"De beste business baas"

The development and evaluation of a prototype of a serious game to train the 21st century skill self-regulated learning, aimed for Dutch sixth grade students

K.J.M. Tönis

Masterthesis
Educational science & Technology
Enschede, July 2018

First supervisor: Dr. H. H. Leemkuil
Second supervisor: Dr. J. ter Vrugte

Table of Contents

Foreword

What's a board game without rules or a video game without characters? The same applies (to me) to a master thesis without a foreword.

Before I started the Bachelor Psychology at the University of Twente I had a "student for a day" with a Psychology student (April 2013). We spoke about the bachelor and she asked me about my plans. This was the first time I spoke about my plan to do two masters, since I was interested in both (clinical) Psychology and Learning Sciences.

This dream became reality after completing my bachelor Psychology (summer 2016), my first master Positive Psychology & Technology (November 2017) and now, my second master Educational Science & Technology. In terms of games, all three levels are completed!

The completion of my second master started in October 2017, with the start of my Final project. The idea for this project comes from a guest lecture on (the training of) metacognitive skills and an article in the newspaper.

But this level (including my Final Project) was not possible without the help of some (in game terms) fellow players. Therefore I want to thank....

- Mom & Dad, for your support, help and the opportunity to continue studying
- Eros (my four legged buddy) for the refreshing walks
- Maaike & Brandon, for your patients and good suggestions
- The pilot-test students & questionnaire evaluators (both student and sixth grade teacher), for your feedback
- Formative evaluation teachers and students, for your opinion & time
- Henny Leemkuil & Judith ter Vrugte, for your feedback and support
- Babs, Jitske & Liza, for the fun & hard work during the "ITBLE" course and support during this Final Project

Summary

The 21st century skill self-regulated learning is important for everybody to be able to deal with the societal developments of the 21st century and contributes to the transition from primary to secondary education. Self-regulated learning skills in this study involve behavioral activity, cognitive (learning), metacognitive and motivational strategies, performed before, during and after a learning activity. Not all Dutch students are good self-regulated learners, as suggested by the almost half million euro spend by Enschede on homework support for students of poor parents. Therefore this study aimed to develop a self-regulated learning skill(s) training for Dutch sixth grade students, to support the transition from primary to secondary education. The training of self-regulated learning skills costs time and effort, and must involve motivational tasks. Because serious games are intrinsically motivating, a serious game was chosen as instructional material. Due to a lack of resources, a prototype of the serious game was developed, instead of a finished serious game. During the design phase a formative evaluation was performed to increase the appeal with the design, learning (match of the level of assignments with the target group), and the motivation to play. For this formative evaluation a qualitative questionnaire was developed and used to get in-depth insight in the opinion of the target group about the three themes (appeal, motivation and learning). These opinions focused on the content of the serious game (the background story), the name of the serious game, the level of some of the assignments, and ideas for improvement. The answers were summarized and reformulated in concrete improvement statements to increase the appeal, motivation and learning of the target group (e.g. include bonus games). This study resulted in a prototype that is ready to be further developed. Therefore, it is recommended to continue the evaluation of the product of each step (e.g. development, implementation) with several teachers and the target group (11-13 year olds). Since this study resulted in a prototype, the effectiveness on the transfer of trained self-regulated learning skills was not tested. To test the effectiveness, it is recommended to use a cognitive consequence approach. These findings can contribute to (scientific) knowledge on the use of serious games to train self-regulated learning skills. If the serious game increase self-regulated learning skills, it can be used to prepare students for a changing society and secondary education.

Introduction

This study aims to develop and evaluate the prototype of a serious game to teach sixth grade Dutch primary education students the 21st century skill “self-regulation”. This introduction section describes the reason for developing (problem statement) the serious game, a definition of self-regulation, and ends with a description of the used design approach.

Problem Statement

The combination of societal developments as the individualization, internationalization, job market flexibilisation and technologisation/technological developments led to an increase of the dynamics of the society, an increase of the importance of skills as planning and self-reflection and therewith the education in order to prepare people for the future (Onderwijsraad, 2011, 2014). Individualization requires self-regulation, self-development and the ability to take responsibility (Onderwijsraad, 2014; Thijs, Fisser, & van der Hoeven, 2014). Internationalization and technologisation require the ability to learn and more flexibility of employees (Onderwijsraad, 2014). The job market flexibilisation requires learning to stay up to date (Onderwijsraad, 2011). These skills are part of self-regulation and self-regulated learning (SRL) skills, which in turn are part of the 21st century skills (SLO, 2017a; Thijs et al., 2014). These 21st century skills are an important theme in the current educational debate as they are thought to be fundamental skills to function in current and future society (Thijs et al., 2014). SRL in this study is defined as the use of behavioral activity, cognitive (learning), metacognitive, and motivational strategies by the student in the own learning process (SLO, 2017a), as will be further explained under “Self-regulation and self-regulated learning (training)”.

Besides being important for functioning in the society, are SRL skills also necessary on the short term. The transition from primary to secondary school can namely be more easy and smooth for students with high SRL skills (Hendriks, 2013; Meusen-Beekman, Joosten-ten Brinke, & Boshuizen, 2015). Secondary school learning requires more independent studying of students, which requires self-regulation skills such as monitoring, planning and selecting learning strategies (Meusen-Beekman et al., 2015). The development of “self-regulated skills in primary education, prior to the complex transition to secondary education, might empower students, and enable them to become successful learners” (Meusen-Beekman et al., 2015, "introduction", para. 5). There is thus a need to prepare students for secondary education by training SRL skills. But are SRL skills included in such a way in primary education that students are prepared well enough for independent learning in secondary education? The Dutch education inspectorate researched the transition from primary to secondary education in one city and one region of the Netherlands. They found that teachers in the last year of primary education prepare students for this transition by paying extra attention to planning, study and independent learning skills (Inspectie van het Onderwijs, 2006 as cited in Inspectie van het Onderwijs, 2007). However, this is training of SRL skills is not sufficient for every student as demonstrated by the high expenses of Enschede in homework support. Enschede, a city of almost 160.000 inhabitants in the eastern of the Netherlands, spend 450.000 euro for homework support for children of poor parents in their city ("Enschede geeft 4,5 ton voor huiswerkbegeleiding arme kinderen," 2016; Kennispunt Twente, n.d.). Homework support can support students by focusing on 1) cognitive (learning) skills such as summarizing or reading a text, 2) organizational skills, such as planning, progress monitoring or the use of an agenda, or 3) intrinsic motivation (Bureau Avant Huiswerkbegeleiding, n.d.; CSG Augustinus, n.d.; Virtuwijs, n.d.). These three ‘types’ of skills are all part of SRL, so this spending indicates that there is still space to improve SRL skills in primary education to prepare students for independent learning in secondary education.

So students entering secondary education need SRL skills, which implies that these skills must be trained in primary education. Dignath, Buettner, and Langfeldt (2008) performed a meta-analysis on the effectiveness of self-regulation training programs aimed at primary school students. They found that these training programs have a positive effect on motivation, strategy use and academic performance. Thijs et al. (2014) analyzed available additional learning materials (aimed at a specific and interdisciplinary theme) aimed at Dutch primary education. They stated that there are only a few additional materials available that focus on self-regulation in primary education. This indicates that self-regulation skills can be trained, and that there is a need for additional materials to stimulate students’ self-regulation skills in Dutch primary education.

In short, SRL skills are needed to be prepared for a changing environment for the long-term and to be able to deal with the independent studying that is required in secondary education. Investments in home-work support suggest that student lack self-regulation skills. This study aims to develop a means to prepare students for independent learning in secondary education and to prepare them the for the increase of the dynamics of the society. This will be focused on Dutch grade six students, since this is the last year of education before students enter secondary education.

Self-Regulation and Self-Regulated Learning (Training)

Self-regulation means that people are able to take responsibility for their actions in a specific environment or situation, act independently and take own capacities into account (SLO, 2017b). According to Thijs et al. (2014) self-regulation is the ability to perform behavior that is goal-directed. Dinsmore, Alexander, and Loughlin (2008) stated that the concepts self-regulation and self-regulation learning (SRL) are sometimes interchangeably used and have a conceptual core, namely "that individuals make efforts to monitor their thoughts and actions and to act accordingly to gain some control over them" (p. 404). Self-regulated learners are learners that "proactively seek out information when needed and take the necessary steps to master it" (Zimmerman, 1990, p. 4). As described in the problem statement, this study follows the definition of the SLO (2017a) in which SRL includes three components: metacognitive, strategical, and motivational. The *metacognitive* component focuses on overseeing, reflecting on and controlling the chosen approach (SLO, 2017a). The *strategical* component involves both a cognitive element namely the use of learning strategies and a behavioral element, namely environment structuring in order to optimize learning (Boekaerts, 1999; SLO, 2017a; Zimmerman, 1990). The *motivational* component involves perseverance, taking initiative and interest in the (to be performed) task (SLO, 2017a). These three SRL components can be found in the three phases of a learning effort: before (or forethought), during (or performance) and after (self-reflection) phase, see Figure 1 (Zimmerman, 2000 as cited in Zimmerman, 2002).The *forethought* phase consists of an orientation on the task (SLO, 2017a), analysis of the task (making a strategic planning and setting goals) and self-motivation (believing in the own learning capabilities, valuing the learning process and task for the own merits and expectations of outcomes) (Bandura, 1977 as cited in Zimmerman, 2002; Zimmerman 2002). The *performance* phase consists of self-observation (noticing personal events such as studying with someone else is more time consuming than studying alone, and experimenting in order to see whether these hypothesis are true), self-control (use of planned strategies or methods and adjusted based on (intermediate) results or situations, and time management), attention and the perseverance (SLO, 2017a; Zimmerman, 2002). The *self-reflection* phase consists of self-judgment (comparing the performance against a (absolute) standard or learning goals, own prior or others' performances and attribution of results, influence on activities that will follow) and self-reaction (the emotional reaction on the own performance, this can be positive, defensive, such a withdrawing, or adjusting ineffective strategies) (SLO, 2017a; Zimmerman, 2002). A self-regulation focused learning activity focuses on making a planning, setting a goal and reflecting on own actions and the process (SLO, 2017a). "Thereby the student will be invited to observe him-/herself 'from a distance', to interpret the observations, to transform these in a concrete action plan and to act accordingly" (SLO, 2017a, "Zelfregulering ontwikkelen", para. 2).

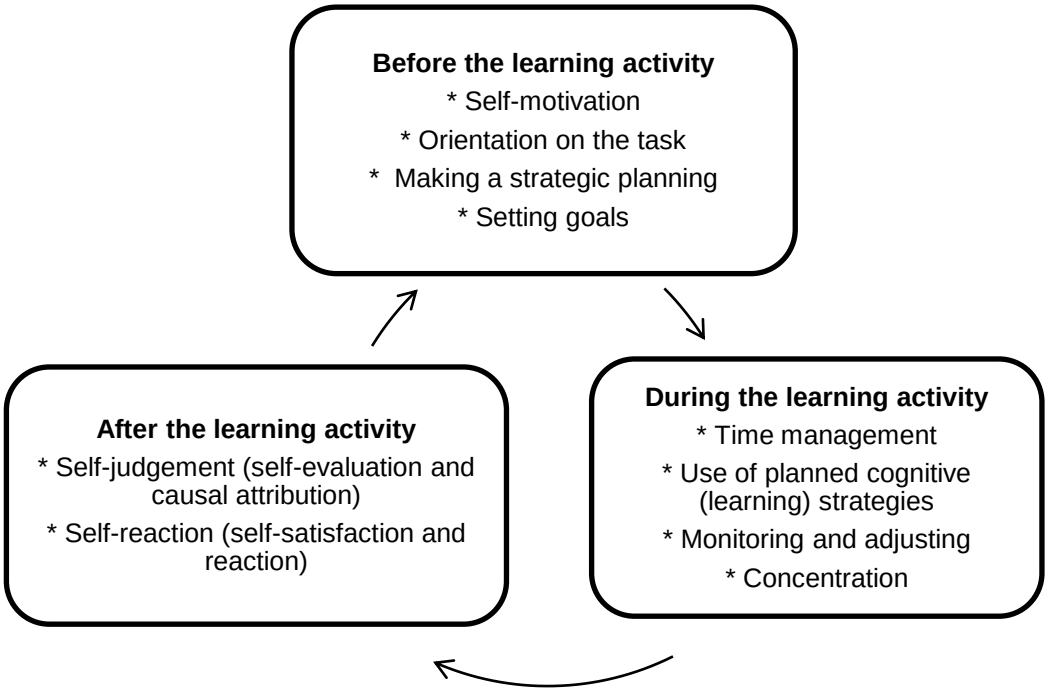


Figure 1. Self-regulated learning in this study

Instructional method (choice)

SRL skills are thus needed and can be trained in primary school students, but which instructional method can be used to train SRL in primary school students? The technological developments, as described above, not only require new skills, but also provide new opportunities for learning. One of these opportunities is the use of serious games. Serious games are games used for educational goals instead of entertainment goals (Michael & Chen, 2006). An important reason for using games for instructional purposes is the idea that games are intrinsically motiving (Garris, Ahlers, & Driskell, 2002; Malone, 1981). This motivational aspect is the main reason for choosing a serious game as instructional method to train SRL in this study, since the training of (parts of) SRL skills requires effort, time and motivational tasks (SLO, 2017a; Veenman, Van Hout-Wolters, & Afflerbach, 2006). The SLO (2017a) refers therewith to the self-determination. According to the self-determination theory of Ryan and Deci (2000), self-motivation will be increased by the satisfaction of the three psychological needs autonomy, relatedness and competence (in learning activities).

