University of Twente

Can worked examples facilitate learning with educational games?

A study of the effect by worked examples in a game based learning environment

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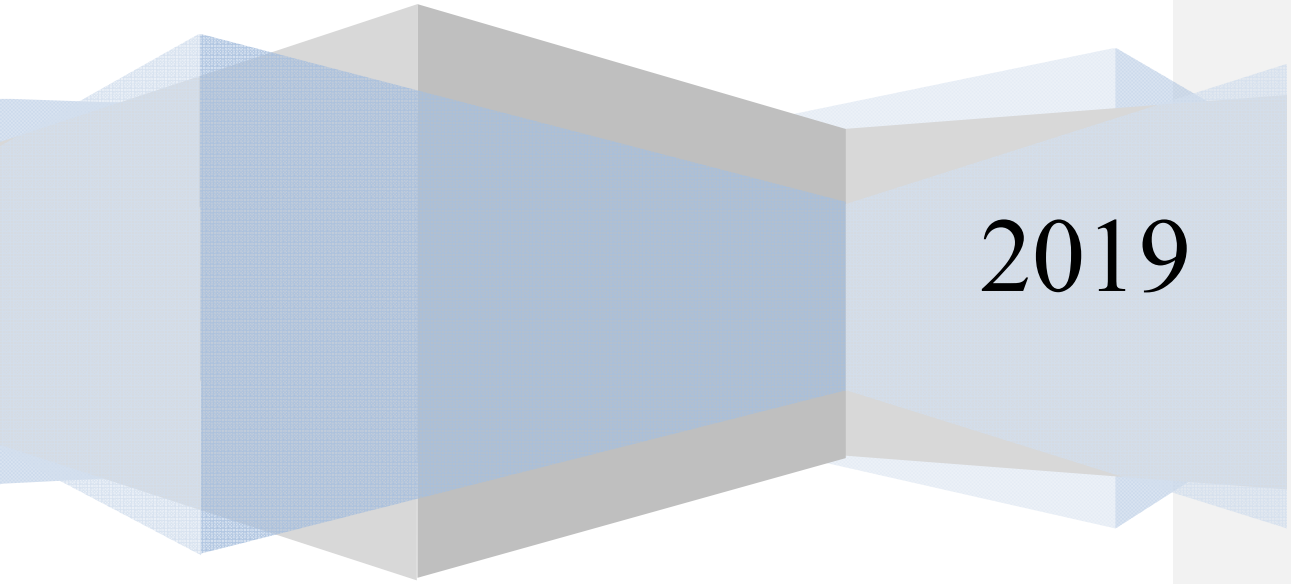

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Content

Summary

Learning with games is getting more and more important over the last years. There are game based learning environments developed to offer a new way of learning to students. Those gaming structures are limited and sometimes can cause problems like delivering too much information at the same time and make it hard for some students to process them properly. Nevertheless, these problems can be reduced by using instructional support. One type of these instructional supports is used in this research: the worked example approach. Within this research the possible effect of worked-out examples in the frame of educational games and in how far learning with educational games can be improved by using worked-out examples is the major aim. The used worked example was set into an instructional video which was meant to help the students while playing the game. Certain guidelines are used to create the worked example, e.g. the instructional guidelines by Mayer and guidelines to format an instructional video. A post test was taken to measure differences in the learning ease of two groups: the experimental group in which the worked example was used and the control group in which the students had to find their own way of learning. Motivation scores were taken to determine if the intrinsic motivation is influenced by the worked example and the way of learning. The FAM Questionnaire was used to measure interest, success, anxiety of failure and challenge. Game scores, which could be achieved while gaming, were compared in order to compare the two groups in how their way of learning is more successful in completing the game.

Using the worked example in the experimental group let to better retention results on the posttest than the control group that only received a short instruction. Furthermore, the experimental group also achieved better game results and was more often able to finish the game than the control group. Regarding the motivation of the students the scores of the two groups differed in interest and success in favor of the experimental group.

Additionally, this research also shows possible improvements (e.g. complexity) of the used worked example and other improvements concerning the set-up of this research. Build up researches should focus more on individual differences while investigating worked examples in game-based learning environments. An example could be the attitude towards instructional support and how students use instructional support.

1 Introduction

In coincidence of a rise in using the Internet, research focuses on opportunities to enhance the use of digital devices and (online -) games. Mainly the interest of online games and games in general became more important over the past years. First developed to entertain, they became more and more used in educational settings. Vygotsky already highlighted the importance of "playing" while learning in the late 30s. He stated that playing in general can help children improve their "psychological, sociological and intellectual developments" (Amory, 2006). Amory further refers to other statements that the imagination, creativity and the possibility to examine new things while playing can lead to better problem solving and principally improved critical thinking (see also Betz, 1996 & Rieber, 1996).

Educational games are defined as games with serious content to enhance performance on several learning tasks. Furthermore, learning with games should give students the opportunity to use their cognitive and affective skills to learn effectively (Wouters & Oostendorp, 2013). Games with educational content are also seen as tools to enhance performance because they can keep the students motivated and give them new opportunities to earn new interests.

Game based learning (GBL)

Learning with educational games is often named *game based learning*, or *GBL* (Wouters & Oostendorp, 2013). Game based learning environments are complex and interactive structures that mostly have a goal to be achieved and challenge the player to fulfill a certain task. The player learns throughout cognitive processes like problem solving and critical thinking. Additionally educational game structures promote situated, social, emotional and self-determined learning (Le et al. ,2013) and support the learner in understanding complex learning tasks and dynamic processes (Garris et al. ,2002). Especially skill acquisition and training of skills can be learned by using GBL environments (Spiegelmann, 2008, Garris et al., 2002).

Beside the benefits of using GBL environments in learning the central problem is the connection between the learning process and the game process. Mostly the gaming process is disrupted by the learning process by including tasks or questions (Kerres et. al., 2009). Additionally Kerres (2009) noted that mostly complex learning tasks cannot be mapped completely in educational gaming environments. Le et al. (2013) added that educational games never achieve the technical and aesthetic level and quality of commercial games so that they seem to be less attractive to use and most of the time need technical or instructional support to be effective (Spiegelman, 2008).

Game based learning environments are complex learning structures that can contain a huge pool of information. Using educational games during learning can overcharge novices especially during the selection of important information presented in the game. Necessary information that e.g. is needed to complete certain goals to finish the game, can get lost by the student because of the inability to process the information. According to the *cognitive load theory*, the human *working memory* is limited, so that a person is only able to process a limited amount of information at one time (Chandler & Sweller,

1991). Mostly novices tend to a large extent to get overloaded by the information and high element of interactivity given in an educational game (Wouters, 2012). The limitations of the working memory is also notable in the *dual-channel theory*, which states that the working memory consists of two independent channel of information, namely the verbal and the auditory channel (Mayer & Moreno, 2003). The working memory is more able to process information when the information is presented in dual mode thus presented in a verbal and in a visual format.

Supporting this idea, the *selecting-organizing-and-integrating theory of active learning* (Mayer, 2009) refers to the consequences of single-mode presented information. If there is too much information presented, students might fail in selecting relevant information of a source. The subsequent other two processes, namely organizing and integrating information, are heavily dependent on this issue. The student does not get the opportunity to organize the information in his memory and is not able to construct new schemas or mental models so that long-lasting learning effects are quite low. If students will discover this kind of problem, they also tend to get less motivated which is seen as problematic predominantly when one of the major advantages of playing with games is keeping the students motivated.

Motivation and learning

One important aspect in learning is the motivation of students. Motivation can be a driving force in how successful students learn. Deci & Ryan (2000) developed a theory concerning motivation: the self-determination theory. This theory insists that if students are intrinsically motivated, such as from inner beliefs or convictions, they show better learning results and learn more deeply (Seifert, 2004). In contrast students that only get motivated by external factors, like rewards, tend to have lower scores and tend to learn less deeply. Being intrinsically motivated is dependent on three aspects: autonomy, competence and relatedness. If students feel competent to fulfill a task, give it relevance and have a feeling of autonomy, the degree of intrinsic motivation raises. In this research intrinsic motivation of the students will be measured to determine the degree of intrinsic motivation and to get to know if they learn on their potential. Especially in combination with some instructional methods motivation of students can be influenced.

