learning, teaching, and technology by M. Forehand, 2005.

Based on Bloom’s revised taxonomy, Core Goal 39, the content lines, and the document elaborating on the knowledge topics for the content lines of ‘Orientation to yourself and the world’, the following learning goals emerge:

- Describe the impact of human consumption patterns on the environment (e.g., the problem of waste and sustainability),
- Describe concepts related to sustainability and climate change,
- Describe how recycling is done and
- Explain what people can do to be better for the environment.

Content

It is important to consider which facts, concepts, and cause and effect relationships are needed to learn to ultimately meet these learning goals. In Table 2, concepts that align with the core goal and content lines are articulated. For some concepts, examples are provided.

Table 2

Important Concepts Related to Core Goal 39

Concept	Meaning	Examples
Sustainable Development	Development that meets the needs of the present generation without compromising the needs of future generations, both here and in other parts of the world (World Commission on Environment and Development, 1987).	
Environment	All nature, the entire environment in which people, plants and animals live (biosphere; van Graft et al., 2020).	
Environmental pollution	Human-induced environmental degradation (van Graft et al., 2020).	Pollution of air (air pollution), water (water pollution) and soil (land pollution; van Graft et al., 2020).
Care for the environment	If you show in your behavior that you strive to preserve the environment (van Graft et al., 2020).	This can be done, among other things, by reducing the amount of waste (prevention, reuse, waste separation and recycling, energy from waste incineration,

		landfilling); reducing the energy consumption of appliances (energy label, economical with energy for wallet and environment); paying attention to water management (drinking water, wastewater and water purification) and focusing on nature protection (van Graft et al., 2020).
Ecological Footprint	The land that humans use to live on (van Graft et al., 2020).	This can include land to build a house on, but also land that we use to process our own waste (van Graft et al., 2020).
Recycle	Reusing waste materials. Collecting waste/raw materials and turning them into new products (Recycle, n.d.).	Glass can be handed in in special glass bins. This is then collected and taken to a glass factory. A glass factory then turns it into new glass bottles (van Graft et al., 2020).

Existing Learning Materials About Climate Change and Sustainability

Next, it is useful to investigate existing learning materials utilised to motivate pupils to learn about climate change and sustainability. This means that it is important to determine which learning materials regarding climate change and sustainability currently exist.

There are several worksheets that address the topics of climate change and sustainability. One example of this is Environmental Education Den Haag (Milieueducatie Den Haag, 2021). On the website of Education Den Haag, they refer to a number of different downloads that can help a teacher to develop a lesson on climate change. One example of these downloads is a worksheet on the greenhouse effect where a pupil can compose two questions and learn about the greenhouse effect. Another example is a worksheet with interviews children from the past about how they went to school. When teachers use this worksheet, they can discuss the impact of (sustainable) choices the children are making in terms of transport, both in the past and today. Most of these worksheets only cover one topic and are often not linked to the SLO's core goals. These are often formal learning methods that pupils can work on individually or collaboratively. The exercises offered correspond to the lower-order thinking tasks from Bloom's revised taxonomy. However, there are two

potential drawbacks to using such worksheets. First, teachers must investigate for themselves whether these worksheets fit the subject and core goal they want to cover. Second, teachers have to combine multiple worksheets to create a lesson.

Furthermore, there are various informative online websites which offers teaching modules about topics on sustainability and climate change for primary education. This information is offered in the form of instructional videos, assignments and games. An example of such an online platform is Aandeslagmetafval (Nederland Schoon, n.d.), which addresses recycling and waste. This website offers different teaching materials for learners from first through third grades, fourth through sixth grades or seventh and eighth grades.

During the last module of seventh and eighth grades, an informative video about garbage on the street is first shown. Next, the pupils can complete several assignments online before finally playing two games. In one of the games, players are shown different objects of waste that they must place in the right bin. If the player makes a mistake, the waste comes out of the wrong bin, and the player must try to place it back in the right bin. These games use drills and practise in the exercises. The material is repeatedly presented to the players until the right answer or solution is achieved. This aligns well with the remembering level of Bloom's revised taxonomy. Apart from the abovementioned assignment, there are also quizzes and other types of games. Aiming at teaching a single topic, this website is not linked to a core goal but is geared towards primary school teachers and instructors. Some assignments could be completed independently, while other parts need to be done with several people or an entire group.

Another example of a game is Klimaatjes (Bordspel Klimaatjes, 2021), an educational board game that is based on core goals. In this board game, three to five players can work together to take charge of their city Groentrecht. Together, players answer knowledge and dilemma questions regarding a variety of sustainability issues. Each player has a different ministerial role and has interests that need to be achieved. In addition, these players have the common goal of keeping the city liveable for people, animals and nature. This teaching method could involve both lower-order thinking and higher-order thinking from Bloom's revised taxonomy.

The knowledge and dilemma questions can be obtained by the students through a mobile application (hereinafter referred to as app). This game is aimed at players between 10 to 14 years in age and takes about 60 minutes. During play, soft skills such as cooperation, discussion and reasoning are also covered and complex problems are presented simply to the players. According to the creators of the game, it also increases pupil motivation and

stimulates long-term knowledge storage through learning in the form of a game; this could be an advantage over the other learning methods described.

In conclusion, different learning methods for the topics of climate change and sustainability have been used. Often, most of the learning methods focus on covering one topic. They tend to cover the lower-order thinking skills according to Bloom's revised taxonomy. As indicated in the task analysis, this is important and also suits with our learning objectives, as the pupils mainly need to remember, understand and be able to apply concepts. In addition, the learning methods can often be used individually, with others in groups or in a combination of both. However, few learning methods have been linked to the core goals put forward by the government. The educational board game "Klimaatjes" is the only method linked to the core goal. Furthermore, the makers of the game have stated that playing the game could possibly increase pupils' motivation and stimulate long-term knowledge storage. Due to its potential benefits, conducting an analysis on educational games as a potential instruction method is promising.

Game-based Learning

Game-based learning (GBL) refers to the use of games in instruction to promote knowledge and skill acquisition (Qian & Clark, 2016). One example of this is the educational board game 'Klimaatjes', described in the previous section. By playing the game, players learn about a certain topic or concept. During the game, learners must solve problems and complete challenges that are relevant to the course content. Many researchers actually talk about digital GBL when referring to GBL. Digital GBL is the use of computer and video games in learning and instruction (Wouters & Oostendorp, 2013). A second less popular form of GBL is non-digital GBL (Naik, 2014). When using non-digital GBL, board games, card games or any other game that can be played in a physical environment could be utilised in learning and instruction. Non-digital GBL offers greater flexibility and openness than video games (Greenhalgh, 2016), and players, in general, accept the educational potential of the non-digital games (Willet et al., 2018).

Besides the fact that games are considered fun, there are several benefits of using GBL rather than traditional instruction. First, educational games stimulate intrinsic motivation (Malone, 1981). This means that players of educational games are willing to invest more effort and time into the game of their own volition and not because of extrinsic rewards they receive when playing the game. Factors that are important to attain intrinsic motivation in educational games are curiosity, challenge and fantasy (Malone, 1981). Second, GBL could increase the engagement of a learner. In this paper, the definition of engagement

is a player's serious involvement in a games. GBL could increase engagement because games are perceived as fun compared to traditional learning, so learners are more likely to participate (voluntarily). Furthermore, there are indications that learners who play educational games could possibly have better learning outcomes, such as cognitive gains or a better attitude towards learning (Vogel et al., 2006). Thus, these advantages of GBL can lead to positive impacts on education.

However, there may also be disadvantages of using GBL. In the research of Cojocariu and Boghian (2014), two disadvantages were described. First, it was difficult for teachers to estimate how long participants spent playing the game. Setting a deadline can be a solution, but this can lead to discouragement and low self-esteem among the participants if a task is not completed on time. Second, while playing the game, participants may make different decisions. This can lead to exposure to different content, leading to teachers having difficulty identifying what pupils have learned through the game. Another disadvantage mentioned by Weitze (2014) is that players tend to focus on winning the game, rather than achieving the learning goals. When developing the game, the disadvantages described above should be considered. For example, designers could ensure that the game can easily be finished within one hour. This can reduce the risk of these disadvantages from occurring.

GBL or educational games are a form of active learning. The audience analysis states that active learning methods can contribute to a better understanding of climate change for children. Furthermore, educational games could stimulate intrinsic motivation, increase engagement and lead to better learning outcomes. In addition, a non-digital educational game offers greater flexibility and openness (Greenhalgh, 2016), and players accepting educational potential may also occur. To conclude, a non-digital educational game could contribute to improving the knowledge of climate change and sustainability for pupils in seventh and eighth grades.

Conclusion of the Analysis Phase

From the above analysis, several design requirements emerged. In the first section, the audience analysis revealed that instruction should not exceed 45 minutes due to the attention span of the target audience. In addition, the instructional method should be accessible to each learner, regardless of their social or cognitive level. Furthermore, consideration should be given to the knowledge that the pupils currently have so that learning new information is not too difficult and pupils are better able to incorporate the new knowledge. The final point that emerged from the audience analysis is that the instruction method should encourage active learning.

The task analysis revealed that the learning content should be based on Core Goal 39 and the content lines developed by SLO (n.d.-a-b). The game must meet the following learning goals:

- Describe the impact of human consumption patterns on the environment (e.g., the problem of waste and sustainability),
- Describe concepts related to sustainability and climate change,
- Describe how recycling is done and
- Explain what people can do to be better for the environment.

In the analyses of existing learning materials about climate change and sustainability, several learning methods which are already available are described. The characteristics of these methods are also described. One particularly interesting learning method is educational games.

In the last section, an analysis of GBL is conducted, describing the advantages and disadvantages of GBL. To conclude, an educational game is an effective instructional method that ties into these analyses and design requirements.

Design

In the second phase, the details of the practical application of the educational game are described. This includes describing the required features for an educational game. In the last section, the design requirements are translated into the design principles for the game.

Game Features

According to Prensky (2001), there are six game features which contribute to the development of an effective educational game – rules, goals and objectives, outcomes and feedback, competition, interaction and context. However, there is little consensus on how these essential characteristics of games are defined. Leemkuil (2006) has used most of these game features as a base for his definition of games and defines games as ‘competitive, situated, interactive (learning-) environments based upon a set of rules and/or an underlying model, in which, under certain constraints and uncertain circumstances a challenging goal has to be reached’ (p. 5). Consequently, the most important features in games are a challenging goal, rules and models, competition, interaction (actions and feedback), uncertainty and representation or context (Leemkuil, 2006). These game features are used in this paper and are described in the next section.

A Challenging Goal

In games, some kind of goal must be reached. Leemkuil (2006) described three types of goals that can be distinguished and are often combined in games. The first type of goal is to solve a particular problem or a series of problems, the second type of goal is to reach the highest level of proficiency, efficiency or both, and the last type of goal is to be the best amongst the competitors.

Note that a challenging goal in a game is not the same as a learning objective, and the learning goal of a game might be of larger importance than the learning objective. The most ideal situation is achieving both the goal of the game and the learning goal of the game at once. This would mean that a player only can ‘win’ or ‘achieve’ something within the game when the player has reached the learning goal of the game.

To implement a challenging goal in the game is to combine the goals of solving a particular problem or a series of problems and reaching the highest level of proficiency, efficiency or both. Furthermore, the player should ideally reach the challenging goal and the learning objective at the same time in the game.

Rules and Models

In a game, there are basic sets of procedural rules. These rules describe which actions a player may and may not take. These rules may limit a player’s actions but should not be so

restrictive that a player does not have many choices in terms of their actions, as this may reduce a player's motivation (Leemkuil, 2006). The rules force players to take specific paths to reach the goal and ensure that all players take the same paths (Prensky, 2001). However, at the same time, players must still have a sense of control over their actions.

Additional constraints could be added to the game to keep players motivated (Cooper, 1978; Leemkuil, 2006). Additional constraints could be in the form of resources or incentives used. Examples include collecting resource cards in the game Catan or losing or winning money in Monopoly. When these resources or incentives are used in a game is often a trade-off that a player has to make. An action that a player takes uses some resources, which are often limited. Consequently, a player must carefully consider when and what resources are used during a turn. Successful actions may yield more resources, and less successful actions may not.

The use of resources may be based on the pre-defined rules but could also be based on an underlying model (Leemkuil, 2006). Such a model could calculate how many resources are available at a given time for each player or team; it could also compute new game states or the values of certain indicators available in the game environment.

To implement rules and models in a game, there should be clear rules, but these rules should also be flexible and allow for a range of permissible actions within the game. Furthermore, resources and incentives can also be used in games to keep players motivated. This could be in the form of points the players have to earn.

Competition

Next, the game should include a sense of winning or losing for the player (Leemkuil, 2006). This can be achieved by beating the system or other players or teams in a confrontation. This can also be done by outperforming oneself or other players or teams. Competition is closely attached to the feature of a challenging goal.

In games, there are different forms of competition. First, one form involves an action taken by a player or team to directly influence the general state of affairs for all other players. In Monopoly, for example, buying a street affects other players, as they can no longer buy that street. Second, teams may act in their "own" world; after a certain time period, the performances of the other players or teams are compared to each other, and a "winner" is indicated. For example, in Trivial Pursuit, each team can try to fill all six squares of their game disc with different-coloured squares pieces by answering questions correctly. Thus, it is not the case that if one team obtains a blue square the other teams cannot obtain a blue square.

In the game in this study, the first form of competition, in which an action taken by a player or team directly influences the general state of affairs for all the other players, is used.

Interaction (Actions and Feedback)

If a player or a team takes an action in the game, this generally leads to changes in the game environment. This is followed by an action from one of the other players or teams or the system.