Serious games can be used for the training of 21st century skills in general. Kickmeier-Rust and Albert (2012) namely stated that "the nature of modern computer games provides a perfect context for the acquisition of those 21st century skills" (p. 680). Which matches Romero, Usart, and Ott (2015), who concluded "our investigation (…) indicates that serious games could be productively adopted to support the development of (…) 21st century skills" (p. 169). This however does not say anything about the specific 21st century skill that is included in this study, namely SRL skills. Romero et al. (2015) performed a literature review to answer whether serious games can contribute to the development and sustaining of 21st century skills. They included three 21st century skills that match the definition of SRL as included in this study. Firstly, learning to learn skills, in order to give learners the ability to shape and construct the own learning process successfully (European Commission, 2002). Pivec (2011) states that these learning to learn skills can be trained in a digital game, since players can experiment in a safe environment (as cited in Romero et al., 2015). Secondly, self-regulation or self-direction, which focus on goal setting and making a plan to achieve such a goal. Massively multiplayer online roleplaying games (MMORG) can contribute to the development of self-regulation skills (Wagner, 2008 as cited in Romero et al., 2015). MMORGs are online videogames in which (avatars created by) players can interact with both software and the avatars of other players (Steinkuehler, 2004 as cited in Childress & Braswell, 2006). According to Childress and Braswell (2006) MMORPGs can be used as environments for cooperative learning. Although cooperation is not explicit included in the definition of serious games, MMORPGs are included, because MMORPGs are games that can be used for learning purposes. Thirdly, planning as in imagining future actions. "Some of the [serious] games in the category of strategy involve the development of planning (…) and adaptability skills"(Romero et al., 2015, p. 160). Although these ideas do not include hard research findings, there is some space to assume that a serious games can be used to train SRL skills.

Design Approach

As described above there is a need for additional materials to train SRL skills in Dutch primary education. Serious games seem to be an appropriate instructional method since SRL training requires motivational tasks and serious games can meet this requirement. In addition, the ideas of several researchers suggest that SRL skills can be trained in serious games. To come up with a motivational training method to fill in the need for additional materials to train SRL skills in Dutch sixth grade students, a (prototype for a) serious game is developed in this study. Therefore an Instructional System Design (ISD) process is used. "ISD is a systematic, flexible, proven process for determining whether instruction is necessary in a given situation, for defining what instruction is needed, and for ensuring development of effective, cost-efficient instruction" (Holden, 2015, p. 3). The ADDIE model as ISD model is chosen for two reasons. Firstly, because it stands at the basis of almost all system models (Allen, 2006). Secondly, because the goal of the ADDIE-model is namely the development of "field-effective and efficient instruction that helps prepare individuals to meet their work-performance requirements" (Allen, 2006, p. 434) meets the goal of the development of the serious game to train self-regulation. One of the revised ADDIE models, is of the Department of the air force (1993), as presented Figure 2. ADDIE is an acronym for the five phases of the development process, Analysis, Design, Development, Implementation and Evaluation (Allen, 2006). The evaluation phase in the model of the Department of the air force (1993) has a central function, in the sense of taking place at every phase. In Table 1, each phase will be explained in terms of the activities that are part of that phase and the application thereof on the development of the prototype of the serious game to train SRL skills in Dutch sixth grade students.

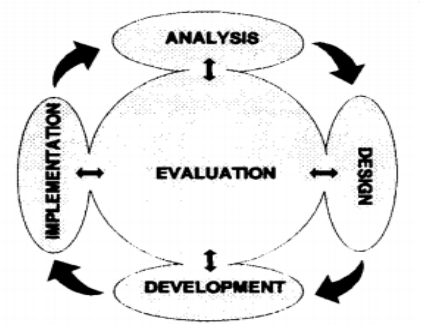


Figure 2. The ADDIE model, which is used to guide the development of the serious game for self-regulated learning skills. Adapted from *AF Manual 36-2234 Instructional System Development* (p. 12), by the Department of the Air Force, 1993, Washington DC: U.S. Air Force.

Study aim

The first study part aims to develop a prototype for a SG to train SRL skills for Dutch pre-secondary school students, resulting in the first research question (RQ):
RQ 1: What are the design requirements for the development of a SG to train SRL skills in Dutch sixth grade students?

The second study part aims to evaluate the prototype. Since a SG as instruction method is chosen because of serious games are intrinsically motivating, the second RQ is:
RQ 2: What can be improved in the prototype to make the SG more motivating?

According to Holden (2015) a formative evaluation aims to improve the instruction. Dick and Johnson (2002) state that this improvement focuses on both the opinion (like) of the learner on the instruction and whether the learner learns something from the instruction. This resulted in the following RQ:
RQ 3: What can be improved to increase the appeal of the player of the serious game?
RQ 4: What can be improved to increase the learning of the serious game?

Table 1.

An overview of the ADDIE model applied to the development of the serious game to train self-regulated learning (SRL) skills in Dutch sixth grade primary education students

Phase	Aim	Activities	Application in this study	Deliverable(s)
Analysis	Determining if the appropriate solution is a training and when this is the case, defining the training requirements (Holden, 2015)	1) Needs analysis to assess whether training can be used to solve the problem (Holden, 2015) 2) Task analysis to assess which action a student should be able to perform (Holden, 2015) 3) Target audience analysis to assess the entry-level skills, demographics, interest, physical strengths and motivational needs (Holden, 2015) 4) Learning material analysis to assess which characteristics the learning material must have of a serious game contribute to use and effectiveness 5) Analysis of the existing trainings for the task	1) The problem analysis and development of a serious game as solution, see the introduction 2) A specification of SRL skills in terms of actions that students must be able to perform 3) The entry level of SRL skills, motivation to learn (as in attention to SRL skills in education), brain development and interests of a 12 year old 4) The characteristics of a serious game that contribute to use and effectiveness. 5) An analysis of what is known about the trainability of SRL skills	Each sub-analysis results in a set of design requirements that will be used in the design and development phase.
Design	Developing a detailed instruction plan (Allen, 2006) based on the design requirements.	1) The selection of instruction methods and material (Department of the air force, 1993) 2) The determination of instructional strategies (Department of the air force, 1993)	The development of 1) a storyboard (illustrations and the narration of the serious game) 2) prototype (print screens to give an idea of how the serious game can look like)	1) A storyboard, containing of a collection of the elements that form the instruction (Legault, n.d.) 2) A prototype, model for the real instruction, that can be tested (Legault, n.d.)

Development	The development of the actual instructional material (Holden, 2015).	1) The development a plan of instruction (POI), which describes the aim, instruction time, supporting materials, instruction time and lesson plan(s) (Holden, 2015) 2) The development of the actual material (Holden, 2015)	A POI will be developed for the serious game to train SRL skills, whereas the development of the actual serious game will be skipped, due to a lack of resources	1) A plan of instruction
Implementation	An efficient and sustained delivery of the instructional material to the target audience and the ongoing management and maintenance of reports and facilities (Holden, 2015).	The implementation of the instructional material	-	-
Evaluation	Besides the constant evaluation of the phases that forms the center of the model) three types of evaluation are distinguished (Department of the air force, 1993)	1) Formative evaluation which is a try out (in small groups) during the analysis and design phases (Department of the air force, 1993) 2) Summative evaluation, which is a tryout during the development (Department of the air force, 1993) 3) Operational evaluation, in which the operational system will be evaluated during the implementation phase (Department of the air force, 1993)	Only a formative evaluation will be conducted based on the prototype to get feedback on the serious game, in order to revise the prototype of the game	

Phase 1: Analysis

This phase of the developing process is a deepening of the problem statement and involves the sub-analysis as described in Table 1. These sub-analysis involve a couple of aims. Firstly, to give an overview of what self-regulated learning (SRL) as skill actually is, in other words, what behavior is part of SRL? (task analysis). Secondly, to find out what is known about the trainability of SRL skills. Thirdly, to find out what 12 year olds already can in terms of SRL, their motivation to learn, their interests and probably the most important, what are they cognitively able to do? (target audience analysis) Fourthly, to find out which serious game characteristics contribute to a usable and effective game? (serious game characteristics). Each of these aims leads to a (series of) design requirements.

Self-Regulated Learning as Skills

The analysis of self-regulated learning as skills can be found in the introduction (see “Self-regulation and self-regulated learning (training)”). This (task-)analysis resulted in the conclusion that SRL contains of three components: a metacognitive component, a strategical component (cognitive learning strategies and behavioral activity), and a motivational component. Each component consists of activities or strategies that can be found in the three phases of a learning effort: before, during and after (see Figure 1). An extended description of each type of strategy can be found below.

Cognitive (learning) strategies

Cognitive (learning) strategies are tactic used to facilitate skills and knowledge acquisition (Smith & Ragan, 2005d). According to them, “direct instruction on cognitive strategies may be beneficial” (Smith & Ragan, 2005d, p. 244). As described earlier involve cognitive (learning) strategies, rehearsal or repeating strategies, elaboration strategies, organizational strategies, comprehension monitoring strategies, and affective strategies (Weinstein & Mayer, 1983). These strategies can be used during the learning activity.

The first strategy involve rehearsal or repeating strategies, which means that students are able to underline or copy the main content of a text. Copying as in literally taking over text from the blackboard is mentioned as a ‘Dutch language’ competence in primary education (Greven & Letschert, 2006). Repeating in this case it is viewed as writing skill, but not as learning strategy. Therefore must be explained that copying also can be used as learning strategy. Besides copying, are verbally repeating the material, underlying and selective verbatim notes taking also part of this learning strategy. The core of this strategy is the active action in terms of writing, saying and pointing the key elements, this in order to select the core of the text and acquisition into the working memory (Weinstein & Mayer, 1983).

The second strategy involve elaboration strategies, which means that students are able to summarizing, paraphrasing or relating new information to existing knowledge. These strategies can contribute to learning, because new knowledge will be integrated with existing knowledge (Weinstein & Mayer, 1983). Paraphrasing as in writing things in own words is also a competence that primary education students must be able to do as part of the ‘Dutch language’ class (Greven & Letschert, 2006). But paraphrasing is seen as writing skill instead of learning strategy, therefore players receive an instruction on the use of these strategies as learning strategies.

The third strategy involves organizational strategies, which means that students are able to create a hierarchy or outline. According to the Dutch core goals for primary school students, students must be able to structure a text, as in ordering it (Greven & Letschert, 2006). Again this is viewed from a writing skill perspective instead of a learning strategy perspective. Therefore must be explained that organizing can be used as learning strategy, because these strategies lead to the transference of selected information into the working memory and relating ideas in the working memory (Weinstein & Mayer, 1983). This requires extra training, that focuses on the structural relation types that exist between ideas, such as a symbolic outline in which phrases, concepts and words are related (Weinstein & Mayer, 1983).

The fourth strategy involves comprehension monitoring strategies, which means that comprehension failure will be checked. This can be done by self-questioning in order to check whether the material is understood and to guide the reading process before one starts with reading a section (Weinstein & Mayer, 1983). Fourth to sixth grade students must learn to be able to think about their own text comprehension and to come up with a solution when the text is not fully comprehended (Wijzer over de basisschool, n.d.).

Fifthly, affective strategies, which means that students are able to overcome anxiety for tests, being relaxed and alert. This involves the choice for a quit place to study without distraction from outside (which is in this study part of the behavioral activity strategy) and the use of thought stopping methods in order to focus on the lesson instead of outside the lesson or fear to fail (Weinstein &

Mayer, 1983). Smith and Ragan (2005d) described based on several publications that this also involves self-motivational skills, which involves stress reduction techniques, positive self-talk and time management.

Metacognitive strategies

Metacognitive strategies focus on the ability to keep an overview on the performed activities (SLO, 2017a). This involves activities before, during and after a learning effort, as explained in the introduction, see Figure 1.