1.1 Guided discovery learning: Learning by examples

Within the field of using instructional methods for giving students support while gaming has in general had less research done so far. The simplest solution is to present new information in an easy manner to not overload the working memory capacity. It is tried to combine usually used instructional methods like modelling, self-explanation attempts or giving of examples which are focusing on that way of instruction with the digital learning environments (Ayres, Chandler, Kolyuga & Sweller, 2003).

The best-known instruction that significantly reduces cognitive load is the worked-out example approach (Paas, Renkl & Sweller, 2003). A worked example is a presented example that models a certain solution to a given problem. This example can help students to filter out necessary information that is needed to fulfill a task or get to a solution for a given problem. For the most part novices do profit from worked examples if they are not used to doing tasks, like in this case playing a game. Designing a worked example that should suit for both groups, novices and experts, it is important to design it not too narrow for experts, thus creating a space for own strategies and own creativity, and on the other hand to give enough help for novices to able to complete the task given, as well.

1.1.1 Design of worked examples

Worked examples need to be designed carefully and depend highly on the perceived cognitive load by students who study them. If their extraneous cognitive load is low, worked examples can improve schema construction and transfer performance. Retention and transfer are important if the gain of instructional content is measured. If the instruction is well designed, the student can get high scores on questions about basic content (retention) and is able to transfer the perceived solution steps to other similar (*near-transfer*) or different (*far- transfer*) problems (Mayer, 2008).

A main obstacle in using worked examples as instructional support is the motivation by students. Motivation by students can influence performance and research outcomes (Richey et al., 2013). The motivation a student shows depends on the support given to him. Too much support can lead to the perception that a task is too easy. Less support can discourage students as the student might perceive the task to be too challenging. Using worked examples as instructional support can cover those two effects. The complexity of a worked example can hinder the participants to find their own solutions and to be creative (Sweller, 1999). It is then to be expected that the motivation gets reduced because the students lose interest in the task. Furthermore, regarding the self-determination theory, the participants can get the perception that they cannot fulfill the task on their own and their perceived self-efficacy gets low. Seifert (2004) suggests that students are more motivated if they think they are capable of fulfilling the task. If worked examples are used, instructors should make sure that the participants get the possibility to be creative, use own solutions and get only the information necessary to stay motivated while doing the task.

Worked examples should not be designed as a *goal-free problem* (Sweller, van Merrienboer & Paas, 1998) which is an example that lacks a concrete goal and gives students the opportunity to figure out the goal on their own. This type of problem allows the student to freely come to a solution but can cause a huge overload of the working memory. In contrast, worked examples should leave out details and concentrate on solution steps and problem states. The more complex a task seems to be, the more sub-goals should be used to capture all necessary steps and information (Paas & Merrienboer van, 1999). Mayer (2008) adds that an effective worked example should contain three elements, namely the problem (main goal), solutions (e.g. sub-goals) and commentary that help the students to reach the

main goal. The commentary consists mostly of sub-goals, hints and tips. Additionally, they should be well structured and organized (Renkl, 2002), mainly if there is high element interactivity to be expected like in game environments, to avoid negative co-effects like for example the *split attention effect* (Kalyuga, Ayres, Chandler & Sweller, 2003). This occurs when one channel e.g. the visual channel of information processing, is overloaded (see 1.1 *dual channel theory*). The principles of Mayer (2001) contain solutions to avoid this and other problems during the design of a worked example. By using for example spoken text and visualizations at the same time both channels get information and none of the two channels get overloaded as long as the channels receive different kind of information. Mousavi et al. (1995) tried to figure out if dual mode presentations can also be used for a worked example. The results were promising: learners that were confronted with dual mode (visual/verbal) presentations could gain higher learning results (higher transfer and higher scores on retention) than learners who were confronted with just visual/ visual information (Atkinson, R. et al, 2000).

The placement of a worked example also seems to matter. Using a worked example in an experimental setting, Sweller (1999) states that it should be presented right before the task to prime the students for the task. As a result, students are more able to automate skills and actions necessary for a task.

1.1.2 Guidelines for designing an instruction

For this research it is tried to combine different instructional guidelines to build up a worked example that is effective for novices but experts as well. The chosen guidelines are picked from the multimedia principles by Mayer (2005) and guidelines for instructional videos (Van der Meij, 2013).

Multimedia principles by Mayer (2005)

There are principles how an instruction should be worded to be effective. These principles mostly focus on in which format the instruction should be presented. According to Mayer an instruction should be a dual-mode presentation using verbal and visual information at the same time to present the information properly. Additionally, they should be well structured and organized (Renkl, 2002), mainly if there is high element interactivity to be expected like in game environments, to avoid negative co-effects like for example the *split attention effect* (Kalyuga, Ayres, Chandler & Sweller, 2003). This occurs when one channel e.g. the visual channel of information processing, is overloaded (see 1.1 *dual channel theory*). The principles of Mayer (2001) contain solutions to avoid this and other problems during the design of a worked example. By using for example spoken text and visualizations at the same time both channels get information and none of the two channels get overloaded as long as the channels receive different kind of information. Mousavi et al. (1995) tried to figure out if dual mode presentations can also be used for a worked example. The results were promising: learners that were confronted with dual mode (visual/verbal) presentations could gain higher learning results (higher transfer and higher scores on retention) than learners who were confronted with just visual/

visual information (Atkinson, R. et al, 2000).
The instruction should also be presented in an integrated format and should only contain the most necessary information which should be supported by using signals to underline them. The users of an instruction should additionally be able to take part in the instruction by controlling their own learning speed and by giving them the opportunity to segment the instruction on their own. In the following the principles by Mayer are listed up in detail (see table 1.1).

Table1.1 *Multimedia Principles by Mayer*

Multimedia Principle	An instruction should contain words and pictures and not only words.
Coherence Principle	An instruction should only consist of the most important information. Leave out unnecessary information.
Pre-training Principle	The instruction should train the user for the task.
Split-Attention Principle	The verbal and visual information should be presented at the same time with the same content.
Contiguity Principle	The task should be presented in an integrated format.
Signaling Principle	Important information should be highlighted by signals.
Segmentation Principle	The instructor should give the control of the instruction to the users so that they can determine their own learning speed.

Guidelines for instructional videos

A good way of combining visual and verbal information is to develop an instructional video. Instructional videos mostly contain auditory and visual information which represents the idea of the dual mode presentation of the principles of Mayer. According to Van der Meij (2013) instructional videos should in general be kept short and easy by presenting only relevant information and also highlight them.

The instruction should be a preview of the task coming up by using the same surface as the task surface. To make sure that the user can follow the instruction, the task should be presented in dual mode, using animation and narration. It should also be presented as an action sequence and should be

more procedural than conceptual. It is advised to use a conventional style to make the task relevant to the user so the user commits to the task. While explaining a step of the task, the instructor should thus address the user by using words like “we” or “our”. If new content is presented the instructor should explain or present it in context by e.g. pointing at a symbol which connects to the idea of the split-attention principle by Mayer (2005). Additionally, the user should also get some control of the video to control the learning speed which is also advised by the segmentation principle.

Guidelines for worked examples

Renkl (2014) listed numerous principles of how instructors should design their worked example. Some of these guidelines match the principles earlier presented by Mayer (2005), like the easy mapping principle which advises to use a dual channel presentation of information to instructors. In general a worked example needs to be clearly arranged and should involve the students’ needs and cognitive abilities. It should be easy to understand and the steps should give a central theme. Within this research the following guidelines (table 1.2) and the instructional guidelines presented by Mayer (2005) and Van der Meij (2013) will be tried to combine.

Table 1.2 *Worked example guidelines by Renkl*

Self-explanation principle	Adding self-explanation prompts to worked examples can improve their effectiveness.
Explanation Help principle	Adding instructional explanations if students lack the ability to form explanations on their own.
Example set principle	Presenting multiple examples containing different problems and solutions can improve learning.
Easy mapping principle	Mapping information into different information channels, e.g. visual and verbal, improves learning with examples.
Meaningful building blocks principle	Presenting sub goals in meaningful units and using signals help students to follow them.
Studying errors principle	Presenting Worked examples as video models that model errors to help students with troubleshooting.
Model observer similarity principle	Instructors or models should mirror the students’ level of expertise.
Focus on learning Domain principle	Instructional design should use easy to process exemplifying
Imagery principle	Students should imagine solution steps on their own.

Fading principle	Presenting fading solution steps to students, leads to better understanding of a given problem.