By taking into account the consequences of their actions and that of their fellow players or the system, players receive feedback that allows them to determine whether the goals of the game have been achieved or whether they have come closer and therefore appreciate their actions (Leemkuil, 2006). Feedback also informs players if they are breaking or staying within the set of rules and how the players are doing compared to the competition (Prensky, 2001).

To incorporate interaction in the game, it is possible to choose to play the game not individually but with several players. This way, players can interact with each other. To ensure that players also know that they are achieving the goal of the game, feedback can be added to the game.

Uncertainty

In a game, the goal may be clear, but whether it can be achieved might remain uncertain. That it remains uncertain could be caused by the unpredictability of the actions of other players, teams or the system; chance; unexpected events that are introduced in the game environment; or the fact that not the entire environment, the underlying model, or all essential information is available at the start of the game (Leemkuil, 2006). Such uncertainty makes players want to explore the game environment, experiment with strategies and take some risks in the game.

To implement uncertainty, it must be ensured that the steps and the end of the game are not pre-determined and whether the goal of the game is achieved is not fixed. Furthermore, a change element, such as a dice, can be added to introduce more uncertainty in the game.

Representation or Context

A game is about something, which is considered the representation of the game. Most games are based on a fictitious situation that could inspire the fantasy of the players. Sometimes, players are expected to play a certain role in the game. This is appealing for players because during the game, they can identify with a role or a situation that they rarely encounter in real life. The context of a game also includes any narrative or story elements in

the game. Representation can be abstract or concrete, as well as direct or indirect (Prensky, 2001).

To incorporate representation and context in the game, a theme for the game can be created. In this case, it is sustainability and climate change. In addition, a storyline with which a player can empathise can be used. This ensures that the players are more motivated.

Factors for Intrinsic Motivation

As mentioned in the first section about GBL, playing an educational game can be intrinsically motivating, and the factors that are important for attaining intrinsic motivation are curiosity, challenge and fantasy (Malone, 1981). Thus, for an educational game to possibly lead to more intrinsic motivation, it is important to also take these factors into account in the game design process. Garris et al. (2002) have also used Malone's (1981) three elements in their research about motivation, games and learning. It is important to highlight that these elements of motivation make games fun to play and are not about what makes games educational.

Fantasy. According to Malone (1981), fantasy can be explained as an attempt to assimilate experiences into existing structures in the real world. A fantasy-inducing environment evokes mental images of things not present to the senses or within the actual experiences of the person involved (Malone, 1981; Malone & Lepper, 1987). Thus, fantasies can offer analogies or metaphors for real-world processes that allow the user to experience phenomena from different perspectives. Games are often activities that are separate from real life in which activities in the imaginary world in the game do not impact real life (Garris et al., 2002). Since pupils learn through a game – and therefore a non-existent world – they learn through play and imagination, and their experiences during the game can then be assimilated into existing structures in the real world.

This means that fantasy can make players more interactive in a different world than in the real world. Players of the game learn how to focus on one specific point in their world of fantasy, which then becomes a replacement for the real world (Garris et al., 2002). According to Coppes et al. (2009), some studies have indicated that that players are more interested and more motivated and attain better learning results because of the role of fantasy in the instruction of a game. Therefore, implementing fantasy in an educational game can also inspire the intrinsic motivation of a player.

Fantasy can be exogenous or endogenous (Rieber, 1996). An exogenous fantasy is simply overlaid on learning content. For example, by calculating multiplication products correctly, a player can earn building blocks, allowing the player to build a house. The

learning content – learning to multiply – is separate from the fantasy – building a house. The opposite of this is an endogenous fantasy, where the learning content is closely tied to the fantasies. For example, pupils can learn about physics by piloting a spaceship on re-entry to earth's orbit. The learning content then becomes interesting if the fantasy is also interesting, and in this case, if the fantasy is interesting, the content can also become interesting. To conclude, endogenous fantasies are more effective motivational tools than exogenous fantasies.

To implement fantasy in games, users have to experience interactions in situations without having to face consequences in the real world (Thomas & Macredie, 1994). When creating endogenous fantasies, the fantasies are related to the learning content.

Challenge. Challenging the players could also help engage them in the game (Malone & Lepper, 1987). Players of the game need an optimal level of challenge. If the difficulty level of the game is too high (i.e., too challenging), the player could become reluctant. In contrast, if the game is not challenging enough, the game could be boring. Thus, the game must ideally have an optimal level of challenge, which is tied with the abilities and knowledge of the players. When there is an optimal level of challenge, players are constantly intrinsic motivated to play.

Uncertainty and feedback about performance are important components of challenge. Uncertainty is important because the players of the game do not need to know the final outcome or the steps to be taken beforehand (Garris et al., 2002). Since there is uncertainty about the outcome and progress of the game, it is challenging. Feedback about performance is also important because if players receive feedback about their performance, they know how to improve themselves and can better strive to complete the goals of the game. These goals should be meaningful for a player to feel challenged while playing a game.

To incorporate challenge in a game, the goals should be meaningful to players by linking activities to valued personal competencies and ensuring an optimal level of challenge using progressive difficulty levels, multiple goals, informational vagueness and progressive feedback.

Curiosity. Malone and Lepper (1987) stated that curiosity is one of the primary factors that drive learning. Curiosity involves an effect of surprise concerning the knowledge and expectations a player has. Curiosity is a form of making sense of the world and about familiarising oneself with how things work (Garris et al., 2002). It is about the gap between what a person knows and the new (learning) information offered to the person. A discrepancy between the optimal level and the current level of knowledge may occur if a player is not

motivated to play a game and or does not have a sufficient amount of attention for the game. In this case, the learning effects of games cannot be guaranteed (Malone, 1981). Overall, curiosity is the most important element contributing to intrinsic motivation because if the discrepancy between what a player knows and needs to learn is too large, a player may become unmotivated and may therefore not learn.

There are two types of curiosity. The first type is sensory curiosity, which refers to interest evoked by novel sensations. This is basically what is described by sensory stimuli. The second type is cognitive sensory, which refers to a desire for knowledge.

To incorporate curiosity into the game, pupils have to desire more knowledge while playing the game. This could be through a search for information in terms of an information gap in the game. In this way the pupils might not have enough information to easily play the activities of the game. Furthermore, activities embedded in fantasy contexts allow users to encounter imaginary situations that differ from their knowledge of how things work in the real world, which then stimulates curiosity (Garris et al., 2002).

Design Guidelines

Learners

First, the game should last a maximum of 45 minutes. In addition, the game should be accessible for any pupil to play, regardless of social or cognitive level. A learning method that suits seventh and eighth grade students involves active learning. GBL is a form of active learning, and there are many forms of active GBL. From the analysis of GBL, it was found that non-digital GBL is more flexible and open than digital GBL (Greenhalgh, 2016). To ensure that learners can engage, the choice to create a board game has been made. By playing the board game, learners are able to interact with each other and be actively engaged.

Learning Goals

Additionally, information about the impact of human consumption patterns on the environment (e.g., the problem of waste), sustainability and climate change and recycling must be included in the game. In addition, pupils should learn what humanity can do to be better for the environment. Thus, these learning objectives should be achieved when the pupils play the board game.

Game Features

Table 3 is a summary of how the different features and design requirements of the game features can be practically applied during the development phase.

Table 3*Design Guidelines*

Guidelines	Practical application
Include fantasy	<ul style="list-style-type: none"> • The game includes a storyline. • The game context includes endogenous fantasies.
Include representation/context	<ul style="list-style-type: none"> • The game allows players to experience interaction without affecting player's situation in the real world.
Include rules/models	<ul style="list-style-type: none"> • The game context has to provide a set of clear rules that are also flexible so that players have a feeling of control. • The game has to include some resources/incentives to keep the players motivated.
Include goals	<ul style="list-style-type: none"> • The game provides a clear goal and learning objectives; these should preferably be achieved by the player at the same time.
Include learning goals	<ul style="list-style-type: none"> • The learning goals of the game focus on the impact of human consumption patterns on the environment and the beginning of an ecological understanding according to Core Goal 39 and the content lines developed by SLO.
Include challenge	<ul style="list-style-type: none"> • The game has to include a challenging goal. This can be done by combining two types of goals, to solve a particular problem or a series of problems and to reach the highest level of proficiency and or efficiency. • The game should match the personal competencies of the player, to achieve an optimal level of challenge. • The game could include progressive difficulty levels, multiple goals, informational vagueness and progressive feedback.
Include interaction	<ul style="list-style-type: none"> • During the game, players have to interact with each other.
Include uncertainty	<ul style="list-style-type: none"> • There has to be some kind of uncertainty during the game.
Include curiosity	<ul style="list-style-type: none"> • The game should arise curiosity from the players and awaken a desire for more knowledge; • The players of the game encounter information gaps. The pupils do not have enough knowledge/information to easily play the activities of the game.
Includes feedback	<ul style="list-style-type: none"> • The feedback in the game must be given immediately after the actions of the player and must focus on the learning goals of the game and must include social interaction (Leemkuil, 2006; Prensky, 2001).

Development

In the development phase, the prototype of the board game is developed. The design principles from the design phase are the basis for the development of the educational game. The name of the game is Milieu Bewust; in this chapter, the details of the board game are elaborated. In the paragraphs, the elements of the board game are described in detail and linked to the design principles described in the section above. The modified manual and an overview of the questions can be found in Appendix B and C.

Goal of the Game

There are two goals in the game. The first goal of the game is to collect 12 plastic points. This is in line with the goal to achieve a certain level of proficiency, efficiency or both.

The second goal is to answer the final question ‘What do you think you can do to be less polluting to the environment?’ when the players reach the city of Utrecht. This is in line with the goal to solve a particular problem or a series of problems. By answering the thinking question, in particular, players are stimulated to think about what they can do to improve the environment.

Role Division

The players play together as a team. This choice was made because according to constructivism (Von Glaserfeld, 1989), learning develops in a social context. Players have to support and help each other to answer the questions; through this process, the players learn in a social context.

Plastic Points

Players can collect points by answering questions on the game cards to the best of my ability. For each correctly answered question, the player receives points in the form of plastic gemstones (see Figure 2). The goal is to collect at least 12 plastic points before the players reach Utrecht. This number of plastic points is needed to melt the plastic into plastic artwork. Earning such rewards can help motivate players.

Figure 2

Plastic Gemstone



Gameboard

The gameboard should be attractive to the pupils to motivate them to play the game. It was decided to turn the gameboard into a train system with 36 boxes on it. Thirty-two of these squares are small coloured circles. Furthermore, there are three intermediate stations (cities) during the game represented as three larger green circles. The last green circle of the game board is the terminal station – Utrecht station.

These coloured circles have three different colours, each of which represents a different card category. The red circles belong to the red question cards, the blue circles belong to the blue question cards, and the yellow circles belong to the Did You Know cards. The green circles represent the stations of Zoetermeer, Gouda, Woerden and Utrecht, which correspond to the green cards.

The gameboard is designed this way to make it easy for the pupils to be able to see the whole board. When players land on one of these circles, they can pick up a card that matches that colour. Either a question can be asked or information associated with that colour can be given. See Figure 3 for the gameboard.

Figure 3

Board Game Bewust Milieu



Dice

A six-sided dice is used during the game. The number of dots on the side of the dice facing up determines the number of spaces a player can move forward (see Figure 4). Adding a dice adds an element of uncertainty.

Figure 4

A Dice

**Pawn**

In the game, there is one pawn in the shape of a train (see Figure 5). The team moves around the game board using this pawn. This makes it clear to the team how much progress they have made in the board game. At the beginning of the game, the team places their pawn on the green start circle, Den Haag, which is also indicated by the word START.

Figure 5

A Pawn in the Shape of a Train

**Gameplay**

First, each player throws the dice. The player who throws the highest number starts the game and takes the first turn. This player throws the dice and the number of dots on the side of the dice facing up indicates how many spaces a player can move the pawn forward.

The player then moves the pawn to a coloured circle. The player who has thrown the dice takes the card which matches the coloured circle and read this card out loud. The players

can then discuss together to answer the question. If the player does not understand a word or concept from the question, then this player can ask the other players if they know the concept. On the back of the card, is the correct answer with an explanation or only an explanation. This is the feedback the players receive as to why the answer to a question is right or wrong.

If the team answers the question correctly, they receive the number of plastic points indicated on the card. If a question is answered incorrectly, then the team receives no plastic points. After the team has received the plastic points, the next player, the player to the left of the previous player, can throw the dice.

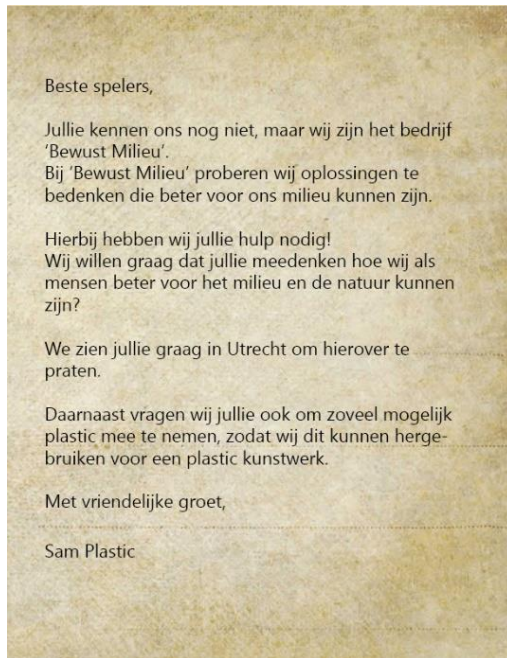
Storyline

A company, Bewust Milieu, invites the players to think about how people can use less plastic, writing this in a letter to the players. To make sure that the pupils feel like they are receiving this letter and engage them more in the storyline, it was decided to provide a letter as part of the game materials (see Figure 6). In addition, the company asks the players to bring as much plastic as possible to reuse it for plastic artwork. This request of the company is linked to correctly answering the Questions, Did You Know, and Thinking cards in the game. Therefore, if the players answer a question correctly or contribute ideas based on the Thinking cards, they earn plastic points. In this way, the different parts of the game always remain linked to the storyline.