Before the learning activity (the 'forethought phase'). According to the SLO (2017a) the learner starts with an orientation on the activity. The first activity, the orientation involves an estimation of the level of a task or chance of success, realizing the importance of the assignment for goals and the learner, and relating previous experiences to this assignment (SLO, 2017a). This process of prior knowledge (or experience) activation is at some level unconscious and automatic, outside explicit control. Therefore this part is not seen as self-regulatory. However, prompts that stimulate learners to think about knowledge on a problem, topic or domain, can stimulate a more conscious process of prior knowledge (Pintrich, 2000). The second activity or metacognitive strategy is (realistic) goal setting (based on previous experiences) before a learning activity starts (SLO, 2017a). According to Bandura (1988) and Locke, Shaw, Saari, and Lathman (1981) three properties of goals contribute to the effectiveness of these goals (as cited in Schunk, 1990). Firstly, to increase self-efficacy, activate self-evaluations and enhance learning, goals must be specific on performance. Secondly, to increase motivation and self-efficacy by observing progress (especially with young children), goals must be proximal. Thirdly, to increase self-efficacy and effort a goal must be difficult. These elements come back in SMART formulated goals, which means that a goal is specific, measurable, attainable, realistic and time bounded. The Collorado Education Initiative (2014) described that grade 6-8 students need help with the formulation of a SMART goal. SMART stands for 1) specific focuses on what the student is going to do, 2) measurable focuses on how the change can be seen, 3) attainable skills, attitudes and abilities that must be learned, 4) realistic focuses on the doable aspect of a goal, in the sense of not too hard and not too simple, and 5) time in which the goal must be completed (The Collorado Education Initiative, 2014). This must be explained in such a way that students are able to formulate these goals. The third strategy is planning (SLO, 2017a). Planning means that students think about when, why and how to act, in order to achieve a learning purpose. This involves an analysis of the context, retrieving the relevant skills and knowledge (also in terms of learning strategies), sequencing the steps needed to solve the problem and structuring the (learning)environment in such a way that the (learning)task performance will be optimized (Desoete, 2008; SLO, 2017a). However this environment structure optimization is part of the behavioral strategy and not of metacognitive strategies. Although planning skills continue to develop up to adulthood, 12 year are able to use planning skills (Balans Digitaal, n.d.).

During the learning activity. The fourth strategies are performed during the learning activity and involve plan execution, monitoring (and when needed adjusting) and time-management (SLO, 2017a). Monitoring is the controlling of cognitive skill use during the performance of the task, in such a way that problems can be identified and plans be modified. This involves an evaluation in the sense of the plan will be followed, whether the plan works, what is needed to perform a task (materials, skills, behavior, previous knowledge and study behavior) (Montague, 1998 as cited in Desoete, 2008; Desoete, 2008) and self-observation (Zimmerman, 1989). This monitoring process is called self-control by the SLO (2017a). Berk (2013a) called this process of progress monitoring, cognitive self-regulation and mentions that this is still hard for the target group, since putting knowledge into practice is difficult. However children can be supported self-monitoring, by questions that made them think about their progress, such as whether they use the question whether the student uses the planned strategy and whether the strategy must be adjusted when it does not work (Schunk and Zimmerman, 2003 as cited in Berk, 2013a). This implies that self-monitoring must be explicitly mentioned in the training for the target group (12 year olds). The fifth strategy is concentration, which can be seen as metacognitive skill according to Zimmerman (2008). Concentration means that one object will be the point of attention (concentration, 2018), which means that the attention will be directed at the task. Zimmerman (2000) designed an intervention to train SRL, in which behavioral and cognitive self-motivation and concentration were trained (as cited in Zimmerman, 2008). Behavioral self-motivation involved the ability to set self-rewards and arrange an environment that is supportive. Cognitive self-motivation involved the ability to self-instruct in order to encourage positive thoughts and stop negative ones. And lastly concentration, which (in their case) involved of systematic relaxation use. Concentration can be trained to eight to twelve year olds according to De Stimulans (n.d.). In addition,

Wouda (2017) described several tools that contribute to concentration, but states that concentration as skill is helpful in the entire level. This implicates that concentration can be trained.

After the learning activity. The sixth strategy is self-evaluation or reflection on the task executing and acting, which will be used after the learning activity is finished. This involves the performance evaluation against the (formulated) goals and own expectations, explain the chosen approach and relate to the performance, attribute the performance to others or the self, and lastly, explain the influence of the own performance on a follow-up task (Pintrich, 2000; SLO, 2017a). Although not described in the overview of activities after the learning activity of the SLO (2017a) is the monitoring of the competence or capacity development also an activity that can be added to the metacognitive strategies after the learning activity. This can be done because self-knowledge is seen as a metacognitive strategy and capacity (or competence) (development) insight is seen as self-regulation strategy (SLO, 2017a). SLO (n.d.) gave an overview of students in grade five and six (10-12 year olds) and describes that students have knowledge of the options they have while they decide and to take that decision. This means that the self-evaluation strategy is manageable for the average 12 year old.

Motivational strategies

Motivational strategies are also used throughout the entire learning activity (before, during and after).

Before the learning activity. According to Zimmerman (2002) the first phase of the learning activity contains self-motivation (beliefs). These beliefs are based on self-efficacy, expectations on outcomes, the perceived value of the lesson and learning goal orientation. *Self-efficacy* is a positive belief about the own competence to successfully perform a task or produce a favorable outcome (Akhtar, 2008). The (perceived) self-efficacy influences the effort one mobilizes, the goal level one set to challenge oneself and the persistence one has when a difficulty faces (Zimmerman, Bandura, & Martinez-Pons, 1992). Self-efficacy will be caused by four sources: 1) performance accomplishments which is based on mastery expectations caused by success and repeated failure experiences, 2) vicarious experiences which is the effort persistence and intensification by observing others performing an activity that is seen as threatening without adverse consequences, 3) verbal persuasion on the belief that someone can succeed, and 4) emotional (and physiological) arousal (such as stress) influences the competence belief (Bandura, 1977). Self-efficacy develops as a consequence of the development of effective self-regulation skills (Berk, 2013a), therefore self-efficacy is not trained in this serious game. To support the four sources of self-efficacy feedback will be included that focuses on the chance that the player will succeed, self-formulated feedback on the own learning process, and assignments that require persistence. According to Bandura (1994) self-efficacy partly determines *expectations on outcomes.* Outcome expectations are the expectations concerning the outcome of their learning effort (e.g. a low mark on a test). Because outcome expectations are partly influenced by self-efficacy, outcome expectations are not included in this serious game. *Intrinsic interest* focuses on valuing a learning task (Zimmerman, 2002). Since this is different for each task, this is element is not included in this serious game as skill or belief to train. *Learning goal orientation* focuses is valuing the learning process (Zimmerman, 2002). A learning goal orientation focuses on the increase of competence (Dweck & Leggett, 1988). This orientation towards understanding is also called achievement-motivation, which is related to making mastery-oriented attributions. This involves attributing success to the own ability, which can be improved by hard trying. In addition, failure will be attributed to controllable or changeable factors (e.g. putting not enough effort in the task or assignment) (Heyman and Dweck, 1998 as cited in Berk, 2013b). In this way it builds on self-attribution and will be stimulated by evaluative feedback.

During the learning activity. Perseverance is the drive to continue, dealing with setbacks and frustration and being confident that something can be learned (De Vos - van der Hoeven, 2012). This type of motivation can be trained by achievable assignments, dividing the assignment in smaller steps, learning to deal with frustration, and success experiences in children (De Vos - van der Hoeven, 2012; SLO, 2017a). SLO (2017a) states that taking initiative is also viewed as motivation. Initiative taking means that someone acts without external motivation (Bentvelsen & Pijlman, n.d.). Taking initiative can be trained to children (De Praktijk 4 Kids, n.d.).

After the learning activity. Self-judgment consists of self-evaluation (part of the metacognitive component) and causal attribution. Attribution is the causal explanation given for behavior or an event that happens (Harvey & Martinko, 2009). The locus of causality is one way to classify attributions, which differentiates between external and internal attributions (Harvey & Martinko, 2009). Internal attributions means that the causes of success (or failure) are internal, such as effort and ability, whereas external attributions means that the causes are externally, such as task ease or the help of others (Weiner, 2000). The ability to distinguish external and internal (ability or effort) causes of

performance in school-age children is the result of evaluative feedback and improvement of reasoning skills (Dweck, 2002 as cited in Berk, 2013b). Therefore feedback will be included in combination with the explicit focus on the causes of performance by making students think about it by explicit questions. In addition self-satisfaction and (defensive or adaptive) reactions are also part of the 'after learning activity'. Because (feelings of) self-satisfaction is a affective component and the reaction are personal and in that way not trainable, these are not included in the serious game.

Behavioral activity

Behavioral activity involves selecting, structuring and creating a learning optimizing environments (Zimmerman, 1986). Zimmerman (1989) defined environmental structuring as the effort students make into arranging and selecting a physical setting that simplify the learning (e.g. isolation in order to prevent from distraction or sitting in silence in order to concentrate). According to De Vos - van der Hoeven (2010) a (young) child can be stimulated at home to take care for an ordered place (which can contribute to concentration). This indicates that the target group of this serious game (12 year olds) can be trained in behavioral activity strategies.

Design requirements

Since the to be developed serious game aims to train SRL (existing of behavioral activity, cognitive, metacognitive and motivational strategies) the following design requirements are formulated based on both the description of SRL and its components:

I. The serious game trains the use behavioral activity strategies, which involves that students learn how to create, select and structure the environment
II. The serious game trains the use of the cognitive (learning) strategies, which involve creating awareness of the use of the five learning strategies of Weinstein and Mayer (1983) as learning strategy
III. The serious game trains the use of metacognitive strategies that can be used before, during and after a learning activity takes place.
IV. The serious game trains motivational strategies which involves motivational strategies before, during and after the learning activity takes place.

The Trainability of SRL

Existing SRL training programs

"Self-regulated learning programs proved to be effective [on learning outcomes, motivation and strategy use], even at primary school level" (Dignath et al., 2008, p. 101). These words are the conclusion of a meta-analysis on the effectiveness of SRL enhancing programs aimed at primary school students. The meta-analysis aimed to find the effect of SRL programs on several outcome variables at primary schools and what the most effective intervention types are. Based on the 48 studies they included, they found an overall effect of d=.62 for academic performance (overall), d=.73 for (meta)cognitive strategy use and d=.76 for motivational outcomes. In addition, Dignath et al. (2008) compared several training (content and context) characteristics and found that the following characteristics increase the effectiveness of SRL training programs on the use of cognitive and metacognitive strategies (shortly strategy use):

Firstly, interventions that are based on a social-cognitive theory led to a higher effect size for strategy use. Since this serious game aims to train (the use of) SRL skills the choice has been made for a social-cognitive theory basis. But what does this theory means for the training of SRL skills? Zimmerman (1989) viewed self-regulated (academic) learning from a social cognitive perspective. According to this view, SRL will be determined by behavioral, environmental and personal processes. Behavioral processes involve self-observation (own performance monitoring), self-judgment (comparison of own performance with the goal) and self-reaction (processes such as metacognitive planning, goal setting and behavioral outcomes). Environmental processes involve social experience and the physical context. And lastly, personal processes involve students' (self-regulative) knowledge of strategies, metacognitive processes (such as planning and behavioral control), affect and long-term goals (Zimmerman, 1989).

Secondly, the highest effect sizes were found on strategy use for interventions that include a combination of strategies, with the highest effect size for a combination of metacognitive and motivational strategies, followed by a combination of cognitive and motivational strategies, and cognitive and metacognitive strategies. Since the to be developed serious game aims to focus on the

training of SRL in the full width (as explained in the previous chapter under 'Self-Regulated Learning as Skills') and the study did not result on a combination of all three components of SRL, is decided to train all components of SRL in the serious game. Dignath et al. (2008) further analyzed the effectiveness of strategies for each component. These results are not taken into account in the development of this serious game because the meta-analysis did not include all strategies as included in this study.

Thirdly, significant differences in effect sizes were found for the comparison of interventions that included group work as training mean and interventions that did not include group work, in favor of interventions with group work. But for group work to be effective, students must know the behavioral rules in a group.

SRL training strategies

Several authors described strategies to train (elements of) SRL strategies. Santrock (2011) focused on SRL as whole (among others metacognitive strategies, which is included in design requirement III). Smith and Ragan (2005d) focused on the cognitive learning strategies (as mentioned in design requirement II). Simons (1994) described strategies to train the motivational element of SRL (as mentioned in design requirement IV). In this way strategies (or approaches) for the training of almost all elements of SRL except for behavioral strategies (design requirement I), will be explained.

Santrock (2011) mentioned six strategies for teachers to support SRL in students: (1) combine learning strategies with self-regulation skills, (2) verbalize and model SRL, (3) give assignments that include self-evaluation, goal setting, planning, performing of the plan and monitoring of progress and outcome, (4) give tips about how the SRL skills can help, (5) create an interesting and challenging classroom learning experience, and (6) make the guiding gradually, because it is time consuming, and requires monitoring and encouraging. In addition, the Nederlands Jeugdinstituut (n.d. a) states that students between nine and twelve year, still have some problems with the independent activation and application of knowledge, therefore cues and triggers can support these students.