1.2 Research question and hypotheses

The aim of this research is to create a worked example which is presented as an instructional video. This example will be used in a game based learning environment and will be designed upon the above listed guidelines. It is tried to avoid the obstacles that might come across while designing a worked example and an instructional support in general. The research focuses on retention scores the worked example group can achieve and how a worked example may influence the intrinsic motivation of the participants. Also the game scores the participants can reach in the game will be examined. The complete set-up of this research will be discussed in the method section. Regarding the guidelines and the aim of this research the following research question is worded:

Does a worked example have influence on motivation scores, game scores and posttest scores in a game based learning environment?

To test this research question three hypotheses are written down, measuring each concept separately. The first hypothesis is focused on how much the participants really learned by comparing post test scores between a control condition (without worked example) and an experimental condition. By using a motivational questionnaire, scores are compared regarding the influence of the worked example on motivation if there can be found any differences between the experimental and control group. The last hypothesis is written down to compare the game scores the participants can achieve while playing.

H1: *Posttest scores are higher for the experimental condition than for the control condition (due to worked example).*

H2: *There are differences in scores on the motivation questionnaire between the control and experimental group.*

H3: *The experimental group achieves higher game scores than the control group.*

Below, there is a short summary of the research set-up for the control condition and the experimental condition. The only difference in the set-up is the manipulation of the experimental group by the usage of the worked example. Both groups played twice to detect differences between the groups regarding the learning ease. For a more detailed description of the set-up of this research see paragraph 2.3.

Control condition

Informed consent → FAM Questionnaire → Pre-test → Introduction → Game Session 1 → Break → Game Session 2 → FAM Questionnaire → Post-test → Debriefing

Experimental condition

Informed consent →FAM Questionnaire → Pre-test → Introduction → Video (worked example) → Game Session 1 (with Video) → Break → Game Session 2 (without video) → FAM Questionnaire → Post-test → Debriefing

2 Method

This research is based on an experimental design, consisting of one control and one experimental condition. The two conditions just differ in the manipulation (worked example) that was used during the first game session in the experimental condition. In the following the main concepts and the content of the experiment will be described.

2.1 Participants

The participants were between 18 and 30 years old. Their common language was German. In total, 61 people took part in this research, 31 participants in the control condition and 30 participants in the experimental condition which were sampled randomly over the two groups. Before the experiment started the participants were asked to fill in an informed consent form that they commit by free will. They were also informed by this paper and by the researcher that they have the chance to quit the experiment at any time and got a global explanation about the content of this experiment. The sample was a convenient sample thrown out of circles of friends and other volunteers. It was tried to weigh both groups equally. In total 61 participants took part on this research, 37 women (60.7%) and 24 men (39.3 %). The average age was 24. Additionally 70.5 % (43 out of 61) of the participants did already play a strategic game on a computer but only 17 (27.9 %) of the participants play often or regularly on a computer. Furthermore 44 respondents (72.1 %) have knowledge about computers and more than the half of respondents (63.9 %) do use computers often or almost every day.

2.2 Materials

In the following, the material which was used in this research will be shortly presented. All materials, except the game used, can be found in the appendix.

2.2.1 Game

The game which was used during the experiment is called “Enercities”. This game is a strategic online game which deals with the creation of a self-designed community (see figure 2.1). The main goal of this game is to achieve a total population of 200 and / or to reach level five. There are many ways how to play the game and respectively achieve the main goal. The player has to pick a strategy on their own from which they think will work out best. Depending on which strategy is used, different accounts of points will result. There are points given for building houses, other buildings or improving the buildings. Different categories like satisfaction of citizens, environmental points or gaining energy have influence on the amount of the total-score the player can achieve. To make the game more realistic some materials like energy, money or natural resources fade over time. There are counteractivities given (e.g. improving buildings) that can be selected by the participants to slow this

process down. In general, this game is used to teach the players important aspects of saving the environment and still be able to earn profit. For this research the German translation for the game was used due to the research population.

Figure 2.1 *Screenshot of the game "Enercities"*

2.2.2 Introduction

Every condition (the experimental condition and the control condition) received, before playing the game by themselves, a short description of the main control keys. The experimental group received the introduction shortly before the presentation of the worked example. Otherwise they might have got into trouble, because they might not understand e.g. where to click or do not understand the meaning of the given icons in the game and also given in the worked example. The control group thus got the same help than people who encounter the game on the internet. This introduction is developed by the company who designed the game (Paladin Studios) and can be found at the website www.enercities.eu .

2.2.3 Prior-Knowledge and attitude questionaire

The questionnaire consisted of in total eleven questions about the prior knowledge the participants already had about the following topics:

Use of computers (2 questions)

The two questions were used to get to know in how far the participants have knowledge about computers (dichotomous question) and how often they are using computers in their daily life (5 Point-Likert Scale). The last question ranged from "frequent" (5) to "not at all" (1). This was tested because the use of computers can have an impact on the game results.

Playing of strategic computer games (2 questions)

These two questions were used to get to know about the participants' gaming behavior. Did they already play a strategic game before (dichotomous question)? And how often do they play this kind of game? Again the last question was ranging from "frequent" (5) to "not at all" (1). Experience on playing strategic games on a computer may also have influence on the gaming behavior of the participants, so these questions were necessary to be included on the pre-test.

Knowledge about protection of environment (4 questions)

The aim of the game is to inform players about environmental issues and how to prevent ecological problems that may occur. Participants that already have a certain amount of information may get influenced by this knowledge while playing the game. The questions were evaluated by a designed rating scale. For each questions the participants get points that are summarized into a total-score on the pre-test for knowledge. The total score the participants could reach was 9.

Attitude towards the protection of the environment (3 questions)

On a 5-Point-Likert-Scale the participants were asked about their attitude towards environmental issues in real life. It ranged from "I do absolutely disagree" (1) to "I absolutely agree" (5). This was done to be able to test if the attitude towards eco-friendly topics may influence their gaming behavior. The pre-test was inspired by earlier research (e.g. see Bang et al., 2006) and ran through a short pre-test phase. Based on this testing the questions were edited and changed. The questions above were the edited questions used during the experiment. Both pre-test versions can be found in the appendix (see 6.1).

2.2.4 Worked example

In general it was tried to follow the guidelines for multimedia principles, design of worked examples and the guidelines for instructional videos. In the following the application of these guidelines and the used strategy is presented.

Construction

The content was presented in a dual mode using a narration and an animation at the same time. The narration contained information of what has to be done, and the animation showed how to do so. So the information presented in the dual modes contained the same information but differed in the quality. The presenter in the video modeled the necessary steps to be taken to complete the main goal and showed a sequence of events the player may occur. The commentary was filled with hints and let the participants know where they might get into trouble so that the participants were able to recognize when they did something wrong.

Referring back to the guidelines for instructional videos, the video was using the same surface and situation the participants were in while playing the game in order to give them a preview of the task.

The most important names and aspects are adopted for the introduction from the game itself which was given to the participants right before the task. It was tried to make sure that the participants don't get confused by using different names in the introduction and the worked example.

The only exception was the length of video. In the guidelines it was suggested to create a video that does not last longer than three minutes. Due to the amount of information which the game contained and the complexity of the worked example the length of this video was chosen to be longer. The video lasted round about 10 minutes to make sure that the worked example with its main goal and sub-goals can be part of it in a suitable speed of processing information. The idea behind that was that even novices who never played a game or not that often can follow the instructions and don't get overwhelmed by it. It was tried to present the information as detailed and slow as possible.

A first person authors-style ("I" and "we") is used to let the participants feel to be committed by the task. „I" is used if the narrator shows something important while "we" is used if the narrator wants the participants to do the same like him.

Regarding the motivation of the participants it is tried to minimize the support to avoid making the task too easy but also too challenging as well. It was also tried to give the participants some space of creativity to keep them motivated while playing.

The participants were able to find the video back during the first game session to watch it again if they needed to. It was left open on the same screen on which the game was played. The participants were also able to have control over the usage of the video. A common used program was used to give the participants the chance to control the speed, volume and size of the video so that the participants could determine their own speed and needs while watching it.

The following table (table 2.1) contains an overview of all the guidelines used and where to find it in the set-up of the video and the research.