At the end of the game, when the players have reached Utrecht, there is an additional Thinking card for the players. This card once again shows the question the players were asked at the beginning of the game in the letter of the company, also the final question. The players can answer the final question to finish the game and also reach one of the goals of the game at the same time.

Figure 6

An Example of the Letter of the Organisation



Question Cards

The content of these cards is based on the content analyses and the various appendices from SLO (see Appendix B). To make the cards attractive, it was decided to print out the cards in a bright colours. In addition, matching pictures or images were added to several cards to help pupils create different connections with the information from the text, pictures and game board.

The questions that are asked include multiple-choice questions with two or three answer choices, as well as questions where they have to put items in the correct order or indicate the correct statements. The question and the different answer choices are on the front of the card, while the correct answer along with an explanation is on the back of the card. The explanation is the feedback the players receive as to why an answer is right or wrong.

One of the players on the team takes a question card and reads it out loud. Next, the players can discuss what they think the right answer is. When the players agree on what they think the correct answer is, they can check the answer on the back of the card. The player holding the question card may then read out the correct answer with a possible explanation.

There are a total of 24 Question cards for the prototype, which means 12 red cards with multiple-choice questions and 12 blue cards with other kinds of non-multiple-choice questions. If a question is answered correctly, players receive the number of plastic points

indicated on the card. See Figure 7 for the red multiple-choice question card and Figure 8 for the blue question card.

Figure 7

An Example of a Red Question Card

Vragen kaart	Antwoord
 <p>Hoelang is de natuur bezig om een mondkapje af te breken?</p> <p>A. 1 jaar. B. Oneindig. C. 14 dagen.</p>	<p>Het juiste antwoord is B.</p> <p>De natuur kan een mondkapje niet helemaal afbreken omdat er kleine deeltjes plastic in het mondkapje zit.</p> <p>Plastic kan namelijk nooit door de natuur worden afgebroken.</p> <p>Beloning:</p> 

Figure 8

An Example of a Blue Question Card

Vragen kaart	Antwoord
<p>Weet jij hoe je van oud blik weer nieuwe blik maakt? Zet de zinnen in de juiste volgorde.</p> <p>Start met nummer 1</p> <ol style="list-style-type: none"> 1. Je gooit je lege blikje in de afvalbak. 2. In de metaalfabriek wordt het metaal omgesmolten en er worden grote metalen platen van gemaakt. 3. Met magneten wordt het metaal uit de verbrande resten gehaald. 4. Het afval wordt verbrand. Het metaal van het blikje verbrandt niet. Dat blijft achter. 5. Het afval gaat naar het afvalverwerkingsbedrijf. 	<p>Het juiste antwoord is 1-5-4-3-2.</p> <p>Let op! Je moet alle nummers juist hebben om de beloning te ontvangen.</p> <p>Beloning:</p> 

Did You Know Cards

Second, there are Did You Know cards (see Figure 9) which contain information on the topics of sustainability and climate change. In addition, the information on the cards is in line with learning goals. By adding these cards to the game, pupils gain additional knowledge. In addition, the information on these cards can also be somewhat more challenging and may be slightly more detailed. Players also receive one plastic point for these cards. There is a total of 10 Did You Know cards.

Figure 9

An Example of a Yellow Did You Know Card



Thinking Cards

The last category of cards is Thinking cards (see Figure 10) which feature thinking questions. The pupils may discuss one or more answers to the thinking cards. The purpose of these questions is to make the pupils aware of what they can do to improve the environment.

These cards with a thinking question on them are linked to a certain city. At the top of the cards are the names of the stations Woerden, Gouda, Zoetermeer or Utrecht. For example, if a pupil arrives on the green circle Woerden, they take a thinking card that belongs to that station. For example, if a player throws four and lands on Gouda station, that player take the thinking card belonging to Gouda.

Figure 10

An Example of a Green Thinking Card



Overview Materials

The game consists of different materials. Figure 11 presents an overview of the board game with all the materials included. The following materials belong to the board game Bewust Milieu:

- A gameboard showing the train journey from Den Haag to Utrecht.
- A pawn in the shape of a train.
- 50 plastic points in the shape of gemstones.
- 12 red Question cards.
- 12 blue Question cards.
- 10 Did You Know Cards
- Four green Thinking cards.
- A letter from the company Bewust Milieu.
- An envelope containing the letter from the company Bewust Milieu.
- An explanation of the rules of the game.

Figure 11

An Overview of the Materials of the Educational Board Game Bewust Milieu



Prototype Evaluation

In this stage, the prototype is evaluated by teachers before the board game is used for instructional purpose. First, the method used to test the prototype is now presented, and in the last section, the results and the subsequent adjustment are described.

Respondents

The first group of prototype evaluators consisted of four teachers who teach sixth, seventh or eighth graders or recently (less than two years ago) taught this target group. The teachers were approached through the personal network of the researcher through convenience sampling. According to Onwuegbuzie and Leech (2007), convenience sampling is used to obtain more insight into phenomena, individuals or events.

Variables and Instruments

First, a questionnaire was used to evaluate the game instruction, the layout of the board game and the question and information cards. The focus of the questionnaire was on language use and whether it was appropriate for 10-, 11- and 12-year-old pupils. In addition, whether the knowledge gained by playing the game matches the knowledge that the pupils have acquired in previous years about sustainability and climate change is verified; the teachers also indicated whether the rules can be understood by pupils in seventh and eighth grade.

Procedure

Informed Consent

First, teachers participating in the questionnaire were asked to provide their informed consent (see Appendix D). They were informed about the purpose of this study, notified that they could stop whenever they wanted to during the research and assured that their data would be processed anonymously.

Questionnaire for Teachers

A questionnaire about the board game was conducted among teachers who taught sixth, seventh and eighth grades (see Appendix E). The questionnaire was divided into four parts; Part 1 was about the explanation for the game, and Part 2 was about the board game itself. Part 3 was about the different cards involved in the game. In the fourth part of the questionnaire, some general information about the game and the teacher was requested. The teachers also received a file containing the game instructions, a picture of the board game and the different contents of the cards. These components corresponded to the different questions in the questionnaire. The teachers were also able to append comments to the files, which were collected at the end of the questionnaire.

The questions mainly aimed to determine whether the language use and level of language correspond to a seventh or eighth grade level. Based on the answers, the questions, information cards and the game explanation were further adapted, resulting in a new prototype that the pupils would test.

Analysis

The results from the questionnaire are analysed using the four categories: the game explanation, the board game, the different cards involved in the game and general information.

Results

Questionnaire With Teachers

Four teachers ($N = 4$) completed the questionnaire. One of the teachers is no longer teaching sixth, seventh or eighth grade but completed the questionnaire. Their responses indicated that the game instructions were clear, but that a few sentences and terms could be improved. Additionally, some sentences were identified as too long and required shortening. These adjustments could improve the clarity and comprehensibility of the instructions for the pupils.

Another observation was that the goal of the game was stated at the bottom of the game instructions in the prototype. Two teachers indicated that the goal of the game should be placed at the top of the explanation for the game. The teachers indicated that they always do this themselves in their lessons and that the pupils are used to it. Furthermore, the fact that there are boxes with examples in the manual was seen as a positive point. This made the game's rules explicit to the players.

The results of the questionnaire showed that the teachers thought that the board game looks good and professional. One teacher said that the pupils would like the colours. There were no further remarks on the layout of the game.

The questionnaire responses also showed that the language used for the different game cards corresponded to a seventh or eighth grade level. However, it was noted that seventh graders who were not as strong in Dutch may have difficulty with some words. With help from fellow players, the game would certainly be manageable. However, for eighth graders who are strong Dutch speakers, the use of language might be seen as easy. In general, the language was correct.

According to the results of the questionnaire, the questions might be slightly difficult seventh grade students, but also challenging for eighth grade students. The questionnaire showed that two questions were very challenging (e.g., 'People from different countries have

a different ecological footprint. Put the countries in the right order, starting with the country with the lowest per capita ecological footprint. A. the Netherlands. B. United States C. India’).

A question about the level of the Did You Know cards was also asked – ‘Does the information on the Did You Know cards fit in with the knowledge that the pupils have already acquired up to grade 6?’ The teachers indicated that most of the cards matched the knowledge the pupils had already acquired in previous years. However, the teachers indicated that on one Did You Know card, it was too difficult to explain the information in a few sentences.

Furthermore, the teachers responded positively to the explanations provided with the answers. These can ensure that students understand why an answer is right or wrong.

Adjustments Based on the Teacher Questionnaire

Some adjustments in the game’s instructions were made according to the results of the questionnaire. Table 3 shows the remarks made by the teachers, the old sentence and the new, improved sentence. First, the goal of the game was moved to the beginning of the document. In addition, some sentences and terms were written differently in the manual to make it easier for the players to understand.

Table 4

Overview of Adjustments of the Game Instruction

Comment	Old phrases/term(s)	Improved sentences/term(s)
Difficult term	The <u>red cards</u> are linked to a city – namely, Zoetermeer, Gouda or Woerden.	The <u>red cards</u> have names of cities: Zoetermeer, Gouda, Woerden or Utrecht.
Making it concrete	There are also cards of four different colours; place the cards in a pile by colour.	There are also cards of four different colours – green, yellow, blue and red. Stack the cards in a pile by colour.
Unclear sentence	The coloured boxes belong to different types of cards:	Below is an explanation of the different colour cards:
Change sequence sentence	A minimum of 15 plastic points must be collected; then, Bewust Milieu can remelt the plastic to make a work of art. When the last question is answered and the plastic points are counted, then the game is over.	When the last question is answered and the plastic points are counted, the game is over. A minimum of 15 plastic points must be collected; then, Bewust Milieu can remelt the plastic to make an artwork.

Note. See Appendix F for translation in Dutch.

In addition to the adjustments in the manual, adjustments to the various cards were also made. Table 4 shows an overview of these adjustments. First, some questions were replaced because the teachers found them very challenging. The results from the teachers' questionnaire showed that the teachers found the information on one Did You Know card too difficult to explain in a few sentences. Therefore, the content of this question was replaced by another subject that was easier to understand in a few sentences. Furthermore, there were also smaller adjustments, such as making sentences shorter or using different terms to better suit the target group. These changes to the question cards ensure that the questions remained challenging for the players but were not impossible to answer.

Table 5

Overview of Adjustments of the Game Cards

Comment	Old questions/ sentences or term(s)	Improved questions/ sentences or term(s)
Change the sequence of the sentences	Green energy is energy generated from renewable energy sources, meaning that you do not have to take anything away from the earth. Please indicate whether or not the following forms of energy are green.	Renewable energy sources are sources of energy which do not require you to take anything from the earth. This is also called green energy. Indicate whether or not the following forms of energy are green.
	A: Green energy B: No green energy. C: Green energy. A and C are green energy because we do not have to take something from the earth. B is not green energy; it is taken from the earth and these energy sources can run out.	A: Yes B: No C: Yes A and C are green energy because we do not have to take something from the earth. B is not green energy; is taken from the earth, and these energy sources can run out.
Sentence too long	A world where people, the environment, and the economy are	A world where people, the environment, and the economy are in balance. When these are in

	in balance so that we do not overexploit the earth.	balance with each other, we ensure that we do not deplete the earth.
Change question	<p>8. What is a greenhouse gas?</p> <p>A. Gas in the atmosphere that causes the earth to warm up.</p> <p>B. Gas which causes water to stay cold.</p> <p>C. Gas which causes cars to run.</p> <p>Answer: The correct answer is A; greenhouse gases cause some of the heat from the sun to stay within the atmosphere, thus warming the earth.</p>	<p>8. What is meant by 'residual waste'?</p> <p>a. Residual waste is waste that cannot be recycled.</p> <p>b. Residual waste is another word for litter.</p> <p>c. Residual waste is 'leftovers', so it is waste left over from eating</p> <p>Answer: the correct answer is A. By residual waste, we mean all the waste that cannot be recycled.</p>
Change question	<p>8. An ecological footprint is the calculation of how much space is needed to meet the needs of a person. This is often given in hectares.</p> <p>People from different countries have different ecological footprints. Put the countries in the correct order, starting with the country that has the lowest ecological footprint per capita.</p> <p>A. Netherlands</p> <p>B. United States</p> <p>C. India</p> <p>Answer: C-A-B. India has the lowest per capita ecological footprint – 0.8 hectares per capita. This is equivalent to about two soccer fields. The Netherlands comes next with 4.4 hectares, about nine soccer fields, and next</p>	<p>8. Indicate whether the following sentences are examples of the unnecessary use of items and waste.</p> <p>A. Buying more food than you need as a family, making you throw away food every week.</p> <p>B. Buying a new plastic bag every time you go to the store.</p> <p>C. Drawing a picture on recycled paper.</p> <p>Answer:</p> <p>A and B are examples of the unnecessary use of stuff or waste.</p> <p>With A, you always buy too much food and thus have to throw that food away again. With B, you keep buying new plastic bags, even though you have some at home that you can use again.</p>

	is the United States with 9.6 hectares, about 20 soccer fields.	Answer C is not an example of unnecessary use of stuff or waste because you are reusing the paper.
Easier formulation	This results in plastic getting into the animals' stomachs. Besides the fact that plastic is obviously not food, it also contains toxic gases. This can cause the animals to die.	The result of this pollution is that many animals think it is food. If animals eat the plastic, it can end up in their stomachs. In plastic, there are toxic substances, and if these are in the stomach of an animal, an animal can die.

Note. See Appendix F for the Dutch translations.