In addition to the strategies of Santrock (2011), described Smith and Ragan (2005d) seven approaches to instruct cognitive (learning) strategies in their chapter on teaching cognitive strategies. The first six approaches to instruct strategies are the result of the literature review of Pressley, Snyder, and Cargilla-Bull (1987) (as cited in Smith & Ragan, 2005d). Smith and Ragan (2005d) added the seventh. The first approach was (guided) discovery, which involved discovering a strategy (by questions of an instructor). The second approach is observing among others a fictional character (textually or visually presented). The third approach is guided participation, which means guiding by the strategic procedure use. The fourth approach is the use of prepackaged strategy instructions. The fifth approach involves direct explanations of teachers on the applicability of where and when a strategy should be used. The sixth approach involves a dyadic instruction, a one-to-one instruction which involves a think-aloud procedure. The seventh approach involves self-instructional training. "Self-instruction training has been used to assist learners in regulating a wide variety of personal processes such as attention, problem solving, response guidance, and motivation" (Zimmerman, 1990, p.10).

Simons (1994) focused on the training of the motivational part of SRL (or 'learning to learn' as they call it) and described based on several sources (e.g. Brophy, 1988) four strategies that contribute to motivation. Their fourth strategy aims to learn students to like learning and see it as it as meaningful to master the lesson instead of making it fun for the student (Brophy, 1988 as cited in Simons, 1994). These strategies are relevant for this serious game, because it contributes to design requirement IV as described above (the training of motivational skills), instead of the motivation to play the serious game as will described in the following chapter under "motivation to play". The training of (self-) motivational strategies can be achieved by five roles that a teacher (or in the case of the serious game, 'a teacher' in the game) has to perform. Firstly, by being an example or expert-model for the students. This can be achieved by 1) showing interest in learning, 2) transfer enthusiasm and explain with pleasure, 3) showing how problems can be solved and ways of thinking related to the course, 4) take away fear to learn new learning strategies, 5) show that learning activities are effective and important, 6) trigger curiosity, 7) focus on learning to learn (SRL skills), and 8) produce cognitive conflicts. Secondly, by focusing on metacognitive skills in order to stimulate active learning steering. This can be done by 1) stimulating reflection on own thinking, 2) make clear why goals are important, 3) promote metacognitive strategies, such as planning, 4) show the importance of and the relation between learning activities and goals, 5) give feedback on self-regulation and learning, 6) teach students self-motivation, and 7) ask students about the used (learning) method. Thirdly, being an external monitor of the chosen learning activities. This involves 1) monitoring of activities and progress towards goals (or desired results), 2) explicit learning activity choices, 3) ask the students for explanations of chosen

actions, 4) assess understanding and remembering of information, 5) give students the assignment to explain to each other, and 6) demonstrate mechanisms on how things can be fixed. Fourthly, scaffolding, which means that guidance will be gradually decreased, by: 1) give students the opportunity to take gradually the responsibility for their learning (choices), 2) decrease external monitoring, 3) make sure that students get the opportunity to use their internal motivation for learning and automatize learning strategies. And fifthly, stimulate positive self-evaluation, by adapting goals, content and feedback to the students in order to stimulate self-confidence.

Design requirements

To develop a serious game that is effective in the training of SRL skills, based on the analysis of existing SRL materials and ideas on training strategies for the SRL components the following design requirements were formulated:

V. The serious game is based on the social-cognitive theory of SRL training (existing of behavioral, environmental and personal processes)
VI. The serious game must involves cognitive, metacognitive and motivational strategies
VII. The serious game involves carefully supported group work assignments
VIII. To train SRL (and metacognitive strategies), the six strategies of Santrock (2011) are followed, which means that the serious game must
    a. combine learning strategies with SRL skills
    b. verbalize SRL
    c. include assignments that involve self-evaluation, goal setting, planning, performing of the plan and monitoring of progress and outcome
    d. include hints about how SRL skills can help
    e. include an learning experience that is interesting and challenging
    f. involve gradually guiding
IX. To train cognitive (learning) strategies, the teaching approach of Smith and Ragan (2005d) is followed in the serious game, involving:
    a. (guided) discovery of a cognitive (learning) strategy
    b. Observing others using cognitive (learning) strategies
    c. Guided participation (guided during the use of (learning) strategy)
    d. Prepackaged strategy instruction use
    e. Direct explanations of teachers
    f. Dyad instruction
    g. Self-instruction training
X. To train motivational strategies, the strategies of Simons (1994) are included:
    a. Be an example or expert-model for the students
    b. Focus on metacognitive skills in order to stimulate active learning steering
    c. Be an external monitor of the chosen learning activities
    d. Scaffolding (gradually decreased guiding)
    e. Stimulation of positive self-evaluations

Target Audience: 12 Year Olds

The following paragraphs describe the development of the brain and SRL skills to 12 year olds, followed by the average motivation to learn, the use of media and games in the target group, which lead to design requirements that are needed for the design of the serious game to train SRL skills.

Brain and SRL development to 12 year olds

Steinberg (2005) gave an overview of the affective and cognitive development during adolescence and stated that the brain of an adolescent is still developing. These changes underpin the improvement of executive functions, which involve metacognition, self-regulation, self-evaluation, planning (on the long-term), and cognition and affect coordination (Keating, 2004 as cited in Steinberg, 2005). However, the direction of this relation between brain-development and improvement of executive functions is not clear; “brain imaging studies (…) confirm significant correlations between structural developments in the brain and improved executive function, but the direction of cause and effect is unclear “ (Goswami & Bryant, 2007, p. 14). Executive function is related to metacognition and involves information processing control and monitor for the production of voluntary action (Fernandez-Duque, Baird, & Posner, 2000). These findings and ideas indicate that the adolescent brain is still developing, but that it is not clear whether this development improves metacognitive and executive functions or whether the improvement of these SRL skills develops the brain.

Despite their brains' development, students are already able to regulate their own behavior and perform independent (learning) tasks with or without others at a young age (SLO, 2017a). Although several researchers stated and found that the metacognitive ability (operationalized as the relationship between confidence in decision making and task performance), cognitive self-regulation (progress control and monitoring towards a goal) and metacognitive knowledge are still improving (Berk, 2013a; Weil et al., 2013). This matches the ideas of Keating (2004) and Goswami and Bryant (2007), which are stated above. However the use of SRL skills is trainable (in the target group) as suggested by the findings of the meta-analysis of Dignath et al. (2008) (see 'SRL training programs'). In this way the serious game can contribute to the development of SRL skills to 12 years, since they not fully master these skills. This implies that players must be supported in the application of knowledge on the actual use of SRL skills.

Motivation to learn

Another important relevant topic for the target group, besides the development of the brain and SRL skills in the target group is the motivation to learn. The Dutch inspectorate of education namely, stated based on the PISA results of 2012 (published by the OECD, 2013) that both Dutch primary and secondary education students are not so motivated to learn, when compared to other countries (Inspectie van het Onderwijs, 2017).

Hornstra, van der Veen, Peetsma, and Volman (2013) performed a longitudinal study on the development of motivation among 722 Dutch primary school students. Motivation was measured with student self-reports that consisted of academic self-efficacy and task-orientation. As described under 'Self-Regulated Learning as Skills', motivation in this study involves among others self-efficacy and task-orientation. For self-efficacy a (small) u-shaped curve was found, meaning that the self-efficacy firstly decreases a bit (during third and fourth grade) and then increases (during fifth and sixth grade). Self-efficacy is defined as the judgment of the own capabilities to perform those actions that are necessary for a successful academic task completion (Bandura, 1977 as cited in Hornstra et al., 2013). For task-orientation a linear decrease was found during the growth from halfway grade three to halfway grade six. Task orientation is defined as the orientation to increase understanding and competence (Covington, 2000 as cited in Hornstra et al., 2013). This last finding indicates that students decrease in the extent to which they are oriented to improve their own knowledge and skills, which matches the conclusion of the Dutch inspectorate of education.

Gaming and media use of 12 year olds

Since (serious) gaming is used as means to train SRL skills, it is important to include the use of games in the target group. Therefore an overview of gaming and media use in the target group is provided. The Dutch Youth Institute is a non-profit institute that aims to come up with reliable and actual information about the Dutch youth (Nederlands Jeugdinstituut, n.d. b). They published the factsheet media-use for several age groups, including one for nine up to twelve year olds. They state that this age group becomes more critical about computer games and TV-programs that do not contain enough action and look for the story behind something. On average, they spend every day almost three hours on gaming, watching TV and working on a computer (Nederlands Jeugdinstituut, n.d. a). According to Nederlands Jeugdinstituut (n.d. a) this age groups wants to be challenged in a game, however the game does not have to include violence. Nikken (2016) stated that Dutch 10 to 12 year olds become less interested in cartoons, however this is not true for ironic or sarcastic cartoons. They watch (together with family) talent- and family (television) shows and prefer adventurous games and games in which they can build a virtual world (Nikken, 2016).

Design requirements

This description of Dutch 12 year olds, the target group, resulted in the following design requirements:

XI. The serious game must take into account that the target group is still developing SRL skills and therefore should be supported in the application of knowledge about SRL on the use of these SRL skills.

XII. The serious game must take into account that the motivation to learn is low, which means that the serious game must be 1) motivational and 2) motivate learners to become motivated to learn (in general, also outside the serious game)

XIII. The serious game must challenge the player in the game and have a story behind it, which fits the wishes of the average 12 year old.

Serious Game Characteristics

The following paragraphs describe what a serious game actually is (definition and elements), how it affects learning and motivation (motivational elements, effective serious game elements, additional support, and effective realism level) and describes relevant guidelines of the manual of Poort (2017).

Definition

In 'Serious Games: games that educate, train and inform', an edited book about serious games, an entire chapter was dedicated to the definition of serious games (Michael & Chen, 2006). According to them "A serious game is a game in which education (in its various forms) is the primary goal, rather than entertainment" (Michael & Chen, 2006, p. 17). Zyda (2005) also stated that a serious game is a computer played game, which has specific rules and is a mental contest. Wouters, Van der Spek, and Van Oostendorp (2009) stated that there are several definitions of games, but that these all can be traced back to the definition of Lindley (2004), which consists of three parts. Firstly, that it is goal-directed. Secondly, that it is a competitive activity, where the competitor can be the player self (or the player's own limitations), others playing the same game or the game developer. Thirdly, that players (implicit or explicit) agree with the rules that form the framework of the game. A serious game is thus a computer game that is a mental contest, a competitive activity, goal-directed and has specific rules in which education instead of entertainment is the primary goal.

Game elements

Game (design) elements can be seen as features or building blocks that are shared by games (Deterding, Dixon, Khaled, & Nacke, 2011). Schell (2008) states that there exist several ways to classify game elements. It is beyond the scope of this analysis to give an overview of all models or classifications, therefore three models are included. Schell (2008) differentiated between four basic elements: mechanics, story, aesthetics and technology. Mechanics involves the game rules and procedures, story involves the events that happen during the game, aesthetics involves the experience (in terms of how the game feels, smells, tastes, sounds and looks) and technology involves the medium that is used. These elements are equally important (Schell, 2008).

The 'Serious Game Design Assessment Framework' (SGDA Framework) was developed as "an attempt to offer a basis to study how the design elements are configured formally and conceptually in relation to the game's aim and purpose" (Mitgutsch & Alvarado, 2012, "The development of the evaluation criteria", para. 6). This framework consists of six elements. *The first element*, purpose (or aim) is the main element, that must reflected in the other game elements. Serious games differ from 'normal' (entertainment-oriented) games in the way that a serious game has a specific purpose that lies beyond the game (Mitgutsch & Alvarado, 2012). *The second element* is 'content and information', which involves all the data, facts and information that is used in and offered by the game (Bateson, 1972 as cited in Mitgutsch & Alvarado, 2012), which involves all, for players, approachable and visible words and data. *The third element* is framing, this involves the framing of the other five elements in terms of the (broader) game topic, target group and play literacy of the target group. *The fourth element* is (game) mechanics, which are the actions players can perform in the game, such as trick-taking, betting and shuffling for card games (Hunicke, LeBlanc, & Zubek, 2004).*The fifth element* is graphics and aesthetics, which is the audiovisual language of the game (e.g. used imagery, artistic media or aesthetic characteristics). *The sixth, and last element* is fiction and narrative, which involves the fictional context (scenario, narrative, setting, story, characters, problem and back story) (Charsky, 2010 as cited in Mitgutsch & Alvarado, 2012).

Prensky (2001) came up with six 'structural elements of games': 1) rules, 2) feedback and outcomes, 3) interaction, 4) story or representation, 5) objectives or goals, and 6) challenge or competition or conflict or opposition. Games are rule-based, in the sense of forcing the player to take specific paths in order to reach a goal. Feedback is an immediate reaction on what the player did, which makes games interactive and it is an form of measuring progress against goals. Interaction involves two aspects, firstly the interaction between computer and player (feedback) and secondly, with others. Representation means that a game includes a story or narrative. Objectives or goals differentiate toys (non-goal-oriented games) from games, because goals prevents from playing in the way the player wants. Challenges or the conflict are the problems that must be solved by the player.