Table 2.1 Main *guidelines presented in the instructional video*

Content video	Design suggestion	Guideline
Unnecessary information beside main goal, sub-goal and commentary are left out	Place only relevant information in the instruction	Coherence principle Worked example Motivation (self-determination theory)
Same screen for video and game, was left open for participants to watch it again if necessary **Common used video program which is easy to handle**	Easy access of the instruction	Imagery principle
While watching the video the	Give users control of the instruction	Instructional videos

participants were able to control the speed, volume and size		Segmentation principle
Same game used in the video and the test phase **Sequence / Tutorial how to play the game**	Preview the task	Instructional videos Pre-training principle Easy-mapping principle
Aural and visual presentation combined	Use narration and animation contained same info but at different channels in an integrated format	Multimedia principle Instructional videos Split attention principle Contiguity principle Easy-mapping principle
Video contained a game tutorial which showed how the game can be played. Actions were following each other in sense making way	Show action to help the participants (action sequence) and use signals to highlight the most important content	Instructional videos Signaling principle Meaningful-building-blocks principle
Main goal is to reach population of 200 **Sub-goals and commentary help to reach the main goal**	Define clear goal	Explanation – help principle Worked example set-up
Commentary gives information about what participants need to be aware of: **Amount of money** **Amount of energy** **Amount of natural resources**	Help participants to recognize that they do something wrong while playing or what they might have trouble with (troubleshooting)	Instructional videos Explanation – help principle
Length is chosen due to speed and processing of information in a slow speed to make sure that the main goal and the sub-goals are recognized by participants, especially novices	Length of instruction should be adjusted to the content of worked example	Worked example set-up

Only one level out of five is played by instructor to give participants the possibility of a creative playstyle and to balance the support	Too much support can have negative effects on performance and can lead to less creative playing	Motivation (self-determination theory) Fading principle Self-explanation principle

Strategy

It is possible to pick many different strategies to fulfill the task and the main goal. In this research a strategy is chosen which focuses on the creation of an eco-friendly community. The commentary of this worked example consisted of hints, warnings and other extra information written down to give extra aid to the participants. There were hints given how to earn money, how to get important game points and how to receive enough energy to continue building structures. The player also received information about obstacles that the player may encounter while playing the game. Reducing the use of natural resources for example was one main issue the player had to deal with. These hints and warnings were worded as well as the sub-goals which the player needed to handle first before reaching the main goal. In table 2.2 these sub-goals are summarized whereas the commentary and the whole narrative script is part of the appendix (see 6.2 & 6.3).

Table 2.2 *Main goal and sub-goals*

Goals	Worked Example
Overall Goal Reach level 5 or respectively a population size of 200	Das Ziel des Spiels ist es eine Bevölkerungszahl von 200 bzw. das Level 5 zu erreichen.
1. Sub-goal Raise the population by building small cities	Um die Bevölkerung zu erhöhen, baue ich als Erstes eine Vorstadt.
2. Sub-goal Take care of the usage of natural resources by improving structures	Als Nächstes entwickeln wir die Vorstadt weiter, um den Verbrauch von Energie und von natürlichen Ressourcen zu verringern.
3. Sub-goal Build industrial structures to take care of your current amount of money	Als Nächstes baue ich Leichtindustrie, um Geld zu beschaffen.

4. Sub-goal Build power stations to get energy for your city	Wie du an der Energieanzeige links unten sehen kannst, brauchen wir nun trotz der Weiterentwicklungen zusätzliche Energie, um weitere Gebäude zu bauen. Also brauchen wir als Nächstes ein Kraftwerk.
5. Sub-goal Level up by building additional small cities	Um den nächsten Level zu erreichen, baue ich nun eine weitere Vorstadt neben der ersten Vorstadt.
6. Sub-goal Build and improve parks and forests to collect environment points	Umweltpunkte bekommst du z.B. durch den Bau eines Parks oder eines Waldes. Auch diese lassen sich weiterentwickeln, um noch mehr Umweltpunkte zu sammeln.
7. Sub-goal Build e.g. markets to get satisfaction points	Die Zufriedenheit der Bewohner kannst du erhöhen, indem du z.B. einen Markt in deine Wohnsiedlung baust, um deinen Bewohnern die Möglichkeit zu geben, Einkäufe zu machen.

2.2.5 Post-test

The post – test was a knowledge test with recall questions about important aspects of the game units. This test was designed to test how well both groups would score on retention. To rate the answers given by the participants, a codebook of possible answers was created. For each answer the participants could get points. Depending on the difficulty of the questions the participants could get points between 0, 5 and 3 points. In total the participants could get a total score of 26. Some of the questions were supported by screenshots of game situations, to help the participants to remember certain game units and situations. Additionally the questions were referring to different stages and levels of the game. The complete questionnaire and the codebook can be found in the appendix (see 6.4). Examples of these questions are shown in figure 2.2.

What is this? What is special about this kind of building?

In the picture below, you can see some improvements.

a. *What are these improvements called?*
b. *To which kind of structure do these improvements belong?*
c. *What do they improve?*

Figure 2.2: *Examples of post-test questions*

2.2.6 QCM (FAM)

This questionnaire was used to test how the participants felt about playing the game and consisted of 18 items testing the attitude and motivation towards the task given. Due to the research population the German version of the QCM (FAM) was used. The internal consistency score for this version varied between α = 0, 66 and α = 0, 90 in earlier research (Rheinberg, Vollmeyer, & Burns, 2001). This questionnaire was built upon four main concepts which measure the intrinsic motivation of the participants: anxiety of failure, probability of success, interest, and challenge. The four concepts are important to measure intrinsic motivation regarding the self-determination theory. The perception of the task can change after watching the instructional video (worked example) and can influence the participants' motivation. That is why the QCM is used twice in this research.

For each concept, there can be examples found below whereas the whole questionnaire can be found in the appendix (see 6.5):

6. This task is challenging me. (Challenge)

12. It would embarrass me if I fail. (Anxiety)

13. I think that everybody can do this. (Probability of success)

17. I would like to do this task in my leisure time as well. (Interest)

The Seven-Point-Likert-Scale used ranged from 1 (*totally disagree*) to 7 (*totally agree*). The mean scores are separately taken for each dimension. Before handing the questionnaire to the participants, a short introduction about the game was given to them by the researcher. This made it easier to answer the questions that were referring to the task.

2.3 Procedure

At first the participants got a short introduction by the experimenter in the form of an informed consent. During this informed consent the participants will be informed over the global set-up of the experiment. Therefore they were also informed about their rights regarding their data and that everything will be handled anonymously. After that the participant got the FAM and the pre-knowledge questionnaire. On average the participants took 15 minutes for both questionnaires. Before starting with the experiment the participant got the short introduction to be able to use the game probably.

Before starting the first individual game session the participants in the experimental condition were shown the video which included the worked example. The participants could determine their own speed while watching and got the chance to go back if they needed to hear or see something once again. Additionally the participants had headphones on while they were listening to the video to not get disturbed by other noises.

During the first game session, they got the chance to view the video once again if it was necessary. The game was stopped at 20 minutes and the experimenter wrote down the scores the player got. When the participants were ready with playing, a short break of five minutes was given before getting started with the second game session which also lasted 20 minutes.

During the second game session, the participants were not allowed to watch the video again and had to try playing the game by themself with the information received and the help they got during the first game session.

At the end of the experiment, the post-test and the FAM again were given to the participants. The participants needed on average 20 to 25 minutes to fill in these questionnaires. When the participants were ready with the experiment, they got the chance to ask questions about the experiment and were informed about the goal of the experiment and other important subjects.

2.4 Analysis

Before analyzing the hypotheses some pre-analyses are done. First, the groups are compared in age, gender, pre-knowledge and attitude. Furthermore the sample is analyzed with the Shapiro-Wilk test if it is normal distributed.

2.4.1 Distribution of the groups

The two groups were compared regarding to age, gender, pre-test scores and the scores on the attitude scores to see if the groups are equally weighted. In general, both groups weigh equally. The experimental group consisted of 18 women and 12 men who averaged 24, 27 years old. In contrast, the control condition consisted of 19 women and 12 men who averaged 24, 19 years old. Additionally the pre-test scores and attitude scores were also close to equality for both groups. The scores of the complete analysis are presented in table 2.2.

Category	Mean score/ Quantity Experimental group	Mean score Control group
Age	24,27 (s= 3,279)	24,19 (s= 3,351)
Gender	Women: 18 (60%) Men: 12 (40%)	Women: 19 (61, 3%) Men: 12 (38,7%)
Pre-test	5,83 (s= 2,245)	6,00 (s= 2,160)
Attitude	11,70 (s= 2,103)	11,68 (s= 1,869)

Table 2.2: *Distribution of experimental and control group*

2.4.2 Scale testing on normal distribution

Before testing the above written hypotheses, a Shapiro-Wilk test is done to test if the scores are normal distributed. This test is chosen due to the small size of the sample (61 < 2000). The analysis is done for each dependent variable separately. If the p-score is lower than 0, 05 the scores are not obtained as normal distributed.