Implementation and Evaluation of the Board Game

In the last two steps of the ADDIE model, the prototype is utilised, partly coinciding with the evaluation phase. First, the method of testing the board game is presented, and in the last section, the results of testing the board game are presented.

Variables and Instruments

To test the board game, a focus group interview was used. A focus group is a convenient method to evaluate and validate an idea or product with children (Pauwels & Dreijer, 2018). Focus groups are appealing, accessible and informal and are more in line with children's world of experience. The pupils were asked whether the educational game appeals to them, whether they found it interesting and fun, whether they have learned something about climate change and sustainability, and whether the gamemanual was understood properly.

Respondents

During the test phase, pupils in seventh and eighth grades, ages 10–12, played the board game. There are different views on how many participants should be in a focus group. According to Johnson and Christensen (2004), a focus group should ideally include six to 12 participants. However, other studies say that there should be between six and 10 participants in a focus group (Morgan, 2007; Langford et al., 2002). Since the board game can only be played with four people, this research deviates from this norm, and one focus group consists of four participants. There may be less discussion during the focus group since there are only four participants, but the researcher can prepare for this by preparing additional questions.

In addition, according to Morgan (1997), approximately three to five focus groups are required to obtain all the necessary information. During the study, 30 participants ($N = 30$) – ages 10 ($N = 17$), 11 ($N = 12$) and 12 ($N = 1$) – took part. The pupils were selected from the same school and the same class through convenience sampling. There were six focus groups in total.

Procedure

Informed Consent

To test the board game with pupils, parental or caretaker consent was necessary before pupils are approached to participate in this study. The school indicated that parents fill in a form at the beginning of the year giving their permission for pupils to take part in studies. For this reason, an objection form was attached to the information letter (see Appendix D).

Playing the Game

The different groups that played the board game were organised by the teacher. The materials for the game were given to the players at the beginning. The first step for the players is to read the manual. After reading the manual, the players started to play the educational board game. The players played the game without instruction from a teacher, and they had between 30 and 45 minutes to play the game. While playing the board game, the researcher was present.

Focus Group

The group interviews were conducted immediately after playing the game. All pupils gave an initial response. After that, the topics of the group interviews were covered (see Appendix G). All group interviews were semi-structured and lasted up to 15 minutes. Furthermore, audio recordings of the interviews were made. Based on these focus group interviews, additional adjustments were made to the prototype. The prototype was again evaluated, as this iterative process continues until the result is satisfactory.

Analysis

The results of the focus group interviews were analysed through a code scheme. making use of different topics – the board game in general, the game’s instructions and the goal of the board game, the game board, game cards, challenges and other feedback (see Appendix G). Positive and negative points were indicated for each topic. If points for improvement were indicated, these were also described.

Results

Focus Group

All invited pupils participated in the focus group (N = 30). The results of the focus group were presented by categories according of the code scheme (see Appendix H).

The Board Game. Almost all pupils indicated that they liked the game. They shared that playing a board game is a fun way to gain new knowledge about sustainability, climate change and the environment. The pupils would like the board game to be a part of nature lessons. In addition, a few pupils would like to play the board game again at home.

Three groups (twelve pupils) indicated that they found the game to be on the short side. These pupils completed the game in 15 to 20 minutes. The other groups played the game for 20 to 30 minutes.

Game Instructions and the Goal of the Board Game. The pupils indicated that they did not find the language used in the game instruction to be challenging. The pupils, however, indicated that the explanation of the game was very long. One pupil said, ‘I can give a shorter

summary of the game explanation myself and then we can play faster and get less distracted.’ The other three pupils in the same group agreed with her.

According to the pupils, the aim of the game was clearly stated in the instructions – namely, to learn about the environment and sustainability. The pupils also indicated that they learned new information about these topics. Several pupils said they did not know that masks are non-biodegradable. One pupil even said, ‘But there are so many masks in nature, so they don’t really disappear on their own’. Another pupil indicated that humans should take better care of the environment and said, ‘If I shower less, I take better care of nature’.

Gameboard. The pupils said that they liked the layout of the board. They found the different colours beautiful and cheerful. Some pupils also indicate that the gameboard could be somewhat larger. Another point the pupils mentioned was to make a train route of cities through Gelderland as well. This is because their school is located in Gelderland, so having a route through Gelderland would make the game more fun because the pupils would be able to identify more easily with the train route and places.

Game Cards. The pupils experienced the different-coloured playing cards as positive. The variation in the types of questions as well as the cards with information ensures that the game remains varied. One pupil even said: *‘That even more questions and more different coloured cards may be added to the game.’* The majority of pupils indicated that the Did You Know cards provided the newest information and that they learned the most from these cards.

Challenge. Some pupils found the questions on the difficult side, while other pupils found the questions not too difficult but also not too easy. The blue multiple-choice questions were also perceived as easier than the red question cards. However, the red questions were not too difficult to answer.

Of the eight groups that played the game, seven groups gained at least 15 plastic points by the end of the game. Out of these seven groups, four groups scored exactly 15 points.

Other Feedback. The pupils also indicated other points of improvement. A first suggestion was to attach a card of another colour card to the board game. These questions could then become personal questions about what a player is already doing personally for the environment. An example of a question was: ‘What are you already doing for the environment?’

The pupils enjoyed working together in a group. A few pupils also indicate that they might also find it enjoyable to compete against each other in pairs. One pupil said that this would make the game more challenging and even more fun.

A final point of improvement was that the pupils would also like it if there were different train routes. The school where the board game was tested is located in the province of Gelderland, and one pupil said, 'It would be nice if the places in this area were also on the game board'. Another pupil said, 'It would also be nice if there were larger routes that also run through other countries'.

Adjustments Based on the Focus Group Interviews

Some adjustments were made according to the results of the focus group interviews. First, it was decided that the pupils would play the game in pairs rather than cooperatively, with all the four players in the same team. This choice was made because this option adds an element of competition against their classmates, which is an important game characteristic and was approved by the pupils themselves. This adjustment also extends the duration of gameplay. This resolves the issue identified in the feedback that the game is somewhat short. After these adjustments, the game would last a maximum of 45 minutes.

Another adjustment made based on the focus group was adjusting the manual. Since the pupils found the manual to be too long, some pupils were distracted and did not follow all the instructions. Shortening the manual could help the pupils to better concentrate on reading the manual. Other options for explaining the game were also considered. However, the students need to be able to play the game independently, so an explanation from a teacher is not desired. In addition, the researcher decided against turning the manual into video instructions because the game should also be playable without an electronic device such as a laptop.

Discussion and Conclusion

This last chapter contains the conclusion, discussion and recommendations of this research. First, the conclusion of this study, in which an educational board game was developed about sustainability and climate change for grades seven and eight in primary education, is described. The next section presents the discussion. In the last section, recommendations for further research are presented.

Conclusion

Awareness of climate change is urgent because the climate is changing, resulting in several consequences. The next generation may notice these consequences, but more importantly, they are the generation that can effectively contribute to the solution. CCE could be helpful as a solution to make children aware of climate change and could start in primary education.

Based on audience analysis, task analysis and an analysis on existing instructional methods, it was determined that GBL can contribute to students' understanding of climate change and sustainability. Based on various game characteristics and features that fit the target group and task, an educational board game about sustainability and climate change was developed in this study. The board game was developed for pupils in grades seven and eight in primary education. To test whether the board game contributes to learning about climate change and sustainability, a prototype of the board game was tested. The pupils' evaluation of the prototype indicated that through playing the board game, they learned more about climate change and sustainability. In addition, some pupils also started thinking about their impact on the environment, and this slight transformation in thinking could contribute to a solution to climate change.

Discussion

In this study, an educational board game was developed to educate pupils about sustainability and climate change. This study was mainly qualitative because the design and development of a game was the main goal of the study. This research could not test whether the educational board game had learning effects. To measure such effects, a quantitative study should be conducted. Quantitative research involves testing theories and hypotheses to see whether or not they can be confirmed. However, the results of the focus group interviews showed that the pupils gained new knowledge about sustainability and climate change. However, to draw generalisable conclusions, quantitative research is needed to compare the board game with other learning methods or to include a control group. Then, whether the

board game is actually a good learning method for teaching climate education to pupils can be measured.

Another point of discussion is the content of the different cards. The cards were developed based on the SLO report with ‘Elaboration of knowledge topics for the content lines of Orientation on yourself and the world’ (see Appendix A). This report briefly describes which concepts and information the pupils must know. However, this report does not explain some concepts or gives very little information about the topics. Therefore, additional information or different definitions were sought from other sources. An example of another source is the dictionary van Dalen. Therefore, terms or information may be described differently from what is meant in the SLO file, and students may acquire different or inaccurate knowledge compared to what is described by SLO.

Furthermore, although it was emphasised that the teachers should be as critical as possible so that the board game could be improved, there was a chance that socially desirable responses were offered since the teachers who completed the survey were mostly individuals the researcher knew personally. This may have caused the teachers to give socially desirable answers that they thought the researcher would like to hear. A major disadvantage of this could be that the explanation, the information on the cards and the game itself had some more points to be criticised, but the researcher may not have found these out because they were not indicated during the questionnaire.

This problem may have also occurred during the testing of the board game. The researcher was present during the testing of the board game and during the focus group interviews. The pupils may not have dared to express themselves honestly and may have given socially desirable answers. This may have caused the pupils to be less critical and not to mention possible points of improvement. More pupils may have not liked playing the board game but did not dare to say so even though the pupils were clearly allowed to express their own opinions, no matter what they might be.

Recommendation

In this section, some recommendations for future research are formulated. First, the contents of the various cards should be analysed and revised where necessary. This can be done by presenting the different cards to experts on sustainability and climate change. Ideally, these experts should also produce educational materials for the target group of 10-, 11- and 12-year-old pupils. This can ensure that the pupils gain accurate knowledge on this subject in an even more effective way. It is most likely that such experts can contribute to the process of developing this game further and that the game can become part of the curriculum.

A next step could be to look, together with the expert, at differentiating the various cards according to difficulty level. Then, the pupils can earn more plastic points for the more difficult questions and fewer plastic points for the easier questions. Differentiating questions can ensure that the pupils experience more challenges. The players who experience most questions as easy then receive more difficult questions in the game and can see these questions as a challenge. This can also make the game more fun for the pupils who currently find the game less challenging.

Second, gameboards of different provinces or even different countries can also be made. During the focus group, the pupils indicated that they would find the board game more fun if it illustrated their surroundings. Whether or not this is true should be investigated. This can also help pupils not only learn about sustainability and climate change but also improve their knowledge of topography. While improving topography knowledge is certainly not the main learning objective for this board game, it can be an additional learning objective.

As described in the discussion paragraph, this study could not test whether there was a learning effect when the pupils played this educational board game. To test the learning effects of the game, a quantitative study is recommended. In such research, the learning effects of the educational board game must be compared with other learning methods, or a control group must be included. To investigate the learning goals of this game, it is recommended to research core goals for primary education, especially Core Goal 39.

References

- Aarnoudse, L. (2019, January 25). *'Scholen doen te weinig aan klimaatverandering'*. OneWorld. <https://www.oneworld.nl/lezen/schone-energie/land/het-westerse-denken-belemmert-duurzaamheid-in-onderwijs/>
- Berlyne, D. E. (1960). *Conflict, arousal, and curiosity*. New York: McGraw-Hill.
- Bonwell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom*. ERIC Clearinghouse Products.
- Bordspel Klimaatjes. (2021, April 19). *Bordspel Klimaatjes - Educatief en interactief bordspel over duurzaamheid*. Retrieved 1 March 2022, from <https://bordspelklimaatjes.nl/>
- Cojocariu, V. M., & Boghian, I. (2014). Teaching the Relevance of Game-based Learning to Preschool and Primary Teachers. *Procedia - Social and Behavioral Sciences*, 142, 640–646. <https://doi.org/10.1016/j.sbspro.2014.07.679>
- Cooper, N. (1978). But it doesn't really happen like that: a look at business games in management training. In: R. McAleese (Ed.), *Perspectives on academic gaming & simulation 3. Training & professional education*. London: Kogan Page.
- Coppes, W., Fisser, P., Smit, M., & Voogt, J. (2009). *De zin en onzin van gaming in het onderwijs*. Enschede: SLO.
- Daellenbach, K. (2018). On carrot cake and marketing education: A perspective on balancing skills for employability. *Australasian Marketing Journal*, 26, 172-179.
- D'Amato, G., Holgate, S. T., Pawankar, R., Ledford, D. K., Cecchi, L., Al-Ahmad, M., Al-Enezi, F., Al-Muhsen, S., Ansotegui, I., Baena-Cagnani, C. E., Baker, D. J., Bayram, H., Bergmann, K. C., Boulet, L. P., Buters, J. T., D'Amato, M., Dorsano, S., Douwes, J., Finlay, S. E., . . . Annesi-Maesano, I. (2015). Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders. A statement

of the World Allergy Organization. *World Allergy Organization Journal*, 8, 25.

<https://doi.org/10.1186/s40413-015-0073-0>

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Journal of Educational Technology and Society*, 18, 75–88.

Dreijer, R., & Pauwels, H. (2018). *Onderzoek doen met kinderen: Verzameling van leuke en creatieve werkvormen geschikt voor het doen van onderzoek met kinderen.*

https://research.hanze.nl/ws/files/25297432/HANZE_18_0205_Waaier_Kind_in_de_de_Wijk_Losbladig_LR.pdf

Forehand, M. (2005). Bloom's taxonomy: Original and revised. Emerging perspectives on learning, teaching, and technology. Retrieved from <http://projects.coe.uga.edu/epltt>.

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, Motivation, and Learning: A Research and Practice Model. *Simulation & Gaming*, 33(4), 441–467.