These three models (or classifications) were combined in order to come with a broader overview of the different game elements. This resulted in the following game elements: 1) goals, especially for a serious game, a purpose besides winning the game; 2) rules and mechanics (performable actions); 3) an underlying story that involves characters, a scenario and narrative; 4) feedback as reaction to what the player did; 5) aesthetics, which is an idea behind the audiovisual part

of the game; 5) interaction with other players; 6) a challenge (a problem that must be solved); and 7) information provided by the game.

Motivational elements

The previous chapters described what a serious game is and what elements it consisted of, but these elements do not say anything about the motivational aspect of a serious game. This is important for the development of the serious game to train SRL skills since motivation is an important reason to choose for a serious game as means. Mayer (2008, 2011) defined motivation as an initiating internal state that keeps up behavior directed at the goal (as cited in Mayer, 2014a). Dondlinger (2007) reviewed literature on the design of educational video games and examined the effect on motivation. Despite the absence of fully agreement about the source of motivation in video games among researchers was motivation examined in several publications. Dondlinger (2007) gave an overview of these motivation sources: the narrative context (e.g. one that promotes fantasy, curiosity and challenge), rewards and goals, objectives that require higher-order thinking skills (decision making or creative problem solving) as found in strategy and adventure games and by providing feedback. So these sources or elements can contribute to an increased motivation to play the game, which is important to train SRL skills, because of the time it cost to train these skills and the motivational assignments that are needed, as described in the problem stamen (see 'Introduction'). These elements match the motivational theories as mentioned by Mayer (2014a): interests, beliefs, goals and needs. *Interests* involves interests in the material, and valuing the learning. *Beliefs*, involving the feeling of being competent to perform the task, the attribution of success and failure to effort, and seeing intelligence as changeable. *Goals*, involving a goal orientation. *Needs*, which involves of the experience of being in charge, experiencing internal rewards, being rewarded earlier, the experience of characters in the serious game that are supportive, and the use of the entire body (to control for example movement in the serious game).

Effective serious game elements

However, a motivational serious game is not enough to learn from. Mayer (2014a) mentioned that understanding of how learning and instruction work is useful for the development of an effective serious game (or game for learning as he calls it).

Learning. Understanding how learning works requires knowledge of the way humans process information. Mayer (2014a) describes three principles that resulted of several studies of several authors on how humans process information. Firstly, the dual channel principle, which means that people process auditory and verbal material via one channel and pictorial and visual material via a second. Secondly, the limited capacity principle, which means that the amount of material or information that can be processed by a channel at a moment is limited as the consequence of a limited working memory capacity. Thirdly, the active processing principle, involving that appropriate cognitive processing leads to meaningful learning. Appropriate cognitive processing means that relevant (auditory and visual) material will be selected, organized into a coherent (verbal and pictorial) representation and integrated (i.e. both representations will be combined with each other and then with prior knowledge). For game development, this implies that distraction by game mechanics must be avoided. To do so, additional instructional features can be added to guide the process of selection, organization and integration (Mayer, 2014a), those are described in the next paragraph.

Instruction. Understanding how instruction works in order to support the learning process builds on the understanding of how information will be processed. (Mayer, 2014a). In a serious game, three types of processing demand the limited cognitive capacity: generative, essential and extraneous (Mayer, 2014a). *Generative processing* focuses on the deeper processing (making sense) of the essential material, which is caused by the motivation of the player (learner) to learn, which is stimulated by motivational features of a serious game. *Essential processing* involves the selection and organization of relevant material, which is caused by the learning material complexity. *Extraneous processing* is the processing of (for the learning objectives) irrelevant material, caused game features and a game design that distracts. For the development of serious games, this implies the following instructional goals: 1) extraneous processing must be reduced by the reduction of distracting features, 2) generative processing must be fostered by motivational features, and 3) essential processing must be managed by content presentation in such a way that this will be achieved (Mayer, 2014a). Mayer (2014a) mentioned that each of these learning goals can be accomplished by the application of some techniques. *The reduction of extraneous processing* can be accomplished by 1) the reduction of perceptual realism, when not needed to achieve a learning objective, and 2) the redundancy principle (the elimination of written words that are also spoken). *Essential processing can be managed* by 1) the pretraining principle (provide key concepts before the serious game starts), 2) the inclusion of

explanations and advice from an expert during the serious game, 3) the segmenting principle (segment the game), and 4) the modality principle (decrease visual processing by the inclusion of spoken words instead of written words). *Generative processing can be fostered* by 1) the prompting of self-explanation or reflection 2) the personalization principle (application of a conversational style), and 3) the opportunity for players to choose parts of the interface appearance.

Mayer (2014b) reviewed serious game features that contribute to learning and found five features that were seen as promising for the improvement of learning by the use of computer games (and simulation games): personalization, modality, self-explanation, pre-training, and coaching. In addition, two features were seen as unpromising: redundancy and immersion. Lastly, six features were defined as 'not yet promising': the inclusion of a narrative, format choice, segmentation, images of an agent, order control by the learner and competition. So an effective serious game must include at least coaching, modality, personalization, pre-training and self-explanation features.

Adding additional support

But applying CLT principles is not enough to make a good learnable serious game. Leemkuil and De Jong (2012) stated based on the conclusion of several authors that support must be added to games in order to lead to effective learning. Wouters and Van Oostendorp (2013) performed a meta-analytic review on instructional support in educational games (including among others serious game and simulation games). They stated that instructional support is needed for learners to engage in cognitive processes, such as the selection, organization and integration of new information. This was supported by the finding that games with instructional support lead to significantly more learning when compared to games without support, with a weighted effect of d=.34 (Wouters & Van Oostendorp, 2013).

Instructional support types. Wouters and Van Oostendorp (2013) distinguished between 24 different types of instructional support types and grouped these 24 types into ten different groups (advice, collaboration, feedback, interactivity, modality, modeling, narrative elements, personalization, reflection and others). However, only collaboration (playing and discussing with at least one other person), feedback (and guidance), modality, modeling (scaffolding, worked examples and modeling), personalization (of characters, topics, ideas and messages) and reflection (and assignments, elaboration, self-explanation) support improved learning.

Effective realism level

Besides a serious game that motivates, takes cognitive load into account and deals with additional support, the design of the serious game in terms of realism level is also important. Wouters and Van Oostendorp (2013) included the effect of (the level of) realism as moderator in their meta-analysis on the effect of instructional support in serious games (or game-based learning). They adapted the taxonomy of Vogel et al. (2006), resulting in the following levels: basic or schematic (involving schematic and low-quality pictures), cartoon(like), (photo)realistic and unknown (when the realism level was not determinable). They found instructional support led to an improvement of learning in serious games with a schematic (d=.45) and cartoonlike (d=.18) design, whereas the effect size of instructional support in realistic designed serious games was not significant. However, "instructional support in basic/schematic designs seems to improve learning more than in cartoonlike and (photo)realistic designs" (Wouters & Van Oostendorp, 2013, p. 421).

Guideline manual

Poort (2017) developed a guideline manual for collaborative serious games. Although collaboration is not included (as described below, under 'information and communication system'), the guidelines described for both feedback and goals are highly relevant for the serious games to train SRL skills, since goals and feedback contribute to motivation and feedback is a form of additional support. In addition, two guidelines for game content are added because the game content must fit the preferences of the target group.

For feedback three guidelines were formulated: (1) the guidance towards correct performance, instead of only focusing on mistakes, by providing hints, (2) providing the first step in the direction of the solution instead of giving the entire answer, and (3) show the score composition and possible score range during the game instead of only a score (Poort, 2017). A fourth guideline was actually written for the category 'data', but is highly relevant for feedback. This guideline involves the use of data as progress monitoring (for player and teacher) and input for feedback (Poort, 2017).

The category goals involves five guidelines: (1) providing multiple goals that can be achieved by the execution of particular actions, (2) include sub-goals to clarify the steps towards the goals, which must be clear for teachers and students, (3) clarity of the rules to prevent from discussion on the rules, (4) give players the opportunity to repeat a task when a better solution (in direction of the goal)

can be performed, by triggering players to choose for a replay, and (5) adapt the task complexity in order to improve and/or acquire skills (Poort, 2017).

And lastly, for game content the following two guidelines were formulated: (1) the match of actions and theme in and of the environment to the goals and (2) personalize the game by giving players the opportunity to choose and adapt characters.

Design requirements

The analysis of effective and motivational game elements resulted in the following design requirements:

XIV. The serious game is a mental contest, goal-directed, competitive and involves specific rules.

XV. The serious game includes the following game elements
   a. goals, especially a purpose besides winning the game
   b. rules and mechanics (performable actions)
   c. an underlying story that involves characters, a scenario and narrative
   d. feedback as reaction on what the player did
   e. aesthetics, which is an idea behind the audiovisual part of the game
   f. interaction with other players
   g. a challenge, which is a problem that must be solved
   h. information provided by the game.

XVI. The serious game is motivating trough the inclusion of a narrative context that promotes fantasy, curiosity and challenge, rewards and goals, objectives that require high-order thinking skills (decision making or creative problem solving), providing feedback, material that is seen as interesting, the attribution theory, an orientation on the goal, choices, internal rewards, support and movement.

XVII. Learning will be supported by the inclusion of coaching, modality, personalization, pre-training and self-explanation features.

XVIII. The serious game will be added with at least one of the following additional support forms: 1) collaboration, or 2) feedback and guidance, 3) modality, 4) modeling, scaffolding and worked examples, 5) personalization of characters, topics, ideas and messages, and 6) reflection, assignments (prompts to investigate variable relations), elaboration and self-explanation

XIX. The serious game has a schematic design, because this has a positive effect on learning in combination with instructional support.

XX. The serious game involves feedback that provides hints in the right direction of the solution and towards correct performance and shows the score composition and possible score range during the game instead of only a score. In addition, data out of the game will be used for both monitoring and as feedback.

XXI. The serious game involves multiple (clear) goals that can be achieved by the execution of particular actions, sub-goals (steps towards the goals). This also involves the opportunity to repeat a task when a better solution (in direction of the goal) can be performed by triggering players to choose for a replay. And lastly, the task complexity is adaptable in order to improve and/or acquire skills.

XXII. The serious game involves a match of actions and theme in and of the environment to the goals, and personalize the game by giving the player the opportunity to choose and adapt characters.

Phase 2: Design

This second phase aims to translate the design requirements in a detailed instruction plan. Before this will be done, (a part of) the formulated design requirements will be reformulated because of duplications within and between the sub-analysis. After that is done, a storyboard will be made, which consists of the narrative and illustrations. Then a prototype will be made, consisting of print-screens and a description of and the narrative per level. This prototype will be tested in a pilot test with the target group to test whether it fits the target group.

Design Requirement Overview

The 22 design requirements (I – XXII) that were formulated during the several sub-analysis will be combined and discussed. However, the first four (I – IV) design requirements were actually learning goals (LG), these will be reformulated into learning goals (see below, A – D). The combined design requirements (1 – 22) can be found in Appendix A.

Learning Goals: SRL Strategies

A. The students are trained in cognitive (learning) strategies (DR II, VI), which involves knowledge about the five learning strategies of Weinstein and Mayer (1983):
    1. Rehearsal or repeating strategies, such as underlining or copying
    2. Elaboration strategies, such as summarizing or paraphrasing
    3. Organizational strategies, such as creating a hierarchy or outlining
    4. Comprehension monitoring strategies, such as comprehension failure checking
    5. Affective strategies, such as being relaxed and being alert
B. The students are trained in metacognitive strategies (DR III, VI, Xb), involving learning how to:
    1. Orientate on a task
    2. Set (realistic) goals (DR VIIIc)
    3. Planning (DR VIIIc)
    4. Perform a plan and monitor the process and outcome, time management (DR VIIIc)
    5. Concentrate on the task
    6. Reflect on own task executing and acting (self-evaluation, DR VIIIc)
    7. Monitor their own competence (development)
C. The students are trained in motivational strategies (DR IV, VI, XII), involving
    1. learning how to take initiative and be thorough
    2. supporting trust their own capabilities (self-efficacy)
    3. supporting failure and success attribution to the self or others ((self)-attribution)
    4. supports an orientation on improvement of understanding and competence (task or learning goal orientation)
    5. learning self-motivation
D. The students are trained in behavioral activity (DR I), which involves learning how to create, select and structure the environment

Training in this sense means that the instructional experience focuses on the acquisition of specific skills that normally almost immediately will be applied (Smith & Ragan, 2005a).

Application of Design Requirements

Training of SRL skills

The SRL skills or strategies (as described in LG A – D) will be trained in the serious game by assignments that require cognitive (learning) strategies (LG A), metacognitive strategies (LG B), motivational strategies (LG C) and behavioral activity (LG D).

To stimulate the use of motivational strategies (LG C) colleagues (coaches) with several functions are included. These functions can be found below, in Table 2.

Table 2.