Hypothesis 1: FAM Scores

Here are the FAM scores taken at the second measurement moment of both groups because at this moment differences are expected. The Shapiro-Wilk test showed that all scores from that questionnaire are not normal distributed (see table 2.3). Therefore a non-parametric test namely the Mann-Whitney U-test for independent samples will be used to explore differences between the two groups.

FAM Score	Shapiro-Wilk score
Interest	0,040
Success	0,009
Challenge	0,009

Anxiety	0,000

Table 2.3: *Shapiro-Wilk scores for FAM*

Hypothesis 2: Post-test scores

The same is done for the post-test scores. The analysis showed that the scores of the post-test scores are normal distributed (p=0,434 > 0, 05) so that a t-test for independent samples will be used.

Hypothesis 3: Game scores

Regarding the game scores achieved by the participants at the second measure moment, also here all scores are not normal distributed (for each one p= 0,000) and a non-parametric test will be used.

2.4.3 Analysis of the pre-test scores

The pre-test questionnaire was not only used to get information about the population but also about the influence the factors measured in this questionnaire can have on the post-test scores and the achieved game scores.

Prior knowledge testing

Due to the possibility of a priming effect by the pre-test onto the post-test, a one way regression analysis is done to exclude this. The analysis showed no influence on the post-test scores to be found (t=0,933, p=0,355).

Attitude testing

It was expected that the scores from the attitude scale can have influence on the post test scores and the environmental game scores. A one-way-regression analysis showed a connection between the attitude scores and the post-test scores (t=2,536, p=0,014) but no connection between the attitude scores and the achieved environmental game scores (t=0,495; p=0,622).

3 Results

In the following the main results of this research and belonging analyses are presented. For each hypothesis (see 1.4) the results are separately taken. Additionally most results refer to the second phase of testing (game session two) to compare both groups on their learning outcomes.

3.1 Is the mean score on the post-test higher in the exp. group than in the control group? (H1)

The experimental group has higher mean scores on the posttest than the control group (see table 3.1). The difference of the post test scores were significant (t=2,051, p= 0.045).

Condition	Mean	Standard deviation
Experiment	15,17	3,92
Control	12,84	4,88
Total-score	13,98	4,55

Table 3.1 *Mean posttest scores of both groups*

3.2 Do the FAM scores differ at the second measure moment? (H2)

Before and after the experiment the participants were handed the FAM questionnaire. The two groups are compared to test if the values of the concepts significantly differ before and after playing the game. By using a Mann-Whitney U-test for independent samples the two groups are compared. The results show that there are significant differences between the groups in interest (p= 0,014) and success (p= 0,037) after the second measurement. The other two showed no significant difference at all (see table 3.2.

Table 3.2 *Mean scores FAM of both groups*

Condition	Interest	Success	Challenge	Failure
Experimental (1)	4,73 (0,98)	5,7 (0,76)	4,97 (0,77)	2,43(1,12)
Control (1)	4,25 (1,34)	4,99 (0,83)	4,56 (0,83)	2,43 (1,07)
Experimental (2)	5,15 (1,3)	5,41 (1,18)	5,13 (1,14)	2,2 (1,21)
Control (2)	4,25 (1,51)	4,52 (1,7)	4,87 (1,48)	2,39 (1,17)

Additionally the mean scores on the interest score were rising from 4, 73 to 5, 15 in the experimental group whereas the scores for the control condition stayed stable. This occurred although the participants in the experimental group scored at the second measurement higher challenge and lower on success and failure (see table 3.1).

3.3 Are there any differences in the game scores between the two groups? (H3)

Further analysis regarding the impact of the manipulation of the experimental group showed that the experimental group scored higher on certain scores the participants could achieve while gaming (game session two). Most important the experimental group scored higher mean scores on level (p=0, 00), total score of the game (p= 0, 00), city value (p= 0, 15) and satisfaction of the citizens (p= 0, 05). Using less resources, which was an important aspect of the strategy presented in the worked example, than the control group could not be clarified (p= 0,231). In table 3.3 the mean scores for both groups are summarized.

Table 3.3 *Mean game scores of the second session of the experimental group compared to control group*

Condition	Level	Total-score	Ressources	Environment
Experimental	4,27 (0,79)	227,13 (112,13)	191,41 (218,35)	42,63 (92,61)
Control	3,19 (1,11)	139,23 (65,42)	179,06 (268,1)	29,65 (23,05)

Condition	Energy	City value	Money	Satisfaction
Experimental	28,70 (41,48)	26,63 (31,48)	-36,65 (448,4)	28,57 (23,26)
Control	37,90 (72,73)	12,65 (8,11)	-48,52 (488,86)	16,65 (12,45)

Referring back to the result that the mean scores of the posttest were higher in the experimental group, these variables are further analyzed if one of these did show a correlation to the posttest scores. Only two of the four scores were remaining showing a correlation to posttest scores: level (p= 0.00) and total points (p=0.00).

4 Discussion

This research was focusing on the question if worked examples can be a suitable instructional tool for game based learning environments. It was suggested that a worked example has to fulfill instructional criteria to be effective. These criteria are combined in this research with the result that worked examples can indeed be a helpful tool to support learning with games. Hypothesis one indicated that it is expected that the control group should have lower scores on the posttest than the experimental group. In this research the mean scores of the experimental group were higher on the posttest than the mean scores of the control condition which literally implies that the experimental group in average scored more answers correct on the posttest than the control group. This met the findings already mentioned in the introduction by Mousavi et al. (1995), Sweller (1999), Paas, Renkl & Sweller (2003) and Mayer (2008). All of these mentioned if worked examples are carefully designed students can profit by them and can earn better results. The results of the post-test can depend slightly on the higher level achievement that occurred because of the worked example. The worked example showed how to play the first level of the game, so that the participants had just to copy the actions of it and spend less time for the first level of the game. The posttest consisted of questions throughout different levels. For example, some structures were only available at a certain level like the hydro station (which occurred in a question of the posttest). If the participants did not reach level three, they were not able to answer the question, because they could not unlock the hydro station.

The scores of the experimental group on the QCM were higher than expected. Sweller (1999) noticed that worked examples can minimize the motivation of students. In this research the experimental group scored higher on interest and lower on challenge than the control group. Regarding the motivational state of the participants, the experimental group was more interested in the game and more confident about their results after playing the game than the control group. The results thus don't meet the expectations that the students in the experimental group scored lower on the QCM than the control group.

This research additionally showed that the experimental group was able to outperform the control group on some game achievements like level, total points and satisfaction. Nevertheless they were not able to outperform them on the amount of natural resources which was a big part of the strategy presented in the worked example. A major goal from the worked example was that the participants had to be careful with the resources to be able to achieve the main goal. Nevertheless some of the participants could not manage them so that the global result was that there was no difference found regarding the natural resources. A possible explanation for this result could be the higher degree of levels the experimental group achieved. With rising level more resources will be used due to the higher amount of structures that have been built. Thus it can be seen as a natural cause of reaching higher levels. Furthermore, even the achievement of higher levels indicates that there were enough resources to reach them. With a lack of resources it would have not be possible to build residential structures to reach a new level. Thus, there was an advantage in the usage of natural resources

otherwise some of the participants in the experimental group would not have been able to achieve higher levels. Due to the fact that the experimental group had an example in which the first level was already done for them, they had an easier start to the game and spent less time getting started with their city. This saving of time led to a higher achievement of levels which is reflected in the mean score of the level (one level higher than the control condition in both game sessions) as well. Not only the amount of natural resources was affected by the achievement but also the scores of the posttest score which led to a clear result in favor of the experimental group.

The population in this research also mattered. The pre-test showed that 70, 9 % of the participants have played a strategic game before but only 27, 9 % of the participants play strategic games often or regularly. This means that the population for the most part consisted of novices and less experts. The few experts did not score higher or lower on the post-test so that no differences between novices and experts were found. This worked example is thus effective for novices and experts respectively.