<https://doi.org/10.1177/1046878102238607>

Von Glasserfeld, E. (1989). Constructivism in Education. In: Husen, T. & Postlethwaite, T. N. (eds.) *International encyclopedia of education*. Supplement Volume 1. Oxford: Pergamon Press.

van Graft, M., Tank, M. K., & van der Linde - Meijerink, G. (2020). *Uitwerking kennisonderwerpen bij de inhoudslijnen van Oriëntatie op jezelf en de wereld*. SLO.

<https://www.slo.nl/sectoren/po/inhoudslijnen-po/inhoudslijnen-orientatie-jezelf-wereld/>

Greenhalgh, S. P. (2016). Affordances and constraints of analog games for ethics education: Dilemmas and dragons. In K. D. Valentine & L. J. Jenson (Eds.), *Examining the Evolution of Gaming and Its Impact on Social, Cultural, and Political Perspectives* (1st ed., pp. 219–237). Igi Global.

- Haines, A., & Ebi, K. (2019). The Imperative for Climate Action to Protect Health. *New England Journal of Medicine*, 380(3), 263–273.
<https://doi.org/10.1056/nejmra1807873>
- Het groene brein. (2015). *Rapportage onderzoek duurzaam onderwijs*. Ministerie van Infrastructuur en Milieu.
<https://www.tweedekamer.nl/kamerstukken/detail?id=2015D25798&did=2015D25798>
- Johnson, B. & Christensen, L. (2004). *Educational Research: Quantitative, Qualitative, and Mixed Approaches*. 2nd ed., Needham Heights, MA: Allyn & Bacon.
- Kagan, J. (1972). Motives and development. *Journal of Personality and Social Psychology*, 22, 51-66. <https://doi.org/10.1037/h0032356>
- KNMI. (2021). *KNMI Klimaatsignaal '21: hoe jet klimaat in Nederland snel verandert*.
https://cdn.knmi.nl/knmi/asc/klimaatsignaal21/KNMI_Klimaatsignaal21.pdf
- Langford, B. E., Schoenfeld, G. & Izzo, G. (2002). Nominal grouping sessions vs. focus groups. *Qualitative Market Research: An International Journal*. 5(1) 58–70.
<https://doi.org/10.1108/13522750210414517>
- Leemkuil, H. H. (2006). *Is it All in the Game? Learner support in an educational knowledge management simulation game*.
https://ris.utwente.nl/ws/portalfiles/portal/263670932/thesis_Leemkuil.pdf
- Malone, T. W. (1981). Toward a Theory of Intrinsically Motivating Instruction*. *Cognitive Science*, 5(4), 333–369. https://doi.org/10.1207/s15516709cog0504_2
- Malone, T. W., & Lepper, M. R. (1987). Aptitude, Learning, and Instruction. In R. Snow & M. Farr (Eds.), *Making Learning Fun: A Taxonomy of Intrinsic Motivations for Learning* (Vol. 3, pp. 223–253). Routledge.

- McKenney, S. E., & Reeves, T. C. (2018). *Conducting Educational Design Research*.
Routledge.
- Milieueducatie Den Haag. (2021). *Werkbladen en lessen over klimaatverandering*.
<https://www.milieueducatedenhaag.nl/catalogus/2021-2022/Primair+Onderwijs/catalogus/product/Werkbladen+en+lessen+over+klimaatverandering>
- Morgan, D. L. (1997). *Focus Groups as Qualitative Research*. 2nd ed., Qualitative Research Methods Series 16. Thousand Oaks, CA: Sage
- Morrison, J. R., Ross, S. J., Morrison, J. R., & Kalman, H. K. (2019). *Designing Effective Instruction*. Wiley.
- Naik, N. (2014). *A comparative evaluation of game-based learning: Digital or non-digital games?* European Conference on Games Based Learning.
<https://www.proquest.com/openview/8c029a2d595b50160e3dd15300c943ac/1?pq-origsite=gscholar&cbl=396495>
- Nederland Schoon. (n.d.). *Afvalspel*. Aandeslagmetafval.
<https://www.aandeslagmetafval.nl/vertelplaat/>
- Onwuegbuzie, A. J., & Leech, N. L. (2007). A Call for Qualitative Power Analyses. *Quality & Quantity*, 41, 105–121. <https://doi.org/10.1007/s11135-005-1098-1>
- Porter, D., Weaver, A. J., & Raptis, H. (2012). Assessing students' learning about fundamental concepts of climate change under two different conditions. *Environmental Education Research*, 18(5), 665–686.
<https://doi.org/10.1080/13504622.2011.640750>
- Prensky, M. (2001). Fun, play and games: What makes games engaging. *Digital Game-Based Learning*, 5(1), 5–31. <https://doi.org/10.1145/950566.950596>

- Qian, M., & Clark, K. R. (2016). Game-based Learning and 21st century skills: A review of recent research. *Computers in Human Behavior*, 63, 50–58.
<https://doi.org/10.1016/j.chb.2016.05.023>
- Recycle. (z.d.). In *Van Dale*. <https://www.vandale.nl/gratis-woordenboek/nederlands/betekenis/recycle#.YiCoDauZOUk>
- Rieber, L. P. (1991). Animation, incidental learning, and continuing motivation. *Journal of Educational Psychology*, 83(3), 318–328. <https://doi.org/10.1037/0022-0663.83.3.318>
- Setiawan, D. W. (2019). The Influence of Active Learning on the Concept of Mastery of Sains Learning by Fifth Grade Students at Primary School. *International Journal of Educational Methodology*, 5, 189–194. <https://doi.org/10.12973/ijem.5.1.189>
- SLO. (n.d.-a). *Oriëntatie op jezelf en de wereld – Mens en samenleving - kerndoel 39* .
[Oriëntatie op jezelf en de wereld - Mens en samenleving - kerndoel 39 - SLO](#)
- SLO. (n.d.-b). *Oriëntatie op jezelf en de wereld - Mens en samenleving - kerndoel 39 - Toelichting en verantwoording*. [Oriëntatie op jezelf en de wereld - Mens en samenleving - kerndoel 39 - Toelichting en verantwoording - SLO](#)
- SLO. (n.d.-c). *Inhoudslijn De ruimte om je heen*. [Inhoudslijnen oriëntatie op jezelf en de wereld - SLO](#)
- SLO. (2021, March 15). *Kerndoelen*. <https://www.slo.nl/sectoren/po/kerndoelen/>
- Thomas, P.& Macredie, R., (1994). Games and the design of human-computer interfaces. *Educational and Training Technology International*, 31, 2, 134-142.
<https://doi.org/10.1080/0954730940310208>
- UNESCO. (2015). *Not just hot air: Putting climate change education into practice*. United Nations Educational, Scientific and Cultural Organization.
- Vogel, J. J., Vogel, D. S., Cannon-Bowers, J., Bowers, C. A., Muse, K., & Wright, M. (2006). Computer Gaming and Interactive Simulations for Learning: A Meta-

Analysis. *Journal of Educational Computing Research*, 34(3), 229–243.

<https://doi.org/10.2190/flhv-k4wa-wpvq-h0ym>

Weitze, L. C. (Ed.). (2014). Developing goals and objectives for gameplay and learning. In *Learning, Education and Games: Volume One: Curricular and Design Considerations* (Illustrated ed., pp. 225–249). Carnegie Mellon University ETC Press.

Willet, B. S., Moudgalya, S., Boltz, L., Greenhalgh, S., & Koehler, M. (2018). Back to the Gaming Board: Understanding Games and Education through Board Game Reviews. *Society for Information Technology & Teacher Education International Conference*. Published. [Back to the Gaming Board: Understanding Games and Education through Board Game Reviews \(matt-koehler.com\)](#)

World Commission on Environment and Development. (1987). *Brundtland Report*.

<https://www.are.admin.ch/are/en/home/media/publications/sustainable-development/brundtland-report.html>

Wouters, P., & van Oostendorp, H. (2013). A meta-analytic review of the role of instructional support in game-based learning. *Computers & Education*, 60(1), 412–425.

<https://doi.org/10.1016/j.compedu.2012.07.018>

Appendix A

SLO Knowledge about the environment and sustainable development and climate change for primary education.

Milieu en duurzame ontwikkeling

Milieu* is alle **natuur**, de gehele omgeving waarin mensen, planten en dieren leven (biosfeer). Belangrijke onderdelen zijn het klimaat, de bodem (geosfeer), water (hydrosfeer) en de lucht (atmosfeer). De natuur brengt voedsel en geeft materialen voor beschutting, energie, technische producten en gezondheid. Met landbouw, industrie en dienstverlening grijpt de mens in op de omgeving. Maar ook wonen en de aanleg van infrastructuur hebben gevolgen voor natuur en milieu. Het kan leiden tot **verstoring van het natuurlijk evenwicht** en tot schade aan het milieu (**milieuvervuiling**) zoals luchtvervuiling, ontbossing, versterkt broeikaseffect, uitputting van de bodem en bodemvervuiling. Een goede **zorg voor het milieu** is de verantwoordelijkheid van de mens. Dit kan onder andere door de hoeveelheid afval te beperken (preventie, hergebruik, afvalscheiding en **recycling**, energie uit afvalverbranding, storten); het energieverbruik van apparaten te verkleinen (**energielabel**, zuinig met energie voor portemonnee en milieu); aandacht te hebben voor waterhuishouding (drinkwater, afvalwater en waterzuivering) en in te zetten op **natuurbescherming**. Een **duurzame ontwikkeling** met een goed **beheer van natuur en landschap** zorgt voor een duurzame samenleving en houdt ook voor toekomstige generaties de aarde leefbaar (**ecologische voetafdruk**). Dit draagt bij aan het in standhouden van de dynamische evenwichten op onze planeet en de soortenrijkdom van planten en dieren.

* milieu kent een tweede betekenis in de verwijzing naar de relaties tussen bevolkingsgroepen (sociale milieu) – Systeem: Levende systemen

Klimaatverandering

Het klimaat op aarde lijkt redelijk stabiel, maar miljoenen jaren geleden zijn er tijden geweest dat een groot deel van de aarde bedekt was met ijs. Deze ijstijden zijn ook in Nederland voorgekomen. Ijstijden werden afgewisseld door warme periodes die enkele duizenden jaren duurden. Wisselingen in klimaat hebben onder andere te maken met het (versterkte) **broeikaseffect**. De invloed van menselijke activiteit kan mede zorgen voor **klimaatverandering**.

– Systeem: Aarde en ruimte systemin

Appendix B

The contents of the different game cards of the educational board game

Blue question cards:

1. Zet de volgende stappen van het recyclen van glas in de goede volgorde:

1. De stukjes glas smelten in de oven.
2. Je gooit het glas in een glasbak.
3. Het glas wordt geplet en een machine sorteert de verschillen kleuren glas.
4. De hete vloeistof wordt in een vorm gegoten. Het koelt af en zorgt voor nieuwe potten.
5. Het glas wordt opgehaald door de vuilnisman en naar een glasfabriek gebracht.

Antwoord:

2-5-3-1-4

1. Je gooit het glas in een glasbak.
2. Het glas wordt opgehaald door de vuilnisman en naar een glasfabriek gebracht.
3. Het glas wordt geplet en een machine sorteert de verschillen kleuren glas.
4. De stukjes glas smelten in de oven.
5. De hete vloeistof wordt in een vorm gegoten. Het koelt af en zorgt voor nieuwe potten.

2. Hoelang duurt het voordat de volgende afval is opgeruimd door de natuur? Zet de producten in de juiste volgorde, start met het product dat volgens jullie het snelst is opgeruimd door de natuur.

1. Appel
2. Plastic flesje
3. Krant
4. Blikje frisdrank.

Antwoord:

1. Appel, een appel heeft ongeveer 14 dagen nodig voordat het is opgeruimd.
2. Krant, een krant wordt in ongeveer 6 maanden door de natuur opgeruimd.
3. Blikje frisdrank, een blikje heeft minimaal 50 jaar nodig om opgeruimd te worden door de natuur.
4. Plastic blijft voor altijd in de natuur, want dat breekt niet af.

Reference: [Aan de slag met afval - Lesmateriaal - Groep 7-8 Afvalopdrachten - Zwerfafval](#)

3. Zet de volgende stappen van het recyclen van glas in de goede volgorde:

1. Het papier wordt opgehaald en gebracht naar een papierfabriek.
2. De pulp wordt zorgvuldig gereinigd.
3. De schone pulp wordt geplet en tot vellen gerold
4. Oud papier wordt gemengd met water en omgezet tot pulp. Pulp is een Pap-achtige brij.
5. Het oud papier wordt in de papierbak gegooid.

Antwoord: 5-1-4-2-3

1. Het oud papier wordt in de papierbak gegooid.
2. Het papier wordt opgehaald en gebracht naar een papierfabriek.
3. Oud papier wordt gemengd met water en omgezet tot pulp. Pulp is een Pap-achtige brij.
4. De pulp wordt zorgvuldig gereinigd.
5. De schone pulp wordt geplet en tot vellen gerold

Reference: Recyclen. (2021, 3 juni). On *Wikikids*. <https://www.wikikids.nl/Recyclen>

4. Geef aan of onderstaande producten in een plasticbak of restafvalbak kan worden wegegooid?

1. Chips zak
2. Speelgoed
3. Yoghurt bekert
4. Plastic flesje

Antwoord:

- 1, 3 en 4 horen in de Plasticbak
2 hoort in het restafval

Al het plasticafval dat een verpakking was en leeg is mag in de plasticbak. Plastic dat geen verpakking is geweest, zoals speelgoed of een tuinstoel, hoort niet in de plasticbak.

Reference: Milieu Centraal. (z.d.). *Plastic verpakkingen: inleveren bij het PMD*. <https://www.milieucentraal.nl/minder-afval/afval-scheiden/plastic-verpakkingen/>

5. Geef aan per stellingen of deze waar is of niet.

1. Plastic verpakkingen zijn nodig om avocado's houdbaar te houden.
2. Elke minuut belandt er een vrachtwagen vol aan plastic in de oceaan.