Functions of colleagues in the serious game

Function	Activities of the colleague to fulfill this function, the coach…
1. Being a gradually decreasing external monitor of chosen learning strategies, to support the motivation to learn and monitoring (metacognitive strategy)* (DR 18)	1.1. monitors the progress towards goals 1.2. asks why a particular learning activity is chosen 1.3. assesses understanding 1.4. motivates the player to explain the content of what has been learned 1.5. demonstrates how problems can be fixed
2. Stimulating players to actively steer their own learning process to support the motivation to learn* (DR 22)	2.1. stimulates self-reflection (on the own thinking process) 2.2. gives feedback (on the self-regulated learning process) 2.3. promotes the use of metacognitive strategies 2.4. stimulates self-motivation 2.5. clarifies (the importance of) goals 2.6. clarifies the importance of particular learning activities 2.7. shows the relation between the type of learning activities and learning activities 2.8. asks players about their used methods
3. Being a (expert-)model to support the motivation to learn* (DR 12d)	3.1. is enthusiastic, interested in learning (processes) and explains with pleasure 3.2. shows the effectiveness and importance of learning activities 3.3. stimulates curiosity and cognitive conflicts 3.4. accentuates learning to learn (self-regulated learning) 3.5. shows ways of thinking and problem solving 3.6. is an example in motivation and affect 3.7. takes away fear of learning new learning strategies
4. Providing scaffolding to support the motivation to learn* (DR 12d) and metacognitive strategies** (DR 12d)	4.1. gives responsibility for choices and the learning process gradually to the player 4.2. has the role of external monitor (which gradually decreases, in such a way that the player takes over) 4.3. motivates the player to use its own motivation to learn 4.4. strives to players' learning strategy automation
5. Stimulating positive self-evaluations to support the motivation to learn* (DR 18)	5.1 adapts (and stimulates players to adapt) goals to the level of the player 5.2. gives feedback that contributes to maintaining the self-confidence of the player 5.3. makes abstract information personal and concrete by giving concrete information
6. Informing on the use of SRL skills ** (DR 12d, 20)	6.1. providing hints on how SRL skills can help** 6.2. verbalize SRL skills**

* = the function and contributing activities are based on Simons (1994), as explained under "SRL training strategies" (Analysis phase)

** = based on Santrock (2011)

To train cognitive (learning) strategies the seven approaches, as described in the analysis ("SRL training strategies"), are followed (DR 12d, 21)(Pressley, Snyder, & Cargilia-Bully, 1987 as cited in Smith & Ragan, 2005d; Smith & Ragan, 2005d). According to this approach, cognitive (learning) strategies can be trained by the use of 1) (guided) discovery, 2) observing others using these strategies, 3) guided participation, 4) a prepackaged strategy instruction, 5) direct explanations of the coach, 6), self-instruction training, and 7) dyad instruction. To train these strategies, players will follow a computer training within the serious game. This computer training contains short instruction videos on cognitive (learning) strategies and self-instruction (a new strategy instruction course or prepackaged instruction). Video instructions are included, because videos match the multimodality of a serious game (as in moving images and spoken instruction, can involve modeling, and provide the opportunity to watch an instruction again when the player needs it. van der Meij and van der Meij (2014) found that students (M = 11.8 years old) who watched an instruction video (on Word's formatting options) outperformed students who received a paper-based tutorial. This indicates that the use of video instructions outperforms paper-based instructions for the target group of this serious game (11-13 year olds). The video in this serious game involves modeling, and direct explanations on the timing of the use of a strategy (DR 12d)). After the video, players will practice with the cognitive learning strategies by guided discovery, guided participation, dyad instruction, and self-instruction (DR 21). Guided discovery means that the trainer in the online program asks questions that guide players in the discovery of the learning strategies (Smith & Ragan, 2005d). Guided participation contains of the procedure use (from orientation on the task to deciding an appropriate strategy) (Smith & Ragan, 2005d). Dyad instruction contains of both a thinking-aloud and demonstration by the coach, and demonstration by the player (Smith & Ragan, 2005d). Self-instruction involves feedback of the coach, and the stimulation of private speech by players.

Theme choice

The behavioral, cognitive, metacognitive and motivational strategies are the main learning goals of this serious game. Therefore the chosen theme, actions and environment must match the goal of the serious game (DR 10, 15), and at the same time promote fantasy, curiosity and challenge (DR 10), involving problems that must be solved to fit the preference of the target group (DR 3). With these two criteria in mind, a brainstorm session was held to come up with ideas for a theme. The results of this brainstorm can be found in Figure 3.

The theme "becoming the business boss" is chosen, because it fits the motive of the development of this serious game, namely to prepare students for both a changing working environment and the change from primary to secondary education. In "becoming the business boss" the player starts as order-picker and performs assignments that require SRL skills/strategies (e.g. making in planning, in terms of what is needed for the first workday) in a smartphone company. The player performs several jobs in the company to become the boss of the smartphone company. These steps can be made by correct performance of SRL skill requiring assignments, which results in experience points (see below 'experience points'). A more extensive description of the "becoming the business boss" theme can be found in below "background story" .

Theoretical background

Due to the choice for a serious game without collaboration and physical assistance of a teacher the advised theoretical background (the social-cognitive theory) will not be followed (DR 1). This theory namely values the social experience as an important element of learning. Therefore a theory that focuses on learning the cognitive processing of the trained skills was searched. Hense and Mandl (2012) aimed to give a theoretical underpinning of game-based learning and analyzed the learning theories of perspectives that are used with the aim to foster learning in such games. They state that these theories do not exclude each other, but can be seen as complementary, since they can contribute to different learning goals within a game. Therefore the behavioral perspective, cognitive perspective, humanism and individual-constructivist theory are used for elements within the game.

Following, the behavioral perspective, operant conditioning is included in order to stimulate learning, by punishment and positive reinforcement (Hense & Mandl, 2012; Wu, Hsiao, Wu, Lin, & Huang, 2012). Positive reinforcement, by the inclusion of experience points (see 'experience points' below for a more extensive description), which are needed to play the next level. The challenge to reach the next level is a motivation (or reason) for playing video games (Lucas & Sherry, 2004), so can be seen as a reward. Failing a level can be seen as punishment (Hense & Mandl, 2012).

Figure 3. Results of the theme brainstorm

The cognitive theory, which focuses on information processing is used as foundational theory by the inclusion of a narrative component and the choices between options which are part of the role-playing (the player fulfills several roles within the company) (Hense & Mandl, 2012; Merriam & Caffarella, 1999 as cited in Wu et al., 2012). These choices must be made in order to solve the problems (DR 3, 8) the player faces in the game. Problem solving is included in the serious game to create a mental contest (DR 4), a challenge (DR 3) and an interesting learning experience (DR 5). The cognitive theory (or cognitivism) is also the background of the self-reflection (DR 13c) that will be included as learning means. One of the principles of the cognitivism is namely internal attribution, which means that the causes of behavior will be attributed to the 'learner' self (Wu et al., 2012). Self-reflection will be triggered by colleagues and the "Feedbee app" (see the paragraph "information and communication system", below), to stimulate monitoring of progress towards goals and explanations of chosen actions, make students think about the used (learning) method they performed and choose, and assess the understanding of the use of SRL skills (application).

The third foundational theory that is used is humanism. This theory states that the trainer is a facilitator while learning is personalized and student centered (Wu et al., 2012). The use of a serious game makes the learning student centered and the personalization can be found in both the increase of complexity over the levels and the personalization of characters (see below, under "players character"). In addition, experiential learning (learning from experiences) is another important principle of humanism (Wu et al., 2012). Kolb (1984) describes the Lewinian model of experiential learning, which consists of (a cycle of) 1) a concrete experience, 2) reflections and observations, 3) abstract concept formation and generalizations, and 4) implication testing in new situations. In the serious game, players will perform a certain action (experience), reflect on this action and receive feedback (reflection), write down these new insights in "Feedbee" (generalization formulation) and will be triggered to think of what has been learned when faced with a similar experience (testing in new situations).This feedback will be written in such a way that the self-confidence of the player will increase. Tzetzis, Votsis, and Kourtessis (2008) performed a study on the effect of different types of feedback on self-confidence (and skills) in 10 to 14 year old badminton players. They stated that "it might be assumed that positive feedback had a positive effect on athletes' self-confidence" (Tzetzis et

al., 2008, p. 376). For difficult tasks, the addition of correction and error cues increase self-confidence because learners perceive this as supportive information. The effect of positive feedback on confidence was also found in a group undergraduates (M = 21 years old) (McCarty, 1986). Although the specific training situation (badminton) and difference in age (21 years vs. 12 years in the to develop serious game) limits the generalizability to this serious game, these ideas were taken into account in the way feedback will be given in this serious game. To contribute to self-confidence, positive feedback will be given, combined with a suggestion towards the right action or performance (DR 12bi). Although not all serious games include a trainer, this serious game includes several facilitators (enthusiastic colleagues), which matches humanism and the strategies of Simons (1994) and Santrock (2011). These colleagues (and boss) stimulate learning, as can be found in Table 2.

The fourth theory is the individual-constructivist perspective, which sees the learner as the constructor of information (based on experiences) and is included in order to provide challenging tasks, which is called cognitive apprenticeship (Hense & Mandl, 2012; Smith & Ragan, 2005b; Wu et al., 2012). This means that these challenges are relevant and authentic (to game reality and experiences of the player) (Hense & Mandl, 2012). In this serious game, the assignments are related to situations that (can) happen in a smartphone company and therefore meet this requirement. In addition, the zone of proximal development (Wu et al., 2012) will be taken into account by the decreasing amount of guidance (as in questions that prompt self-evaluation and hints to the correct way), which matches the strategies to train SRL skills of both Simons (1994) and Santrock (2011) (see "SRL training strategies").

Background story

The player starts as order-picker (firstly under supervision, which gradually decreases) in a small smartphone factory. The factory expands, but this growth is not a linear process. Just as in a 'real' factory, there are unforeseen events (such as a high demand for the smartphones by problems with the phones of the competitor, or problems with someone that tries to steal phones). After the first level is finished, the player becomes the secretary of the boss. The business grows and smartphones will be sold worldwide. This requires a transport planner, a new challenge for the player. After being able to complete this job, the player starts (in level four) as trainee to become the boss. This training requires motivation, learning strategies (to survive the self-study books, DR 19) and dealing with feedback. The fifth level is that of the big boss, the student successfully finished the training and is able to lead the business. But what happens when the new assistant is a girl with a –for the player- unknown culture. This motivates the player to learn more about this unknown culture. And then, when everything seems to be better than ever before, several potential takeover candidates emerge. This background story is pre-pilot tested in order to check whether the theme, story and character appeals the target group. This resulted in the conclusion that the theme, story and characters fit the target group and a small change, namely the addition of stolen phones in the third level in order to add a bit more action in the serious game. The full description of this pre-pilot test can be found under "Evaluation phase".

Experience points

As described earlier, experience points can be earned by fulfilling activities that belong to a job (such as picking a number of orders), independent self-study activities, using feedback and achieving goals that were set by the player. Achieving goals before a self-set deadline will be rewarded with extra points (DR 11) to stimulate competition against the 'computer' (DR 6). These points can be used to 1) personalize the character by buying new clothes or changing the hair of the character (DR 12e), 2) buy a relevant guided training (such as a planning course or course in the learning strategies), and 3) are needed to make the step to a new job (level). The calculation and reason why specific points are given will be included as feedback (DR 12bii). In this way, reaching learning goals contribute to goals of the game (namely reaching the next level by earning experience points).

Levels

The serious game will consist of levels that are built around a few SRL related jobs within a smartphone factory. This is done in order to create growth or progress, by gradually decreasing the amount of support a player receives (DR 2, 12e) and an increase of SRL skills. The "game" aim is to reach the highest level where players are the boss of the company, by the collection of enough experience points in every level of the game. A full description of the levels can be found below (see Prototype).

Motivation to play (and learn)

Motivation will be included in two ways: 1) the training of motivation as SRL skill, and 2) the motivation to play this serious game. To increase the motivation to play, this serious game contains the following elements: a narrative context (background story), rewards (experience points), goals and objectives that require higher order thinking skills, and choices (DR 16).

Mayer (2014a) described motivational theories especially for serious games (see "motivational elements") and distinguish between interests (also in DR 5), beliefs, goals and needs. *Interests* focus on both interested and valuable material. The formative evaluation is used to adapt the content (narrative and assignments) to meet the interests of the target group. To increase the value of the material, players will be explained that the serious game aims to prepare them for (mainly) independent learning in secondary education (see the Lesson Plan in Appendix D). *Beliefs* involve self-efficacy, attribution and view on intelligence (changeable). Self-efficacy and attribution are relevant for serious game for players who have low self-efficacy and/or ability attribution (instead of effort) in traditional learning and high self-efficacy and/or effort attribution in serious games. Both increase the willingness to persist in serious games. Success experiences on tasks that are challenging can change the view on intelligence. *Goals* involve a goal orientation. Players bring their own goal focus (i.e. performance-approach, performance-avoidance and mastery goal), but there is less evidence on the trainability of a goal-orientation. However, Mayer (2014a) states a serious games' design must motivate the player to intrinsically willing to master the material. Spending time playing is given as a reason for the transition from performance-approach into a mastery goal orientation. *Needs* involve experiencing control, internal rewards, earlier rewards, supportive others and movement. Control will be included by choices, such as interface personalization and replay of challenging (parts of) levels. Mayer (2014b) included this form of control in the review and found not enough studies for making a hard statement, but since it can contribute to motivation it is included in this study. To prevent from distraction, it is only possible to choose before the first level and after every level. Intrinsic motivation (in addition to internal rewards) can be stimulated by curiosity, challenge and fantasy (Malone, 1981 as cited Mayer, 2014a) (also match DR 10).