It can be suggested that not only prior knowledge concerning computers and gaming in general can influence the results but also the play style or how the participants are using instructions. So including other measurements or set–up's would give more detailed information about how worked examples work inside the field of game based learning. Penrose & Seiford (1988) stated that in their research only 14 % of the participants were reading a before handed manual before using a computer software they did not use before. They found an explanation for this by referring to the lacking meta-knowledge of the participants. Due to the fact that the participants maybe did not know on what they should focus on during studying the manual and which information could be new to them, they may have missed the important information the manual should deliver to them in not reading the manual. To overcome this in future research enhancing the interactivity effect (Mayer, 2003) could be a solution. The participants in the experimental group could watch the video not only before but also during the first game session like in this research with the only difference that they watch *and* play at the same time. They could start the game and the video, directly imitating the actions in the video. The participants should be instructed by the researcher to first listen to an important step, stop the video and try to do the move on their own in the game. Using the video like this, the participants would automatically use the video more actively and could not only remember the certain steps just by listening but also by doing. In this case, the researcher should ensure that the participants get enough time, maybe extending the play time up to 30 minutes instead of 20 minutes.

Another option to get more insight of the effect of the worked examples, presented by Mayer (2003) and suggested by Ertelt (2007), is the pre-training option. Some of the participants could get some help with the worked example when they first receive training how to use a worked example correctly. This training could e.g. consist of giving the participants two other worked examples (also being constructed as an on-screen video) before the game sessions, letting them figure out the most important information delivered by the videos. The researcher gives them feedback on what they figured out and lets them explain their choices. This would improve the awareness of the participants

concerning worked examples and would give less experienced online game players an impression which steps could be useful and on which information they should pay attention to.

5 References

Amory, A. (2007). Game object model version II: a theoretical framework for educational game development. *Education Tech Research Dev* 55, 51-77.

Atkinson, Derry, Renkl & Wortham, (2000). Learning from examples: Instructional principles from the worked examples research. *Review of educational research, 70*(2), 181-214.

Bang,M., Torstensson,C. & Katzelf,C. (2006). The powerhouse: a persuasive computer game designed to raise awareness of domestic energy consumption. In W. Ijsselsteijn et al (Eds.) Persuasive (pp.123-132). Berlin, Heidelberg: Springer Verlag.

Chandler,P. & Sweller,J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, 8, 293-32.

Ertelt, A. (2007). On screen videos as an effective learning tool. The effect of instructional design variants and practice on learning achievements, retention, transfer and motivation (Doctoral dissertation). Albert-Ludwigs Universität, Germany.

Garris, R., Ahlers, R., Driskell, J. E. (2002). Games, Motivation and Learning: Research and Practice Model. In: Simulation & Gaming, Newbury Park, Sage Publ.

Kalyuga, S., Ayres, P., Chandler, P. & Sweller, J. (2003).The expertise reversal effect. *Educational psychologist*, 38(1), 23-31.

Kerres, M., Bormann, M. & Vervenne, M. (2009)**:** Didaktische Konzeption von Serious Games: Zur Verknüpfung von Spiel und Lernangeboten. In: MedienPädagogik. Online-Zeitschrift für Theorie und Praxis der Medienbildung.

Le, S., Weber, P. & Ebner, M. (2013)**:** Game-Based Learning. Spielend Lernen? In: Schön, Sandra/Ebner, Martin (Hrsg.): *Lehrbuch für Lernen und Lehren mit Technologien* (L3T).

Mayer, R.E. (2001). Chapter 11: Principles of multimedia design. In R.E. Mayer (Ed.), Multimedia learning (pp. 183-194). New York: Cambridge University Press

Mayer, R.E. (2008). Learning and Instruction.Second Edition. Pearson. ISBN 0-13-170771-X

Mayer, R.E. & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist, 38*(1), 43-52.

Mousavi, S.Y., Low, R. & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology, 87*, 319- 334.

Paas, F., Renkl, A. & Sweller, J. (2003). Cognitive load theory and instructional design: recent developments. *Educational psychologist, 38(1)*,1-4.

Paas, F. & Merrienboer, J. van (1994). Variability of worked examples and transfer of geometric problem – solving skills: a cognitive load approach. *Journal of educational psychology,* 86 (1), 122-133.

Penrose, J.M. & Seiford, L.M. (1988). Microcomputer users' preferences for software documentation. An analysis. *Journal of Technical Writing and Communication*, 18, 355-365.

Renkl, A. (2002). Worked-out examples: instructional explanations support learning by self-explanations. *Learning and instruction*, 12, 529-556.

Renkl, A. (2014). Learning from worked examples: how to prepare students for meaningful problem solving. In: Benassi, V.A., Overson, C.E. & Hakola, C.M. (2014). *Applying science of learning in education. Infusing psychological science into the curriculum*. Retrieved from the society for teaching of psychology.

Rheinberg, F., Vollmeyer, R. & Burns, B. D. (2001). A questionnaire to assess current motivation in learning situations. *Diagnostica*, 2, 57-66.

Richey, J.E. & Nokes-Malach, T.J. (2013). How much is too much? Learning and motivation effects of adding instructional explanations to worked examples. *Learning & instruction*, 25, 104-124.

Ryan, R.M. & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development and wellbeing. *American psychologist, 55 (1)*, 66-78. DOI: 10.1037//0003-066X.55.1.68

Seifert, T.L. (2004). Understanding student motivation. *Educational Research, 46*, 137-149. DOI: 10.1080/0013188042000222 42.

Spiegelman, M., & Glass, R. (2008). Gaming and learning: Winning information literacy collaboration. *College & Research Libraries News, 69(9),* 522-547.Retrieved from http://crln.acrl.org.

Tuovinen & Sweller (1999). A comparison of cognitive load associated with discovery earning and worked examples. *Journal of educational psychology,* 91(2), 334-341.

Van der Meij, H. & Carroll, J.M. (1998). Principles and heuristics for designing minimalist instruction. In J.M. Carroll (Ed.), *Minimalism beyond the Nurnberg funnel* (pp. 19 - 53).Cambridge, MA: MIT Press.

Van der Meij,H. & Van der Meij, J. (2013). Eight guidelines for the design of instructional videos for software training. *Technical Communication*, 60 (3).

Wouters & Oosterndorp, van. (2013): A meta-analytic review of the role of instructional support in game-based learning. *Computers and Education* 60. 412-425.

6 Appendixes

6.1 Pre-test

Respondenten-nummer :

Alter :

Geschlecht : o Männlich o Weiblich

Dies ist ein kleiner Fragebogen vorab. Versuche die Antworten so ehrlich wie möglich zu beantworten. Du hast pro Frage nur eine Antwortmöglichkeit. Kreuze Zutreffendes bitte an.

Ich beschäftige mich ... mit Computern

o Regelmäßig o Häufig o Selten o Wenig o Gar nicht

Ich kenne mich mit Computern aus

o Ja o Nein

Ich habe am Computer bereits strategische Spiele gespielt

o Ja o Nein

Ich spiele ... am Computer

o Regelmäßig o Häufig o Selten o Wenig o Gar nicht

Im Folgenden findest du Fragen zum Thema Umwelt. Versuche die Fragen so gut wie möglich zu beantworten.

Ich kenne ein oder mehrere Beispiele für erneuerbaren Energien, nämlich…
Rohstoffe kann man sparen durch…
„Nachhaltigkeit“ bedeutet für mich…
„Umweltschutz“ bedeutet für mich…

Bei diesem Fragebogen hast du pro Frage nur eine Antwortmöglichkeit. Kreuze Entsprechendes an.

	Ich stimme gar nicht zu	Ich stimme nicht zu	Unentschlossen	Ich stimme zu	Ich stimme voll und ganz zu
Ich interessiere mich für Umweltschutz					
Mir ist eine saubere Umwelt wichtig					
Für mich gehört Umweltschutz zum alltäglichen Leben (wie z.B. Müll trennen, nur Auto fahren, wenn dies notwendig ist etc.)					