Antwoord:

Stelling 1 is niet waar. Een avocado heeft een dikke schil om zichzelf houdbaar te houden en plastic is dus niet nodig.

Stelling 2 is waar. 8 van de 10 stuks plastic is zwerfafval van land dat in de zee stroomt via rivieren en kanalen.

Reference: Van der Nat, S. (2021, 30 augustus). *Het plastic monster*. Greenpeace Nederland. <https://www.greenpeace.org/nl/lesmaterialen/het-plastic-monster/?e=1>

6. Weet jij hoe je van oud blik weer nieuwe blik maakt? Zet de zinnen in de juiste volgorde, begin met de stap 1.

1. Je gooit je lege blikje in de afvalbak.
2. In de metaalfabriek wordt het metaal omgesmolten en er worden grote metalen platen van gemaakt.
3. Met magneten wordt het metaal uit de verbrande resten gehaald.
4. Het afval wordt verbrand. Het metaal van het blikje verbrandt niet. Dat blijft achter.
5. Het afval gaat naar het afvalverwerkingsbedrijf.

Antwoord:

1 – 5 – 4 – 3 – 2

7. Je kan een plasticfles voor frisdrank opnieuw gebruiken, dit kan je op verschillende manieren doen. Zet onderstaande zinnen op, begin bij de manier van opnieuw gebruiken die het minst belastend is voor het milieu.

1. Een plasticfles weggooien bij het restafval.
2. Een plasticfles inleveren bij de supermarkt.
3. Een plasticfles opnieuw vullen met kraanwater.

Antwoord: 3-2-1.

Antwoord C is als eerste, want een flesje vaker gebruiken is beter voor het milieu. Er hoeft geen nieuw flesje gemaakt te worden. Daarna komt antwoord B. Als je het flesje toch wilt weggooien kan je dit het beste doen bij de supermarkt. Zo kan de petfles nog worden hergebruikt. Antwoord A komt als laatste, dit zorgt ervoor dat de petfles niet hergebruikt meer kan worden en is dus het vervuilendste voor het milieu.

8. Welk van de volgende zinnen zijn voorbeelden van het overbodig gebruik van spullen en afval?

1. Meer eten kopen dan jullie als gezin nodig hebben. Waardoor je elke week eten moet weggooien.
2. Elke keer een nieuwe plastic tasje kopen als je bij de winkel staat.
3. Het gebruiken van gerecycled papier om een tekening op te maken.

Antwoord: 1 en 2

Bij 1 koop je steeds te veel eten en moet je dat eten dus weer weggooien. Bij 2 koop je elke keer een nieuw plastic tasje, terwijl je er thuis ook genoeg hebt liggen die je opnieuw kan gebruiken.

Antwoord 3 is geen voorbeeld van het overbodig gebruik van spullen of afval, want je gebruikt het papier opnieuw.

9. Duurzame energiebron zijn bronnen van energie waar je niks van de aarde hoeft af te pakken. Dit wordt ook wel groene energie genoemd. Welke energiebron is duurzaam?

1. Zonne-energie
2. Aardolie
3. Windenergie

Antwoord: 1 en 3.

1 en 3 zijn voorbeelden van groene energie, omdat we niet iets van de aarde hoeven af te pakken. 2 is geen voorbeeld van groene energie, want aardolie wordt gehaald uit de aarde en deze energiebronnen kunnen opraken.

Reference: Groene energie. (2021, 12 februari). On *Wikikids*.
https://wikikids.nl/Groene_energie

10. Er zijn natuurlijk verschillende vervoersmiddelen om mee te reizen, maar niet elke vervoersmiddel is even goed voor het milieu. Zet de vervoersmiddelen in de juiste volgorde, start met het vervoersmiddel wat het minst schadelijk is voor het milieu.

1. Vliegtuig
2. Auto
3. Fiets
4. Trein

Antwoord: De juiste volgorde is 3-4-2-1.

Een fiets kost grondstoffen bij het maken en daarna stoot het geen CO₂ meer uit. In een trein zit je niet alleen, maar deel je met meer mensen en is de uitstoot van CO₂ minder groot dan een auto. In een auto kunnen namelijk maar één tot vier personen. De vliegtuig stoot het meeste CO₂ uit en is dan ook het vervuilendst voor het milieu om mee te reizen

Reference: *Vervuult een vliegtuig dan zoveel meer dan een auto of trein?* (z.d.). Wat doen we voor het klimaat? <https://www.watdoenwevoorhetklimaat.be/q/vervuult-een-vliegtuig-dan-zoveel-meer-dan-een-auto-of-trein>

11. Een ecologische voetafdruk is de berekening van hoeveel ruimte er nodig is om te voorzien in de behoefte van een persoon. Dit wordt vaak aangegeven in hectaren. Mensen uit verschillende landen hebben een andere ecologische voetafdruk. Zet de landen in de juiste volgorde, start met het land wat de laagste ecologische voetafdruk heeft per inwoner.

- A. Nederland
- B. Verenigde staten
- C. India

Antwoord: C-A-B.

India heeft als land de laagste ecologische voetafdruk per inwoner, namelijk 0,8 hectaren per inwoner. Dit staat gelijk aan ongeveer 2 voetbalvelden. Nederland komt daarna met 4,4 hectaren, ongeveer 9 voetbalvelden en daarna is de Verenigde Staten met 9,6 hectaren, ongeveer 20 voetbalvelden.

12. Welke stelling(en) zijn juist?

1. Met de tram reis je klimaatvriendelijker dan als je met de bus gaat.
2. Twee dagen minder vlees in de week te eten verlaag je meer CO₂ uitstoot mee dan de hoeveelheid voedsel die je weggooit te halveren.

Antwoord: Stelling 1 en 2 zijn juist. De tram rijdt via elektriciteit en is daarom vriendelijker dan het reizen met de bus. Door 2 dagen per week minder vlees te eten bespaar je 130 kilo CO₂ uitstoot en door de helft minder voedsel weg te gooien maar 80 kilo CO₂ uitstoot.

Reference: Milieu Centraal. (z.d.-a). *Klimaatquiz: test jouw kennis.*

<https://www.milieucentraal.nl/klimaat-en-aarde/klimaatverandering/quiz-klimaatquiz/>

Red question cards:

1. Wat is recyclen?

- A. **Het opnieuw gebruiken van afvalmateriaal.**
- B. Het gebruiken van nieuwe grondstoffen.
- C. Het weggooien van afvalmateriaal.

Antwoord A is het juiste antwoord. Bij recyclen wordt afvalmateriaal opnieuw gebruikt, om er weer spullen van te maken.

Reference: Appendix A

2. Wat is Zwerfafval?

- A. Afval dat je in je broekzak hebt zitten.
- B. Afval dat in de prullenbak zit.
- C. **Afval dat je in de natuur ziet slingeren.**

Antwoord: C. Zwerfafval is afval dat je in de natuur ziet slingeren. Bijvoorbeeld een plastic flesje dat je op straat ziet liggen.

Reference: Zwerfafval. (z.d.). In *Encyclo*. <https://www.encyclo.nl/begrip/zwerfafval>

3. Wat is milieu?

- A. **Dat is de gehele omgeving waarin mensen, planten en dieren leven.**
- B. Dat is een naam voor alle oceanen en rivieren in de wereld.
- C. Dat is de afval die de natuur vervuult.

Antwoord: A. Milieu is de gehele natuur waarin jij en ik, maar ook planten en dieren allemaal leven. Antwoord B is onjuist want dit klopt niet en antwoord C is onjuist want dit is milieuvervuiling.

Reference: Appendix A

4. Wat is de plastic soep?

- A. Soep gemaakt van plastic.
- B. **Stukken plastic afval die in zeeën en rivieren drijven.**
- C. Een plek op de vuilnisbelt waar alle plastic ingeleverd wordt.

Antwoord: B. Alle kleine en grote stukken plastic die terecht komen in zeeën en rivieren.

Reference: *What Is The Plastic Soup in The Oceans ?* (2020, 30 januari). Plastic Soup Foundation. <https://www.plasticsoupfoundation.org/en/plastic-problem/plastic-soup/>

5. Welk van de opties is het beste voor het milieu?

- A. Afval op straat gooien.
- B. **Met de fiets naar school.**

C. De tv na het kijken aan laten staan.

Antwoord: B. Het juiste antwoord is B, door met de fiets naar school te gaan vervuיל je het milieu niet. A en C zijn niet goed. Bij antwoord A, vervuיל je juist de natuur en bij antwoord B, gebruik je juist veel energie wat ook vervuילend is voor de natuur.

6. Waar wordt plastic van gemaakt?

- A. Aardolie
- B. Klei
- C. Steen

Antwoord: Het juiste antwoord is A. Plastic wordt gemaakt van aardolie.

Reference: KIVO Plastic Verpakkingen. (2021, 19 april). *Hoe wordt plastic gemaakt?*
<https://www.kivo.nl/kennisbank/faq-pe/hoe-wordt-plastic-gemaakt/>

7. Mogen plastic flessen waar schadelijke stoffen in hebben gezeten bij het plasticafval?

- A. Ja
- B. Nee**

Antwoord: Het juiste antwoord is Nee. Plastic flessen waar schadelijke stoffen in hebben gezeten mogen niet bij het plasticafval. Dit komt omdat deze schadelijke stoffen anders gevaarlijk kunnen zijn voor de mensen die met het afval werken.

Reference: *Plastics met gevaarlijke stoffen: recyclen of verbranden?* | RIVM. (2015). RIVM.
<https://www.rivm.nl/publicaties/plastics-met-gevaarlijke-stoffen-recyclen-of-verbranden>

8. Wat wordt er bedoeld met 'restafval'?

- a. Afval dat niet te recyclen is.**
- b. Restafval is een ander woord voor zwerfafval.
- c. Restjes afval dat overblijft van het eten.

Antwoord: Het juiste antwoord is A. Met restafval bedoel we al het afval wat niet te recyclen is.

Reference: Restafval. (z.d.). In *Encyclo*. <https://www.encyclo.nl/begrip/Restafval>

9. Hoelang is de natuur bezig om een mondkapje af te breken?

- A. 1 jaar
- B. Oneindig**
- C. 14 dagen

Antwoord: Het juiste antwoord is B. De natuur kan een mondkapje niet helemaal afbreken omdat er kleine deeltjes plastic in het mondkapje zit. Plastic kan namelijk nooit door de natuur worden afgebroken.

10. Wat is duurzame wereld?

- A. Een wereld waar geen grondstoffen meer worden gebruikt.
- B. Een wereld waar we kiezen voor producten die niet lang mee gaan.
- C. Een wereld waar mens, milieu, en economie met elkaar in evenwicht zijn, zodat we de aarde niet uitputten.**

Antwoord: Het juiste antwoord is C. Een wereld waar mens, milieu, en economie met elkaar in evenwicht zijn. Als dat in evenwicht is met elkaar zorgen we ervoor dat we de aarde niet uitputten. B is onjuist omdat in een duurzame wereld je juist kiest voor producten die lang meegaan of producten die te recyclen zijn.

Reference: Duurzaamheid - Wikikids. (2021, 8 oktober). On *Wikikids*.

<https://wikikids.nl/Duurzaamheid>

Greenpeace. (z.d.). *Tijd voor duurzaam*. Greenpeace.

https://www.greenpeace.org/static/planet4-netherlands-stateless/2019/07/152ea07a-handleiding_vo.pdf

[152ea07a-handleiding_vo.pdf \(greenpeace.org\)](https://www.greenpeace.org/static/planet4-netherlands-stateless/2019/07/152ea07a-handleiding_vo.pdf)

11. Wat is een broeikasgas?

- A. Gas in de atmosfeer wat ervoor zorgt dat de aarde wordt opgewarmd.**
- B. Gas wat ervoor zorgt dat het water koud blijft.
- C. Gas wat ervoor zorgen dat auto's kunnen rijden.

Antwoord: Het juiste antwoord is A, broeikasgassen zorgen ervoor dat een deel van de warmte van de zon binnen de atmosfeer blijft, en de aarde warm wordt.

12. Wat is geen oorzaak van klimaatverandering?

- A. de toename van broeikasgassen in de lucht;
- B. vulkaanuitbarstingen;
- C. beide antwoorden zijn goed**

Antwoord: Het juiste antwoord is C. Door de toename van broeikasgassen in de lucht en vulkaanuitbarstingen verandert het klimaat.

Reference: Ministerie van Infrastructuur en Waterstaat. (2022, 12 januari).

Klimaatverandering en gevolgen. Klimaatverandering | Rijksoverheid.nl.

Geraadpleegd op 3 maart 2022, van

<https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/gevolgen-klimaatverandering>

Information on the Did You Know that cards:

1. Duurzaam betekent letterlijk 'van lange duur'. We kiezen voor producten die lang meegaan of die gemakkelijk (liefst volledig) te recyclen zijn.

Reference: Duurzaamheid. (2021, 8 oktober). In *Wikikids*.

<https://wikikids.nl/Duurzaamheid>

2. Plastic soep is al het plastic dat in de zee terecht komt. Dit is natuurlijk niet goed voor de natuur want dit afval vervuult ook de bodem van de zee. Het gevolg van deze vervuiling is dat veel dieren denken dat het voedsel is. Als de dieren dit

plastic opeten kan het in de maag van de dieren komen. In plastic zitten giftige stoffen en als dit dus in de maag van een dier zit kan een dier hier dood aan gaan.