In addition to these ideas, the ARCS model of Keller (1987) is included to improve the motivational appeal of materials that are used for instructional purposes. ARCS stands for Attention, Relevance, Confidence and Satisfaction, the four conditions that aim to motivate and keep the learner motivated to learn. For each condition, the application of some strategies are described. *Attention* means that the learner gets and sustains attention for the learning material. This will be applied in the serious game by 1) the use of the game itself, which requires participation (strategy A6.1), 2) the inclusion activities that require problem-solving (strategy A5.2), 3) variation in the instruction format in, e.g. pictures/animation and the information in the Feedbee app (see below, "information and communication system") (strategy A3.2), 4) examples of principles (or in this case, SRL skills or strategies) (strategy A2.2), and 5) content-related anecdotes (which will be done by the story of a colleague in the game) (strategy A2.3). *Relevance* stands for the relevance of the to be learned content for the learner, by 1) trying to stimulate interest (R1.3) by the chosen theme, 2) explicitly stating that the serious game aims to improve the SRL skills instated of learning from scratch (R1.1), 3) presenting the value of the skills for the future (R3.1), 4) the inclusion of a model (colleague) that models with enthusiasm (R 5.3), and 5) the inclusion of alternative road to accomplish a goal (R6.1). *Confidence* stands for the expectancy of success. Therefore, 1) self-evaluation will be stimulated by Feedbee, which is linked to one of the aims of the serious game, namely metacognitive strategies (C1.2), 2) the difficulty and complexity of the levels increases (C2.1), 3) goal setting in Feedbee will be supported in order to support students to make sure that these goals are realistic (C3.3), 4) internal attribution, by questions like "what did you do right today?" in Feedbee (C4.1), and 5) independent learning within the serious game (C5.1). *Satisfaction* stands for feeling good about the achievements. This is applied in the serious game to train SRL skills by 1) verbal rewards of 'colleagues' in the game when the player performs difficult tasks (S1.2), 2) both boring and interesting tasks will be rewarded with experience points in order to motivate the learner extrinsically (S2.1, 2.2), 3) feedback by colleagues and the 'boss of the company' about the actions of the player in the direction of improvement and what went well (S 3.1, 3.3), 4) a gradually increase of self-formulated self-evaluation of the player in order to prevent from too much feedback from others (S4.3), and 5) the rewards (experience points) are linked to actions performed by the player and self-evaluation (S5.1).

Player's character

Personalization as additional support (DR 12e) is included in the choice for an avatar (see Figure 4) and name before the first play and personalization with earned experience points. Players want to have more control over the appearance of these characters (e.g. adding a sunglass), as mentioned in the formative evaluation (improvement statement 4). Therefore these avatars will be presented as basic element to give players the opportunity to change the shape and color of the eyes, ears, nose and mouth, and to add accessories (e.g. a sunglass).

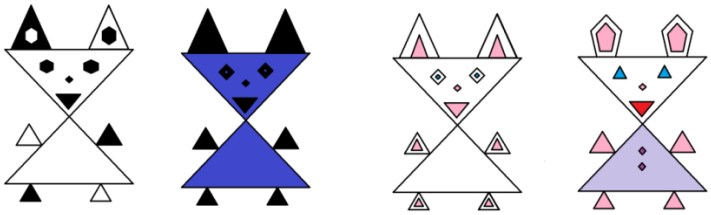


Figure 4. The player's character

Communication system

To train the player in monitoring the plan and adjusting it when needed (LG B). Players receive information about used strategies and performed actions via feedback of a colleague (DR 12biii).Then players will be stimulated to write this feedback in own words in a visual smartphone screen ("Feedbee", from the word feedback). This contributes to elaborating strategies (LG A) and enables players (and teachers) to monitor progress (LG B). In addition self-explanation questions will be asked (DR 12f) to stimulate the player to think about what went wrong/well (LG B). This provides the opportunity to set new goals to improve the performance and learning (LG B). Setting new goals will be stimulated in Feedbee, by support via hints towards these goals.

The communication with other characters will be spoken in a conversational word style by an actual human voice (DR 9). Playing against other players can lead to competition (DR 6) or with other players (collaboration, DR 12a), but the choice has been made to only include computerized fellow players. The exclusion of the possibility to play the game against or with 'real' fellow players is made for several reasons. Firstly, because the player must learn to motivate themselves (LG C) without others motivating them to perform certain actions or the possibility to repeat what the other player did. The idea is that the player learns by getting feedback on chosen performances. Secondly, players must learn to make (conscious) decisions. By repeating a 'right' action of a fellow player, players do not learn to decide themselves. Thirdly, the (triggered) opportunity to repeat a task when it could have been done better (DR 8c). When another player would be included, it would not be possible to repeat a task when the other player performed better.

Rules and mechanics

According to design requirement 7 the serious game must be based on clear rules and mechanics (performable actions). Concerning mechanics, players are able to perform all kinds of actions that can be performed within the job (e.g. performing assignments). These rules are clearly described after players chose an avatar and name. The following rules are established:

- When a level is started, it can be paused but not restarted until it is finished
- A player needs to have enough experience points before he/she can start a new level
- As described above, experience points can be earned by performing SRL actions
- Players can contribute to decisions taken in the company, such as product choice or ways of performing things (e.g. how to pick orders in the first level), which is personalization

(Sub-)Goals

The serious game must be goal-directed in terms of SRL, which can be achieved by higher-order thinking skills, such as decision making or creative problem solving to be a mental contest (DR 4, 8). These are needed to deal with the unforeseen events (which are described under "background story") and to increase the fun of the game as mentioned during the formative evaluation (improvement statement 1). Because every level has its own job with corresponding requirements, each level has its own sub-goal (DR 8b). These sub-goals are described for each level under "prototype". To achieve a (sub-) goal, particular actions must be executed, these are part of the job the player performs (DR 8a). The aim of each level will be presented at the start of a 'working day' to inform students and teacher(s). The complexity of tasks related to the (sub-)goals gradually increases to improve the skills (DR 8d).

Guidance

As described above gradually decreasing guidance will be included in the serious game. This guidance starts with observing colleagues performing a certain job (DR 12d) and guided discovery (DR 21, involving supporting questions of colleagues in the serious game). Guidance will also be provided by dyadic instruction (DR 21, thinking-aloud), self-instruction training (DR 21) and worked examples, which are examples that consist of a problem formulation and final solution" (Renkl, 2014, p. 407). Prompts to investigate variable relations (assignments, DR 12f) are not included, because it is not relevant to investigate relations between variables. Guidance involves information and hints/instructions on the use of SRL skills (DR 20, 12bi, 21). Pre-training to support learning is included in a short instruction about self-regulated learning (see Appendix D for this instruction).

Design

A schematic design is chosen for the background, because this seems to have a positive effect on learning (DR 14). Wouters and Van Oostendorp (2013) gave an example of a basic (visual) design and a schematic design in Figure 1 (on page 416), these are basic: black/white and gray colors and lack a background. With the target group in mind, a cartoonlike design (with some color) is chosen for the characters. But what is a cartoonlike design actually? A cartoon is 1) a drawing, painting or preparatory design, 2) intended to be humorous, a caricature or a satire or 3) an unrealistic, ludicrously simplistic or one-dimensional version or portrayal (Definition of cartoon, 2018). So a cartoon design is an unrealistic, simplistic drawing or painting.

Aesthetics and audiovisual part of the game

Following design requirement 14, the audiovisual part of the game is based on aesthetics and an idea. According to Hunicke et al. (2004) aesthetics is the desired emotional response (fun) in the player, when playing the (serious) game. They distinguish eight components of aesthetics: challenge (obstacle course), discovery (uncharted territory), expression (self-discovery), fantasy (make-belief), fellowship (social framework), narrative (drama), sensation (sense-pleasure) and submission (hobby). This serious game aims to trigger fantasy, a challenge, a discovery to stimulate curiosity (DR 10) and expression to stimulate self-discovery and to practice with the SRL goals (LG A-D) In addition, challenging tasks are seen as essential factors for the motivation to learn in a serious game (Wouters, Van Nimwegen, Van Oostendorp, & Van Der Spek, 2013).

In addition to aesthetics is the audiovisual part of the game also based on an idea. Within the game design, two point of view (POV) types are distinguished (first-, and third-person POV). The first-person POV is being the character in the sense of seeing the world by "the eyes of the avatar" (Lim & Reeves, 2009, p. 348). The third-person POV is seeing the character as if the camera is placed behind the avatar (Lim & Reeves, 2009). Lim and Reeves (2009) investigated the effect of POV on subjective game experience evaluations and physiological arousal in a small study (n=22). No significant direct effect was found of POV on arousal. The same applies to the effect of POV on presence in the game (for players that played the game with chosen avatar). Kallinen, Salminen, Ravaja, Kedzior, and Sääksjärvi (2007) also performed a study (n=50) on the effect of POV on emotional responses and presence. Their findings suggest that a first-person POV generates more presences when compared to a third-person POV, whereas a third-person POV felt more pleasant. However "high presence may usually be related to positive emotions" (Kallinen et al., 2007, p. 3). Therefore is chosen to use a first-person POV for this serious game.

Laamarti, Eid, and El Saddik (2014) gave an overview of serious games and suggested that music is one of the most important characteristics. According to them, music contributes to motivation to practice while using the game. Background music does not only contribute to motivation, but also to fact memorization in immersive virtual worlds (Richards, Fassbender, Bilgin, & Thompson, 2008). This indicates that the inclusion of music is important for learning (especially memorization) and motivation. However, music is a matter of preference. Therefore music preference will be asked during the pilot test with the target group (see Appendix B).

In order to distract from the actions that must be performed in the game, the system must be logically usable. This means that the main character will be controlled by the mouse/touchpad of the computer, or by swiping on a tablet (as resulted from the formative evaluation). Actions can be performed by clicking on materials (e.g. to study), persons (e.g. say something to a person) or the character self ('the I-person in the serious game, to think about feedback or set goals, by clicking on a book). By clicking on such a thing/being a couple of performable actions (or sentences in the case of communication) pop up and the player can choose from these options. This "opportunity to make choices" (autonomy) is seen as an essential factor for the motivation to learn from a serious game (Wouters et al., 2013, p. 2).

Storyboard

Based on the previous chapter (“application of the design requirements”), a short description of the job will be given, followed by the learning goals, and the narrative of that level which also includes a description of the assignments.

Deliberately removed, please contact the author for the storyboard via k.tonis2018@gmail.com

Prototype

Based on the storyboard a prototype has been made to show how the serious game will look like. This prototype, existing of a couple of screenshots per level from the (to be developed) serious game is presented in Figure 20 to Figure 44 in Appendix C.

Deliberately removed, please contact the author for the prototype via k.tonis2018@gmail.com

Phase 3: Development

Although the development phase consists of the development of the actual instructional material and a plan of instruction (POI) (Holden, 2015), due to a lack of resources only the POI is developed. “The POI (…) serves as the overall plan for conducting instruction in a particular course” (Holden, 2015, p. 9). The POI involves a description of the course, the aim(s), instruction sequence, instructional hours (and allocation to aims), requirements of the teacher/instructor, instruction method, support material, utilization of the media and equipment, guidance for the instructor, the lesson plan and training standards that support the instruction unit (Holden, 2015). All these elements are included in the lesson plan that can be found in Figure 45 in Appendix D.

Phase 4: Implementation

The implementation phase will be skipped because there is no actual developed serious game that can be implemented.

Phase 5: Evaluation

Pre-Formative Evaluation

The background story (as described under 'background story' which is part of the design phase) is tested in order to test if it fits the target group. Therefore a (Dutch) written translation of the background story and the four figures (or characters) is presented to four 11-13 year olds (two boys, two girls, M = 11.5 years). This is combined with a short questionnaire about the opinion on the story in general, the characters and the option to say what I (as developer) can change to improve the appeal of the serious game (story, characters or theme). This questionnaire involved gender, age, 1. "What do you think of the story in the game? (interesting or non-interesting) and Why?, 2. "What do you think of the characters (you may choose one)?" and 3. "What can I change to make it more nice/interesting ?"

All four participants indicated that they found the story interesting, fun and exciting. One of the participants stated "I find it nicely that I [as player] can be the boss of the business". Both verbal and written reactions on the characters were positive, these were described as funny and cool. The third question on improvements of the serious game showed promising results in terms of satisfaction with the story, one of the participants stated "I am interested in the entire story" and verbally mentioned that when the game would be available he would like to play it. Another stated "I would like to see that the smartphones will be stolen" (in the sense of some action in the game), which is added in the third level (in combination with the theft of secret business information). Overall the pre-pilot resulted in the conclusion that the theme, story and characters fit the target group. Therefore the story will continued and written into detail in this report.