6.2 Worked example Script (Spoken text in the video)

Formatiert: Englisch (USA)

Introduction

<< Hallo und Willkommen beim Beispielvideo für das Spiel „Enercities“ . Bei diesem Spiel geht es darum eine umweltbewusste Siedlung zu errichten. Das Ziel des Spiels ist es eine Bevölkerungszahl von 200 bzw. das Level 5 zu erreichen. Wie viele Bewohner deine Siedlung hat und welchen Level du schon erreicht hast, siehst an der Level-Anzeige unten in der Mitte. Dort kannst du auch sehen, wie viele Bewohner du noch brauchst, um den nächsten Level zu erreichen. >>

Presentation of the strategy

<< Ich möchte Dir nun eine Strategie zeigen, wie du das Ziel, eine Bevölkerung von 200 zu erreichen, erreichen kannst. Dafür spiele ich mit dir den ersten Level durch und gebe dir Tipps, wie du weiter machen kannst. Dann fangen wir mal an. >>

<< Um die Bevölkerung zu erhöhen, baue ich als Erstes eine Vorstadt. Dafür klick ich oben auf das Haussymbol und wähle die Vorstadt aus. Wenn du mit dem Mauszeiger auf der Vorstadt bleibst, so wie ich jetzt, kannst du sehen, welche Werte sich durch den Bau der Vorstadt verändern. Du kannst jetzt z.B. sehen, dass deine Vorstadt 2 Einheiten Energie benötigen wird, deine Bevölkerung um 7 Bewohner steigen wird und deine Umweltpunkte um 1.5 Einheiten verringert werden. Ich baue die Vorstadt direkt neben dem Rathaus, um die Zufriedenheit der Bewohner zu erhöhen. Das kannst du an dem grünen Wert neben dem Smiley sehen. Jetzt warten wir kurz bis die Vorstadt fertig gebaut ist. >>

<< Als Nächstes entwickeln wir die Vorstadt weiter, um den Verbrauch von Energie und von natürlichen Ressourcen zu verringern. Dazu klicke ich auf die Vorstadt. Dann öffnet sich eine Übersicht der möglichen Verbesserungen. Ich fange mit der Entwicklung von energiesparenden Glühlampen an, um den Energieverbrauch zu verringern, und entwickele die verbesserte Isolierung weiter, um natürliche Rohstoffe ein zu sparen. Da ich noch genug Geld übrig habe, entwickele ich auch noch Solardächer weiter, um noch mehr Energie und natürliche Ressourcen zu sparen. Die Vorstadt ist dann in der Lage eigene Energie zu produzieren. Um auch Umweltpunkte zu sammeln, entwickele ich auch den Regenwasserspeicher für die Vorstadt und baue eine Bushaltestelle. Das Weiterentwickeln dauert ein wenig, aber wir können ja schon mal weitermachen. Also klicken wir auf Zoom, um wieder zur Vollansicht zurück zu kommen. >>

<< Wir haben noch Geld übrig, aber wir sollten trotzdem dafür sorgen, dass das auch so bleibt. Als Nächstes klicke ich also auf das Rathaus und erhebe CO2-Steuern, um zukünftige Gewerbe- oder Industriegebäude dazu zu bewegen, weniger CO2 aus zu stoßen. Die Weiterentwicklung bringt dir auch Umweltpunkte. Diese Entwicklung dauert etwas länger, also klicken wir wieder auf Zoom. >>

<< Als Nächstes baue ich Leichtindustrie, um Geld zu beschaffen. Dazu klicke ich auf das Euro-Symbol und gehe dann auf Leichtindustrie. Wie du sehen kannst, wird sich das Bauen der Leichtindustrie negativ auf den Verbrauch deiner natürlichen Ressourcen auswirken und auch die Umwelt belasten. Deshalb werde ich nach dem Bau der Leichtindustrie, das Gebäude direkt weiterentwickeln um diesem Effekt entgegen zu wirken. Leichtindustrie sollte immer fern von Wohnsiedlungen gebaut werden, da deine Bewohner nicht gerne neben Industriegebäuden wohnen möchten. Wer möchte schon neben einem qualmenden Schornstein wohnen? Damit würde auch die Zufriedenheit sinken. >>

Formatiert: Deutsch (Deutschland)

<< Wie du an der Energieanzeige links unten sehen kannst, brauchen wir nun trotz der Weiterentwicklungen zusätzliche Energie, um weitere Gebäude zu bauen. Also brauchen wir als Nächstes ein Kraftwerk. Dazu klicke ich oben auf das Blitz-symbol und wähle die Windkraftanlagen aus. Wie du erkennen kannst, sind Windkrafträder umweltschonend, da sie keine Schadstoffe abgeben, wie z.B. das Kohlekraftwerk. Also wählen wir die Windkraftanlagen aus und bauen diese neben der Leichtindustrie, die wir eben gebaut haben, da Bewohner auch nicht neben Kraftwerken wohnen möchten. Windkrafträder können nämlich sehr laut sein. >>

<< Auch Kraftwerke können weiterentwickelt werden. Dadurch können sie mehr Energie produzieren. Dadurch sparst du Platz, um z.B. weitere Wohnsiedlungen zu bauen. >>

<< Um den nächsten Level zu erreichen, baue ich nun eine weitere Vorstadt neben der ersten Vorstadt. Auch diese entwickele ich weiter, wenn sie fertig gebaut ist, um erneut Ressourcen und Energie zu sparen. >>

<< Wie du unten an der Level-Anzeige sehen kannst, sind wir jetzt ein Level aufstiegen. Um in den nächsten Level zu kommen, klickst du auf „Level up“. Durch das Level-up hast du neue Bauflächen bekommen mit denen du deine Stadt ausbauen kannst. Des Weiteren kannst du auch neue Arten von

Gebäuden bauen, wenn du genug Geld hast. Wenn du Level 3 erreichst, kommen noch weitere hinzu. Diese Gebäude sind nun nicht mehr grau unterlegt und sind unter den jeweiligen Symbolen im Bau-Menü zu finden. Wenn du z.B. auf das Haus-Symbol klickst, siehst du, dass du jetzt eine Stadt bauen kannst. Städte können mehr Bewohner beherbergen, was dazu führt, dass deine Bevölkerungszahl schneller steigt. Allerdings ist eine Stadt auch teurer als eine Vorstadt, also solltest du vor dem Bau einer Stadt darauf achten, dass du genug Geld hast, um sie bauen zu können. >>

<< Vergiss auch nicht deine Zufriedenheit deiner Bewohner zu steigern und Umweltpunkte zu sammeln. Umweltpunkte bekommst du z.B. durch den Bau eines Parks oder eines Waldes. Auch diese lassen sich weiterentwickeln, um noch mehr Umweltpunkte zu sammeln. Die Zufriedenheit der Bewohner kannst du erhöhen, indem du z.B. einen Markt in deine Wohnsiedlung baust, um deinen Bewohnern die Möglichkeit zu geben, Einkäufe zu machen. >>

Ending

<< Das war es von meiner Seite und du bekommst jetzt die Möglichkeit selber zu spielen und deine eigene Siedlung zu bauen. Ich hoffe, dass du mit meiner Strategie dein Ziel erreichen kannst. Viel Spaß und viel Erfolg dabei. >>

6.3 Hints and warnings given to the participants

Used design styles and hints	Worked example
1. Hint	
How to use the building menu of the game	Wenn du z.B. auf das Haus-Symbol klickst, siehst du, dass du jetzt eine Stadt bauen kannst Dazu klicke ich oben auf das Blitz-symbol und wähle die Windkraftanlagen aus
2. Hint	
Building of structures change amounts of money, power and natural resources	Du kannst jetzt z.B. sehen, dass deine Vorstadt 2 Einheiten Energie benötigen wird, deine Bevölkerung um 7 Bewohner steigen wird und deine Umweltpunkte um 1.5 Einheiten verringert werden. Ich baue die Vorstadt direkt neben dem Rathaus, um die Zufriedenheit der Bewohner zu erhöhen. Allerdings ist eine Stadt auch teurer als eine Vorstadt, also solltest du vor dem Bau einer Stadt darauf achten, dass du genug Geld hast, um sie bauen zu können

3. Hint	
Improving structures right after building them will reduce the usage in the long term	Deshalb werde ich nach dem Bau der Leichtindustrie, das Gebäude direkt weiterentwickeln um diesem Effekt entgegen zu wirken Auch diese entwickele ich weiter, wenn sie fertig gebaut ist, um erneut Ressourcen und Energie zu sparen.
4. Hint	
Position of the structures can influence the amount of points	Leichtindustrie sollte immer fern von Wohnsiedlungen gebaut werden, da deine Bewohner nicht gerne neben Industriegebäuden wohnen möchten
Reference to reality	Wer möchte schon neben einem qualmenden Schornstein wohnen? Windkrafträder können nämlich sehr laut sein
Comparison	Wie du erkennen kannst, sind Windkrafträder umweltschonend, da sie keine Schadstoffe abgeben, wie z.B. das Kohlekraftwerk Städte können mehr Bewohner beherbergen, was dazu führt, dass deine Bevölkerungszahl schneller steigt. Allerdings ist eine Stadt auch teurer als eine Vorstadt, also solltest du vor dem Bau einer Stadt darauf achten, dass du genug Geld hast, um sie bauen zu können.
Visible author style	"…baue ich „ / „entwickeln wir"