Reference: *What Is The Plastic Soup in The Oceans ?* (2020, 30 januari). Plastic Soup Foundation. Geraadpleegd op 3 maart 2022, van <https://www.plasticsoupfoundation.org/en/plastic-problem/plastic-soup/>

3. Door slecht met de natuur om te gaan kan er schade aan het milieu zijn, dit heet ook wel milieuschade. Milieuschade kan leiden tot uitputting van natuurlijke hulpbronnen (Hout) en het kan leiden tot vervuiling van de aarde.

Reference: Duurzaamheid. (2021, 8 oktober). In *Wikikids*. <https://wikikids.nl/Duurzaamheid>

4. Het zorgen voor het milieu is erg belangrijk want wij hebben maar één aarde! De volgende manieren kunnen helpen om goed voor het milieu te zorgen:
 - De hoeveelheid afval te beperken
 - Het energieverbruik van apparaten te verkleinen
 - Aandacht te hebben voor het gebruik van water.
 - In te zetten op natuurbescherming,

Reference: Milieu. (2021, 5 juni). In *Wikikids*. <https://wikikids.nl/Milieu>

5. Er zijn al vele projecten opgezet om proberen het plastic in de zee op te ruimen. Een van die projecten is bedacht door Boyan. Boyan zat op de middelbare school toen hij een mogelijke oplossing heeft bedacht. Het idee is een machine die in de zee drijft, die drijvende afval opvangt. Deze installatie kan je zien op de foto. Vet he?! Als je zoiets kan bedenken.

Reference: The Ocean Cleanup. (2022, 21 februari). *Full Circle: Trash into Treasure*. Geraadpleegd op 3 maart 2022, van <https://theoceancleanup.com/from-trash-to-treasure/>

6. Doordat het klimaat veranderd, worden warme plekken juist kouder en koude plekken warmer. Het Amazone regenwoud wordt op die manier langzaam een woestijn en de Saharawoestijn juist steeds groener.

Reference: *Deze 9 dingen wist jij (vast) nog niet over het klimaat*. (2019, 15 februari). Kidsweek - dé weekkrant voor kinderen van 7 t/m 12 jaar. Geraadpleegd op 3 maart 2022, van <https://www.kidsweek.nl/nieuws/deze-9-dingen-wist-jij-vast-nog-niet-over-het-klimaat>

7. Onderzoekers hebben gevonden dat de noordpool in 2040 misschien ijsvrij zou kunnen zijn doordat het klimaat veranderd. Dit willen wij natuurlijk niet! Waar moeten de ijsberen dan heen?

Reference: *Deze 9 dingen wist jij (vast) nog niet over het klimaat*. (2019, 15 februari). Kidsweek - dé weekkrant voor kinderen van 7 t/m 12 jaar. Geraadpleegd op 3 maart 2022, van <https://www.kidsweek.nl/nieuws/deze-9-dingen-wist-jij-vast-nog-niet-over-het-klimaat>

8. Doordat de aarde steeds warmer wordt, wordt $\frac{3}{4}$ van het koraalriffen bedreigd. Koraal kan namelijk slecht tegen de stijging van de temperatuur van het water. Dit heeft als gevolg dat koraal verbleekt en het koraal doodgaat.

Reference: *Deze 9 dingen wist jij (vast) nog niet over het klimaat.* (2019, 15 februari). Kidsweek - dé weekkrant voor kinderen van 7 t/m 12 jaar. Geraadpleegd op 3 maart 2022, van <https://www.kidsweek.nl/nieuws/deze-9-dingen-wist-jij-vast-nog-niet-over-het-klimaat>

9. Dat bij het maken van één tandenborstel, 1,5 kilo aan afval wordt geproduceerd. Reference: *Afval | Belgium.be.* (z.d.). Belgium. Geraadpleegd op 3 maart 2022, van https://www.belgium.be/nl/leefmilieu/duurzaam_consumeren/afval

10. In Parijs in de 19^e eeuw werd er voor het eerst verplicht om afval te scheiden. Er was een vak voor etensresten een voor vodden en papier en een voor oesterschelpen, glas en aardewerk.

De Fransman Eugène Poubelle stond aan de basis van deze nieuwe regels, om afval niet zomaar meer op straat te gooien. Hij vond ook de vuilnisbak uit. In het Frans is 'une poubelle' een vuilnisbak.

Content on the Thinking cards

1. **Zoetermeer:** Bedenk nog meer manieren waar je plastic flessen voor kan gebruiken! Een voorbeeld is om een lege plasticfles te gebruiken als vaas.
2. **Gouda:** Hoe zou je ervoor kunnen zorgen dat er minder afval in de natuur komt te liggen? Een voorbeeld zie je op de foto. Deze prullenbak staat bekend als Holle Bolle Gijs en staat in de Efteling. Deze prullenbak zegt steeds “papier hier”. Dit maakt het leuk om spullen weg te gooien.
3. **Woerden:** Op dit moment verbruiken alle mensen op aarde veel grondstoffen en de natuur kan dit niet zo snel herstellen als wij het gebruiken. Hierdoor ontstaat er een tekort aan grondstoffen, maar ook omdat wij zoveel gebruiken zijn er veel schadelijke stoffen. Dit heeft gevolgen voor ons allemaal. Welke gevolgen denk je dat dit voor jullie en de leerlingen na jullie heeft?
4. **Utrecht:** Wat denken jullie dat je kan doen om minder vervuilend te zijn voor het milieu? Een voorbeeld is minder lang douchen. Door minder lang te douchen verbruik je minder energie en minder water. Dit is beter voor de natuur!

Appendix C

Manual of the game (Dutch)

Het doel van het spel.

Als team is het doel om het bedrijf 'Bewust Milieu' te helpen! Dit kunnen jullie doen door zoveel mogelijk plastic punten te verzamelen. Plastic punten kunnen jullie als team verzamelen door vragen goed te beantwoorden of mee te denken met denk vragen. Er moeten minimaal 12 plastic punten zijn verzameld, dan kan 'Bewust Milieu' het plastic omsmelten om er een kunstwerk van te maken.

Tijdens het spel wordt er door jullie kennis opgedaan over het milieu, recyclen en klimaatverandering. Dit helpt om de eindvraag van 'Bewust Milieu' te kunnen beantwoorden, wat denken jullie dat je kan doen om minder vervuילend te zijn voor het milieu?

Aantal personen

Het spel wordt gespeeld met 4 spelers.
Er zijn 2 teams van twee spelers.

De voorbereiding

Leg het grote bordspel op tafel. Op het bordspel staat een treinroute van Den-Haag naar Utrecht. Onderweg kom je samen met je team de volgende steden tegen: Zoetermeer, Gouda en Woerden. Ook zijn er 4 verschillende kleuren kaarten, namelijk groen, geel, blauw en rood. Leg de kaarten per kleur op een stapel. Zorg dat de voorkant van de kaart naar boven is gericht. De voorkant van de kaart kan je zien doordat er opstaat wat voor kaart het is.



Een voorbeeld: Bij de kaarten waar vragen op staan, staat boven op Vragen Kaarten.

Uitleg van het spelbord en de spelkaarten

Spelbord

Op het bordspel staat een treinroute. Het bordspel bestaat uit 32 kleine gekleurde vakken. Deze vakken hebben drie verschillende kleuren, namelijk blauw, geel en rood. Naast deze kleine gekleurde vakken zijn er ook 5 groten groene vakken met steden op het bord. De steden zijn Den-Haag, Zoetermeer, Gouda, Woerden en Utrecht.

Envelop met brief

Er is ook een envelop met een brief. Deze wordt straks aan het begin van het spel voorgelezen door een van de spelers.

Spelkaarten

Wanneer de pion op een van de kleine gekleurde vakjes komt, mag de speler een kaart pakken die hoort bij de kleur waarop de pion staat.



Een voorbeeld: Staat de pion op een blauw vak, dan mag er een blauwe volgorde kaart gepakt worden.

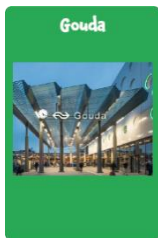
Hieronder staat de uitleg van de verschillende kleuren kaarten:

De rode kaarten en blauwe kaarten zijn vragen kaarten. De rode kaarten zijn meerkeuze vragen en de blauwe kaarten moet je zinnen in juiste volgorde zetten, de juiste stellingen kiezen of aangeven of iets waar of niet waar is.

Als jullie een antwoord hebben gekozen, staat op de achterkant het juiste antwoord. Als jullie antwoord klopt, ontvangt het team 2 plastic punten. Dit staat ook aangegeven op de kaart.



De gele kaarten zijn Wist je dat kaarten. Op deze kaarten staan leuke weetjes en informatie over duurzaamheid en klimaatverandering. Onder de informatie staat dat jullie 1 plastic punt ontvangt hiervoor.



Op de groene kaarten staan namen van steden, namelijk Zoetermeer, Gouda, Woerden of Utrecht. Wanneer jullie in een beurt op een groenvak komt, pakken jullie de kaart met dezelfde naam als de stad waar de pion op staat. Op deze kaarten staan denkvragen die jullie samen kunnen beantwoorden. Onder deze vraag staat dat jullie 1 plastic punt ontvangt voor het beantwoorden van de denk vraag.

Een voorbeeld: Er wordt 2 gegooid, dan mag de pion 2 hokjes vooruit worden gezet. De pion stopt nu op een groen vakje, Gouda. Jullie pakken dus een groene Denkkkaart waar op de voorkant Gouda staat.

Verloop van het spel

De twee teams zetten de pion bij Den-Haag centraal. Een van de spelers pakt de envelop met de brief erin en lees deze hardop voor. De speler die het hoogste getal gooit met de dobbelsteen mag de beurt van zijn team starten. Deze speler mag met de dobbelsteen gooien. Als zijn beurt is afgelopen gaat de beurt naar het andere team mag met de dobbelsteen gooien.

Wanneer een speler aan de beurt is gooit de speler de dobbelsteen. De hoeveelheid ogen die gegooid is, mag de pion vooruit geplaatst worden op het bordspel. Daarna pakt de speler een van de gekleurde kaarten die bij het gekleurde vakje hoort.

Een voorbeeld: Er wordt 4 gegooid, dan mag er met de pion 4 hokjes vooruit worden gezet. De pion stopt op een geel vak. Je pakt dus een gele Wist je dat kaart.

Het einde van het spel

Als de pion het station Utrecht heeft bereikt, is er nog een rode kaart met Utrecht erop. Dit is de laatste kaart die jullie als team gaan voorlezen en beantwoorden. Nadat de kaart is beantwoord, worden de plastic punten geteld.

Als de laatste vraag is beantwoord en de plastic punten zijn geteld, dan is het spel afgelopen. Er moeten minimaal 15 plastic punten zijn verzameld, dan kan 'Bewust Milieu' het plastic omsmelten om er een kunstwerk van te maken.

Materialen

- Het spelbord
- Een pion in de vorm van een trein
- Een dobbelsteen
- Denk kaarten
- Vragen kaarten
- Volgorde kaarten
- Wist Je Dat kaarten
- Envelop met brief
- Plastic punten

Appendix D

Informed consents

Informed consent for the teachers

Door toestemming te geven geef je aan dat je onderstaande punten hebt gelezen en dat je er mee in stemt:

Ik bevestig:

- dat ik via de informatiebrief naar tevredenheid over het onderzoek ben ingelicht;
- dat ik in de gelegenheid ben gesteld om vragen over het onderzoek te stellen en dat mijn eventuele vragen naar tevredenheid zijn beantwoord;
- dat ik gelegenheid heb gehad om grondig over deelname aan het onderzoek na te denken;
- dat ik uit vrije wil deelneem.

Ik stem ermee in dat:

- de verzamelde gegevens voor wetenschappelijke doelen worden verkregen en bewaard zoals in de informatiebrief vermeld staat;
- de verzamelde, geanonimiseerde onderzoeksgegevens door wetenschappers kunnen worden gedeeld en/of worden hergebruikt om eventueel andere onderzoeksvragen mee te beantwoorden;
- er voor wetenschappelijke doeleinden geluidsopnamen worden gemaakt (zie voor delen en hergebruik van deze gegevens onderstaande box).

Ik begrijp dat:

- ik het recht heb om mijn toestemming voor het gebruik van data in te trekken, zoals vermeld staat in de informatiebrief.

Ik geef toestemming voor het gebruiken van mijn gegevens voor het onderzoek:

- Ja
- Nee

Informed consent for the parents

Informatie over deelname aan: testen van een educatief bordspel, Bewust Milieu

Het onderzoek

Er is een educatief bordspel ontwikkeld voor leerlingen uit groep 6, 7 en 8. Het bordspel gaat over het thema duurzaamheid en klimaatverandering. Dit sluit aan bij een van de kerndoelen die de leerlingen behandelen tijdens hun leertraject. Om te kijken of het bordspel goed is ontwikkeld, vragen wij leerlingen om het bordspel te spelen en daarna kort feedback te geven. Het bordspel wordt op school gespeeld.

Hoe wordt het onderzoek uitgevoerd?

De leerlingen zullen in groepjes van 3 tot 4 leerlingen samen het bordspel spelen. Ik (Nicole) zou de hele tijd aanwezig zijn terwijl de leerlingen het bordspel spelen. Dit wordt gedaan om de leerlingen te observeren en eventueel te helpen als iets niet duidelijk is tijdens het spel. Het spel duurt tussen de 30 tot 45 minuten.

Nadat de leerlingen het spel gespeeld hebben, ga ik de leerlingen een paar vragen stelen. De vragen zullen gaan over hoe de leerlingen het bordspel vonden, of er nog verbeterpunten zijn en of de leerlingen iets hebben geleerd van het spelen van het bordspel. Dit duurt maximaal 15 minuten.

Het onderzoek duurt totaal dus maximaal 60 minuten. Daarnaast zullen er geen risico's zijn voor de leerlingen voor het deelnemen aan het onderzoek. Eventuele voordelen kunnen zijn dat de leerling nieuwe kennis opdoet over de thema's klimaatverandering en duurzaamheid.