6.4 Posttest & Codebook

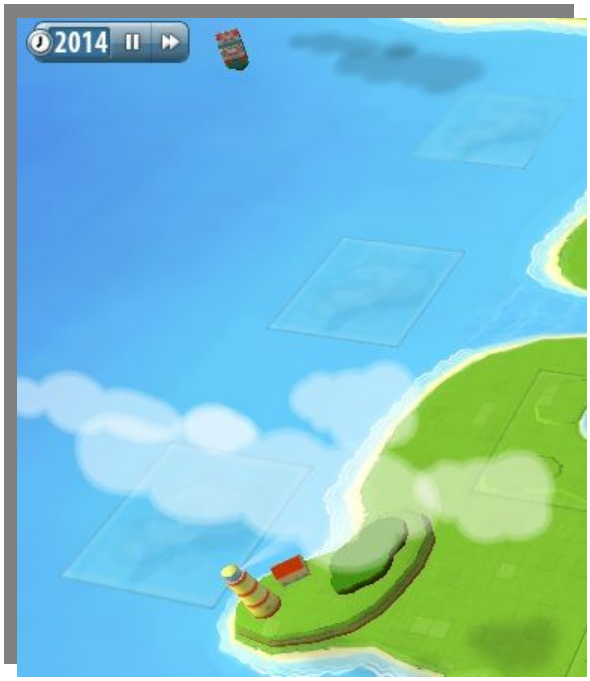
Posttest questions

1. Im folgenden Bild kannst du eine Spielsituation finden.

Was denkst du, hätte man besser machen können, um die Zufriedenheit der Bewohner zu erhöhen?

2. Was ist das? Was ist das Besondere an diesem Gebäude?

3. Auf den unten abgebildeten Wasserfeldern, ist es auch möglich ein bestimmtes Gebäude zu bauen. Welches Gebäude ist das und welchen Effekt hat es auf das Gebäude, wenn es auf ein Wasserfeld gesetzt wird?



4. Dieses Spiel ist darauf ausgerichtet strategisch zu handeln. Wenn du dir den unteren Spielstand ansiehst, worauf ist hier mehr Wert gelegt worden und wodrauf weniger?

5. Nenne zwei Möglichkeiten, wie man im Spiel „Enercities“ Umweltpunkte sammeln kann.
6. Was weisst du über die natürlichen Ressourcen im Spiel?
7. Nenne drei umweltfreundliche Kraftwerke, die in dem Spiel „Enercities“ vorkommen.
8. Nenne Unterschiede zwischen einer Leichtindustrieanlage und einer Schwerindustrieanalage.

9. Welche Verbesserungen kann man im Spiel an dem Markt vornehmen? Welche drei Werte können hiermit verbessert werden?

10. Im unteren Bild kannst du Verbesserungen sehen.
    a. Welche sind das?
    b. Zu welcher Art Gebäude gehören sie?
    c. Wofür sind diese Verbesserungen nützlich?

Codebook

1. Mögliche Antworten :
    a. Kraftwerke / Industrie nicht beim Wohnviertel bauen (0,5 Punkt)
    b. Gebäude bauen um Zufriedenheit zu erhöhen (z.B. Markt usw.) (1 Punkt)
    c. Wohnsiedlungen um das Rathaus herum bauen (0,5 Punkte)
    d. Parks und Wälder bauen (1 Punkt)
2. Wasserkraftwerk ist richtig. Dieses Gebäude kann ausschließlich nur am Wasserfall gebaut werden und auch nur einmal im Spiel. (2 Punkte)
3. Windkraftanalagen sind richtig. Dadurch, dass sie auf dem Wasser stehen, erzeugen sie mehr Energie. (2 Punkte)
4. Der Fokus bei diesem Spieler liegt mehr auf der Zufriedenheit der Bewohner und mehr auf genügend Kapital. Also wird hier weniger wert auf die Umwelt gelegt. (3 Punkte)
5. Mögliche Antworten :
    a. Bauen von Parks, Wäldern usw. (2 Punkte)
    b. Weiterentwickeln von Gebäuden die Umweltpunkte geben (1 Punkt)
6. Natürliche Ressourcen sind nicht erneuerbar, d.h. sie können nicht wiederhergestellt werden. Dadurch ist das Beschützen dieser Ressourcen wichtig. (1 Punkt)
7. Mögliche Antworten :
    a. Solaranlagen (1 Punkt)
    b. Windkrafträder (1 Punkt)
    c. Wasserkraftwerk (1 Punkt)
    d. Superwindkraftanlagen (2 Punkte)
    e. Supersolaranlagen (2 Punkte)
8. Leichtindustrie ist billiger, aber bringt auf der anderen Seite auch nicht so viel Kapital (im Vergleich zur Schwerindustrie). Schwerindustrie hat aber mehr negativen Einfluss auf die Umwelt (2 Punkte).
9. Mögliche Antworten :

a. Vegetarische Nahrung (Umwelt/ Zufriedenheit/ Ressourcen) (1 Punkt)
b. Biologische Nahrung (Umwelt/ Zufriedenheit/ Ressourcen) (1 Punkt)
c. Bushaltestelle (Umwelt/ Ressourcen) (1 Punkt)

10. Antworten :
    a. Öko-Dach, Verbesserte Isolierung, Co2- Verringerungsplan, Thermalspeicherung & Recyclinganlagen (für jedes 0,5 Punkte)
    b. Leichtindustrie (0,5 Punkte)
    c. Verbessern von Umwelt, Einsparung / Beschützung von Ressourcen & Einsparen von Energie leichte Zunahme vom Energieverbrauch (0,5 Punkte)

Zusammen können 26 Punkte erreicht werden.

6.5 FAM questionaire

	Trifft nicht zu	**trifft zu**
1. Ich mag solche strategische Spiele. (I)	1 2 3 4 5 6 7	
2. Ich glaube, der Schwierigkeit dieser Aufgabe gewachsen zu sein. (E)	1 2 3 4 5 6 7	
3. Wahrscheinlich werde ich die Aufgabe nicht schaffen. (E)	1 2 3 4 5 6 7	
4. Bei der Aufgabe mag ich die Rolle des Wissenschaftlers, der Zusammenhänge entdeckt. (I)	1 2 3 4 5 6 7	
5. Ich fühle mich unter Druck, bei der Aufgabe gut abschneiden zu müssen. (M)	1 2 3 4 5 6 7	
6. Die Aufgabe ist eine richtige Herausforderung für mich. (H)	1 2 3 4 5 6 7	
7. Nach dem Lesen der Instruktion erscheint mir die Aufgabe sehr interessant. (I)	1 2 3 4 5 6 7	
8. Ich bin sehr gespannt darauf, wie gut ich hier abschneiden werde. (H)	1 2 3 4 5 6 7	
9. Ich fürchte mich ein wenig davor, dass ich mich hier blamieren könnte. (M)	1 2 3 4 5 6 7	
10. Ich bin fest entschlossen, mich bei dieser Aufgabe voll anzustrengen. (H)	1 2 3 4 5 6 7	
11. Bei Aufgaben wie dieser brauche ich keine Belohnung, sie machen mir auch so viel Spaß. (I)	1 2 3 4 5 6 7	
12. Es ist mir etwas peinlich, hier zu versagen. (M)	1 2 3 4 5 6 7	

Formatiert: Deutsch (Deutschland)

13. Ich glaube, dass kann jeder schaffen. (E)	1 2 3 4 5 6 7
14. Ich glaube, ich schaffe diese Aufgabe nicht. (E)	1 2 3 4 5 6 7
15. Wenn ich die Aufgabe schaffe, werde ich schon ein wenig stolz auf meine Tüchtigkeit sein. (H)	1 2 3 4 5 6 7
16. Wenn ich an die Aufgabe denke, bin ich etwas beunruhigt. (M)	1 2 3 4 5 6 7
17. Eine solche Aufgabe würde ich auch in meiner Freizeit bearbeiten. (I)	1 2 3 4 5 6 7
18. Die konkreten Leistungsanforderungen hier lähmen mich. (M)	1 2 3 4 5 6 7