Wat gebeurt er met de gegevens?

Nadat de leerlingen het bordspel hebben gespeeld, ga ik vragen aan hen stellen. Dit moment wil ik de audio opnemen, met het doel om dit later terug te kunnen luisteren. Alle gegevens worden anoniem verwerkt en zullen niet terug te lijden zijn naar u of uw kind. De audiogegevens zullen na het afronden van het onderzoek worden verwijderd.

Wat zijn uw en uw kinds rechten?

Deelname is vrijwillig. De gegevens van uw kind mogen alleen voor mijn onderzoek verzameld worden als u hier toestemming voor geeft. Als u of uw kind toch besluit niet mee te doen, hoeft u alleen het bezwaarformulier in te vullen. U hoeft niet te zeggen waarom uw kind niet wil meedoen. Als uw kind wel meedoet, kunt u of uw kind zich altijd bedenken en op ieder gewenst moment stoppen — ook tijdens het onderzoek. En ook nadat uw kind heeft meegedaan kunt u uw toestemming nog intrekken. Als u daarvoor kiest, hoeft de verwerking van de gegevens van uw kind tot dat moment overigens niet te worden teruggedraaid. De onderzoeksgegevens die wij op dat moment nog van uw kind hebben, zullen worden gewist.

Meer informatie over dit onderzoek?

Heeft u nog vragen? Stel ze gerust. U kunt contact opnemen met masterstudent onderwijswetenschappen Nicole van Daalen (n.vandaalen@student.utwente.nl). Dit onderzoek is goedgekeurd door de ethische commissie van Twente.

Bezwaarformulier

Let op: Bij kinderen tot en met 11 jaar hoeft alleen de ouder/voogd dit bezwaarformulier te ondertekenen.
Bij kinderen van 12 jaar en ouder ondertekenen de ouder/voogd én het kind.

BEZWAARFORMULIER betreffende deelname aan:

Testen van een educatief bordspel, Bewust Milieu

- Ik, ouder of voogd van het hieronder genoemde kind, en ik als kind van 12 jaar of ouder maak/maken hierbij bezwaar tegen het gebruik van gegevens van mijn kind/van mij voor bovengenoemd onderzoek.

Naam ouder of voogd: _____

Handtekening: _____

Naam kind: _____ Klas: _____

Handtekening kind (12 jaar of ouder): _____

Datum, plaats: ___ / ___ / ____, _____

Appendix E

Questions in the questionnaire for teachers

1. Is het taalgebruik juist voor de leerlingen van groep 7 en 8?
2. In hoeverre is de handleiding van het spel begrijpelijk voor de leerlingen?
 - a. Liket schaal Niet begrijpelijk – helemaal begrijpelijk
 - b. Optie: opmerkingen
3. Heb je nog verbeterpunten voor de handleiding?
4. In hoeverre is het doel van het spel duidelijk?
 - a. Liket schaal Niet begrijpelijk – helemaal begrijpelijk
 - b. Optie: Opmerkingen
5. In hoeverre is het spel uitdagend?
 - a. Liket schaal erg uitdagend – niet uitdagend
6. Wat vind je van het verhaallijn in het spel?
7. Wat vind je van de lay-out van het bordspel?
8. Heb je eventuele aanpassingen voor het bordspel?
9. In hoeverre zijn de vragen te beantwoorden door de leerlingen?
 - a. Liket schaal Makkelijk – Moeilijk
 - b. Wil je dit verder toelichten?
10. Sluit de informatie van de Wist je dat kaarten aan bij de kennis die de leerlingen tot en met groep 6 al hebben opgedaan?
11. Welke spelkaarten hebben nog verbetering nodig?

Appendix F
Dutch translation of Table 4 and 5

Table 4

Overview of Adjustments of the Game Instruction

Comment	Old phrases/ term(s)	Improved sentences/ term(s)
Difficult term	De <u>rode kaarten</u> zijn gekoppeld aan een stad, namelijk Zoetermeer, Gouda of Woerden.	Op de <u>rode kaarten</u> staan namen van steden, namelijk Zoetermeer, Gouda, Woerden of Utrecht.
Making it concrete	Ook zijn er 4 verschillende kleuren kaarten, leg de kaarten per kleur op een stapel.	Ook zijn er 4 verschillende kleuren kaarten, namelijk groen, geel, blauw en rood. Leg de kaarten per kleur op een stapel.
Sentence too long	Wanneer je langs een van deze steden komt, dan hoeft er die beurt alleen een rode denk kaart gepakt te worden, met dezelfde naam als de stad waar de pion langs is gegaan. Op deze kaarten staan denkvragen die jullie samen kunnen beantwoorden.	Wanneer je in een beurt langs een van deze steden komt dan hoeft er die beurt alleen een rode denk kaart gepakt te worden. Pak wel de kaart met dezelfde naam als de stad waar de pion langs is gegaan. Op deze kaarten staan denkvragen die jullie samen kunnen beantwoorden.
Unclear sentence	De gekleurde vakken horen bij verschillende soorten kaarten:	Hieronder staat de uitleg van de verschillende kleuren kaarten:
Change sequence sentence	Er moeten minimaal 15 plastic punten zijn verzameld, dan kan 'Bewust Milieu' het plastic omsmelten om er een kunstwerk van te maken. Als de laatste vraag is beantwoord	Als de laatste vraag is beantwoord en de plastic punten zijn geteld, dan is het spel afgelopen. Er moeten minimaal 15 plastic punten zijn verzameld, dan kan

en de plastic punten zijn
geteld, dan is het spel
afgelopen.

‘Bewust Milieu’ het plastic
omsmelten om er een
kunstwerk van te maken.

Table 5*Overview of Adjustments of the Game Cards*

Comment	Old questions/ sentences or term(s)	Improved questions/ sentences or term(s)
Change sequence sentences	Groene energie is energie die opgewekt is uit duurzame energieReferencenen en dat betekent dat je niks hoeft af te pakken van de aarde. Geef aan of de volgende vormen van energie groen zijn of niet?	Duurzame energieReferencenen zijn Referencenen van energie waar je niks van de aarde hoeft af te pakken. Dit wordt ook wel groene energie genoemd. Geef aan of de volgende vormen van energie groen zijn of niet?
	A: groene energie B: Geen groene energie. C: Groene energie. A en C zijn groene energie, omdat we niet iets van de aarde hoeven af te pakken. B is geen groene energie gehaald wordt uit de aarde en deze energieReferencenen kunnen opraken.	A: Ja B: Nee C: Ja A en C zijn groene energie, omdat we niet iets van de aarde hoeven af te pakken. B is geen groene energie gehaald wordt uit de aarde en deze energieReferencenen kunnen opraken.
Sentence too long	Een wereld waar mens, milieu, en economie met elkaar in evenwicht zijn, zodat we de aarde niet uitputten.	Een wereld waar mens, milieu, en economie met elkaar in evenwicht zijn. Als dat in evenwicht is met elkaar zorgen we ervoor dat we de aarde niet uitputten.
Change question	8. Wat is een broeikasgas?	8. Wat wordt er bedoeld met 'restafval'?

-
- | | |
|--|--|
| <p>A. Gas in de atmosfeer wat ervoor zorgt dat de aarde wordt opgewarmd.</p> <p>B. Gas wat ervoor zorgt dat het water koud blijft.</p> <p>C. Gas wat ervoor zorgen dat auto's kunnen rijden.</p> | <p>a. Restafval is afval dat niet te recyclen is.</p> <p>b. Restafval is een ander woord voor zwerfafval.</p> <p>c. Restafval zijn 'restjes', ofwel 'kliekjes'. Het is dus afval dat overblijft van het eten</p> |
|--|--|

Antwoord: Het juiste

antwoord is A, broeikasgassen zorgen ervoor dat een deel van de warmte van de zon binnen de atmosfeer blijft, en de aarde warm wordt.

Antwoord: Het juiste

antwoord is A. Met restafval bedoel we al het afval wat niet te recyclen is.

Change question

8. Een ecologische voetafdruk is de berekening van hoeveel ruimte er nodig is om te voorzien in de behoefte van een persoon. Dit wordt vaak aangegeven in hectaren. Mensen uit verschillende landen hebben een andere ecologische voetafdruk. Zet de landen in de juiste volgorde, start met het land wat de laagste ecologische voetafdruk heeft per inwoner.

- A. Nederland
- B. Verenigde staten

8. Geef aan of de volgende zinnen voorbeelden zijn van het overbodig gebruik van spullen en afval?

- A. Meer eten kopen dan jullie als gezin nodig hebben. Waardoor je elke week eten moet weg gooien.
- B. Elke keer een nieuwe plastic tasje kopen als je bij de winkel staat.
- C. Het gebruiken van gerecycled papier om een tekening op te maken.

Antwoord:

	<p>C. India</p> <p>Antwoord: C-A-B. India heeft als land de laagste ecologische voetafdruk per inwoner, namelijk 0,8 hectaren per inwoner. Dit staat gelijk aan ongeveer 2 voetbalvelden. Nederland komt daarna met 4,4 hectaren, ongeveer 9 voetbalvelden en daarna is de Verenigde Staten met 9,6 hectaren, ongeveer 20 voetbalvelden.</p>	<p>A en B zijn voorbeelden van het overbodig gebruik van spullen of afval.</p> <p>Bij A koop je steeds teveel eten en moet je dat eten dus weer weggooien. Bij B koop je elke keer een nieuw plastic tasje, terwijl je er thuis ook genoeg hebt liggen die je opnieuw kan gebruiken.</p> <p>Antwoord C is geen voorbeeld van het overbodig gebruik van spullen of afval, want je gebruikt het papier opnieuw.</p>
<p>Easier formulation</p>	<p>Dit heeft als gevolg dat plastic in de maag van de dieren komen. Naast dat plastic natuurlijk geen voedsel is, bevat het ook nog giftige gassen. Dit kan ervoor zorgen dat de dieren dood kunnen gaan.</p>	<p>Het gevolg van deze vervuiling is dat veel dieren denken dat het voedsel is. Als de dieren dit plastic opeten kan het in de maag van de dieren komen. In plastic zitten giftige stoffen en als dit dus in de maag van een dier zit kan een dier hier dood aan gaan.</p>

Appendix G

Semi-structured questions for focus group with students:

Algemeen

1. Wat vond je van het spelen van het spel?
2. Zou je dit spel als onderdeel van een natuur les willen spelen op school?
3. Zou je het spel nog eens in je vrij tijd willen spelen?

Doel van het spel

4. Nadat jullie samen de handleiding hadden gelezen, wisten jullie toen direct wat je moest doen?
 - Eventuele verbeterpunten voor de handleiding?
5. Wat was volgens jullie het doel van het spel?
6. Welke nieuwe dingen heb je geleerd tijdens het spelen van het spel?
 - a. Wat vond je leuk aan deze nieuwe dingen?
 - b. Van welke dingen in het spel heb je het meest geleerd?
7. Heb je nieuwe informatie opgedaan over duurzaamheid, recyclen, klimaat verandering?

Spelbord

8. Wat vind je van de lay-out van het spelbord?
9. Welke verbeteringen hebben jullie voor het spelbord?

Spelkaarten

10. Wat vond je van de verschillende spelkaarten in het spel?
 - a. Welke spelkaarten hebben nog verbetering nodig?

Challenge

11. Wat vond je moeilijk aan het spelen van het spel?
 - Hoe komt het dat je dit moeilijk vond?
12. Waren de vragen en volgorde-kaarten moeilijk?

Afsluiting

13. Welke tips of suggesties heb jij om het spel leuker te maken?

Appendix H

Coding scheme

Table 5

Coding Scheme of Focus Group Interview

Themes	Subthemes	Examples
The board game	Fun	<i>The game is fun and interesting. I like that you have to answer the fun questions.</i>
	Do not like it	<i>I think the board game is stupid. I don't like board games. A little bit boring.</i>
	Short	<i>Fun game but it was out quickly. The board game may last longer, with more parts.</i>
	Informative	<i>I have become wiser by playing the board game.</i>
Game instruction and goal of the board game	Not clear game instruction	<i>It is not very clear and convenient.</i>
	Too long instruction	<i>R1: I can give a shorter summary of the game explanation myself and then we can play faster and get less distracted. R2: Yes, I agree with her! The manual was too long</i>
	Clear game goal	<i>Learning about the environment.</i>
	Learned new information	<i>To get to Utrecht and collect 15 plastic points. But there are so many masks in nature, so they don't really disappear on their own. If I shower less, I take better care of nature. That you should take better care of the environment.</i>
Game board.	Beautiful	<i>'The game board is pretty. Beautiful with the different colours of the board and the cards.</i>
	Bigger	<i>The game board may be larger, because then it is easier to play together.</i>
	Not plastic	<i>The game board should not be made of plastic.</i>
Gamecards.	Like cards	<i>I love the cards! Because without the cards the game was stupid. The different questions cards were fun.</i>
	Not enough questions	<i>There should be more questions in the game.</i>
	Learning through cards	<i>Through the different question cards, I learned a lot.</i>

	Cards were informative	<i>The playing cards were informative.</i>
		<i>Through the different maps I learned new things.</i>
Challenge	Difficult blue cards	<i>The blue cards were difficult, because I didn't know anything about them.</i>
	Easy	<i>I didn't find it difficult, I knew how to answer many questions.</i>
		<i>Make it more challenging, then it's more fun to learn.</i>
	Medium	<i>If you don't know something yourself, someone in the group will.</i>
	Difficult to agree	<i>It was hard to have to agree with everyone because everyone has a different idea.</i>
Other feedback		<i>It would be fun if you play with groups against each other.</i>
		<i>Some words we don't know yet, such as burden. So you would have to modify that.</i>
		<i>Making different types of game boards. For example, grab an area where we live.</i>