Questionnaire Evaluation

Before the questionnaire (as described in the following paragraph) was used for the actual pilot-test it was presented to an independent grade sixth teacher in order to get an answer on the question whether the level of the questions fits the target group (sixth grade students). This evaluation resulted in the conclusion that the questionnaire must include more pictures in order to make it more visual and thus alive for the students. After this change, the questionnaire was presented to a sixth grade student (11 years, male) in order to test it in practice. This resulted in the conclusion that it the questionnaire is doable for a sixth grade student. Therefore it was used in the actual pilot test.

Formative Evaluation

To test whether the (prototype of the) serious game fits the target group (11-13 years old, Dutch students), elements from the prototype are presented to the target group and a grade six teacher. What follows is a description of the ethical aspects, the sampling method and respondents, the (developed) instrument to perform the formative evaluation, the followed procedure during the formative evaluation and data analysis.

Ethical approval. Before the formative evaluation was performed, the ethical committee of the University of Twente in Enschede gave approval for this evaluation. Because of the target group, the parents were asked to give passive informant consent for their child after being informed (by e-mail, send via the teacher of their child) about the aim and procedure of the study.

Sampling and respondents. A school class was recruited by cluster sampling (Bhat, n.d.). Cluster sampling means the all members from a randomly selected cluster (natural group) will be included (Bhat, n.d.). This is an appropriate method for the aim, because students within a class vary in (intrinsic) motivation to learn, level of SRL skill and preferences concerning the serious game. Bhat (n.d.) stated that this method is applicable for a within group diversity. This group involved 19 Dutch speaking sixth grade students. Seven of them did not fill in age or gender, two were boys (M=12 years) and ten girls (M=12 years). The teacher (male, 24 year old, 1-5 years experience as sixth grade teacher) was recruited by convenience sampling, since other teachers did not respond on the request to participate in this study.

Instrumentation development. A printed qualitative questionnaire was be used (for the students), that involved two demographic questions and questions about the content and motivation to play, appeal and difficulty level, aiming to improve the fit of the serious game to the target group. The motivation to play is included because the serious game is used as instructional method to train the SRL skills because of its motivational effect. The motivation to learn is increased by the inclusion of the four elements of the ARCS model of Keller (1987), namely attention, relevance, confidence and satisfaction. The appeal, and level of difficulty are included to test whether the design choices that were made based on the Serious Game Design Assessment Framework (SGDA Framework) of

Mitgutsch and Alvarado (2012) actually fit the preferences of the target group. This framework was used as foundation for the development of the serious game and therefore also as foundation for the evaluation of the opinion of the target group in order to adapt the prototype more to the preferences of the target group. The 'Serious Game Design Assessment Framework' (SGDA Framework) was developed as "an attempt to offer a basis to study how the design elements are configured formally and conceptually in relation to the game's aim and purpose" (Mitgutsch & Alvarado, 2012, "The development of the evaluation criteria", para. 6). This framework consists of six elements, that are described in Table 3 in Appendix E. The conceptualization involves 1) the element(s) of the SGDA Framework, 2) the application in the serious game, and 3) the questions. For example purpose (element 1), which will be asked in a few assignments from the serious game with the question to write down how to perform the assignment, as shown in Table 3, Appendix E. The difficulty is also tested in order to prevent from an cognitive overload, which does not contribute to learning (as described in the Analysis phase, under 'cognitive load theory').

Instrument. The questionnaire started with two demographic questions (age and gender) and then contained questions on understanding/difficulty and appeal (based on the SGDA Framework, as shown in Table 3, Appendix E). Then questions about motivation were included, which are based on the ARCS model. The conceptualization of this model can be found in Table 4 (Appendix E). The entire student questionnaire can be found in Appendix B. The teacher received the English explanation of the first level with five questions: 1) gender, 2) age, 3) years of experience, 4) Do you think that sixth grade students can understand the content (e.g. assignments and instructions), when this is included in a serious game in Dutch?, and 5) Do you think that sixth grade students will learn self-regulated learning skills (as described under '(sub-) goals of the level'). This was done in order to answer the fourth research question concerning whether students can learn from the (to be developed) serious game.

Procedure. The students that got permission to participate (or the parents did not rejected participation of their child) were in their regular classroom during school hours. The researcher explained the aim of the training of SRL (as preparation for secondary school and a future in which things must be learned independently), the aim of the serious game (namely the learning of SRL skills), the possibilities of the player in the serious game (watching, walking, talking, performing assignments) and the background for the duration of 10 minutes. Then the students receive the questionnaire (as presented in Appendix B) which also involves some descriptions (the background story, the first level, a conversation) and fill in the questions, which cost 30 minutes. After all students finished the questionnaire they got the opportunity to ask everything they wanted and the session was ended with a thank for the participation. The teacher will receive an e-mail with the questions and description of first level. After answering the questions the teacher was thanked for participation.

Data analysis. The qualitative questionnaires result in qualitative data, answers that describe the opinion and improvements of the students about the serious game. This data will be placed in a table per question. The feedback per question will be inductively coded by two independent assessors in order to increase the reliability of the interpretation. Inductive coding and inductive research use content for the development of a theory (Miller, 2013). This was done by reading the text and then combining the answers that mention the same. In case of differences in opinion the assessors discussed until agreement. In case of more answers for a respondent, every answer was coded independently. Then, for each question a general conclusion of the feedback or answers was written. This conclusion on its turn will be transformed into improvement statements (for each element), which again will be done by two assessors (to increase the reliability of this interpretation) and in case of disagreement this was discussed in order to come to agreement. In case of contradictory feedback, the feedback will be used in such a way that it will be made more easily to understand, because the serious game must be understandable for all students. The improvement statements will be used to adapt the prototype for the serious game in terms of attractiveness and suitability to the target group.

Results. The teacher mentioned that students can understand the content and can learn these self-regulated learning skills from the game. However, according to the teacher the training of planning skills is hard. "The game can be a good method to introduce planning skills, (…) but I do not know whether planning can be learned fully". In addition, the teacher stated "Anyway, it gives good handles and I belief that is important". The teacher also mentioned that the use of a serious game can hit the spot, since gaming interests the target group. An overview of the results of the formative evaluation with the students, including the questions of the students at the end of the formative evaluation session, information concerning the age and gender (Table 5), an overview of the (number of) answers per code of the students (with the respondent number behind the code), and answers concerning movement in the serious game (Table 6) can be found in Appendix F. The conclusion based on these codes can be found for each question in Table 7 in Appendix G. Based on these

conclusions, for each research category (motivation, appeal and learning) improvement statements were formulated.
To increase the appeal/fun of the serious game:

1. add bonus games, in which the SRL related assignments in the private life sphere
2. more problems, action and exciting things (e.g. money problems, broken phones) and working with other factories must be included
3. the name must be “De beste business boss”
4. selling better phones
5. include the option to choose background music and colors at the beginning of each level, and exciting music on exciting moments in the serious game
6. include the option to adapt the character of the player in the sense of colors, figures, ears/eyes/nose and clothes/accessories (such as a sunglasses)

To add games (as suggested) and problems (improvement statement 1, 2), a second storyline (the private story) is extended. In this second story line players must coordinate the renovation of the old house that was bought. This requires small assignment that include planning skills, such as the order of construction workers (e.g. when the plumber is finished, the kitchen deliverers). When one of the construction workers did not show up (short before an important deadline) players will be stimulated to learn and perform these jobs. This requires cognitive (learning) strategies to learn these performances from online texts. During the performance of these tasks, players will be motivate to monitor the own process in terms of time, progress and gaps in knowledge on what and how to perform these tasks (such as assembling a kitchen cabinet). After performing the jobs, players will be stimulated to reflect on the performed job.

However, students stated that (1) the inclusion of rewards at the end of each level, (2) a more realistic figure, and (3) the inclusion of communication and advice from other figures in the serious game would increase the appeal, these suggestions are not followed. The first two ideas are not followed, since both ideas are actually in the game, but not explained in the formative evaluation. The third idea is not included in the game, since a schematic design is chosen because instructional support increases learning more in a schematic design than a realistic design (Wouters & Van Oostendorp, 2013).

To increase the motivation to play the serious game:

7. increase more action (the same as improvement statement 2, see above)
8. include an agenda (in Feedbee)

According to the students, a 3D serious game would also increase the motivation to play. However, this ‘advice’ was ignored since a schematic design was chosen for this serious game (DR 14), because this contributed to learning.

To increase learning:

9. players must be supported and trained to think about the reason for choosing an option and possible other solutions for a specific problem during self-reflection
10. support players to write down what they think

The following ideas are not part of those categories, but also interesting:

1. Make both a laptop and tablet version of the serious game in which players can walk around by the use of a computer mice and swiping.
2. To increase the awareness of earned experience points (and the reason why this specific number of points is earned), this will pop up in the screen when points are received and it must be clickable in order to buy the next level
3. To make more clear what players will learn, this will be explained at the start of each level, this in order to manage expectations

Discussion

This study aimed to develop and evaluate a prototype for a serious game to train SRL skills. It was designed for Dutch sixth grade students. The focus on SRL skills was deliberated, as these skills are essential to prepare students for a changing (21st century) society (Onderwijsraad, 2014; SLO, 2017b). In addition they are related to being a successful learner as they contribute to the transition from primary to secondary education (Hendriks, 2013; Meusen-Beekman et al., 2015). A serious game was chosen as instructional method to train these needed SRL skills, since serious games are motivating and the training of (parts of) self-regulated learning skills requires motivational tasks, time and effort (Garris et al., 2002; Malone, 1981; SLO, 2017a; Veenman et al., 2006). For the development and analysis of the prototype of a serious game, the ADDIE model was used. This model consists of five phases: analysis, design, development, implementation, and evaluation (Allen, 2006). However, due to lack of resources the actual development and implementation of the serious game were skipped.

In the first phase, consisting of three sub-analyses, a literature study was performed on 1) the content of the training, namely SRL skills and the trainability of SRL in the target audience, 2) the target audience, 12 year olds, and 3) the instruction method (serious games) in order to answer the first research question concerning the design requirements for the development. These sub-analyses resulted in 22 design requirements (see Appendix A for these requirements) concerning the theoretical background of the training, the target group, characteristics of the serious game, and self-regulated learning (partly included under the characteristics of the serious game). The SRL analysis resulted in the conclusion that SRL in this serious game involves motivational, metacognitive, behavioral and cognitive strategies. The analysis of the target audience resulted in the conclusion that the background story is highly important for the target group. The last analysis on serious game characteristics resulted in nine design requirements, mainly focusing at the elements a serious game must consist of, additional support that must be added, a schematic design and the goals that forms the basis of the serious game. To increase the likelihood that the serious game increases SRL skills the findings of the review of Mayer (2014b) of serious game features that contribute to learning are included. These features are personalization, modality, coaching, self-explanation and pre-training. In addition learning will be supported by the inclusion of reflection, modeling, feedback and collaboration (and again modality and personalization), as suggested by the findings of Wouters and Van Oostendorp (2013). Collaboration was not included, because this serious game aimed to stimulate independent learning and give players the opportunity repeat a level when needed.

These design requirements were the input of the design phase, in which the serious game was described in terms of the training of SRL skills, theoretical background, the background story that forms the basis of the serious game (players grow in a smartphone factory from order-picker to boss), content (experience points, levels, information and communication in the serious game, rules, goals, guidance), the stimulation of motivation to play/learn, the design and aesthetics and audiovisual part of the serious game. These descriptions were used to make the storyboard, that exists of a description of the five levels of the serious game, for each level a description of the job players had to perform, the goals for the level (in terms of which SRL skills the learner trains) and ends with a description of the narrative including the assignments of that level. This will be combined with pictures of that level. This description is made visible in the prototype, consisting of pictures that show the highlights of each level to get an idea of how the serious game will look like. The development phase involves an instruction or lesson plan, that can be used by teachers who want to implement the serious game in their class.

During the design phase two evaluations were performed to answer research question two, three and four, concerning the improvement of motivation, appeal and learning of 11-13 year olds. Firstly, a small pre-formative evaluation during the design phase aiming to answer the question whether the target group liked the background story and theme of the SG. The four participants (11-13 year olds) reacted enthusiastic on the story and therefore the theme was used in the development of the levels. After developing the levels, the first level was used for a formative evaluation. To answer the fourth research question (concerning learning) a sixth grade teacher was asked to check whether students can learn from the serious game. The teacher mentioned that students could learn from the level, but also that planning skills are hard to train and will probably not fully trained with the serious game. The students (sixth grade) received a for this serious game developed questionnaire based on the SGDA Framework of Mitgutsch and Alvarado (2012) and the ARCS model of Keller (1987). These models were used for the serious game, since the design was (partly) based on the SGDA framework and the motivation to play was the main reason for choice for a serious game as instruction method. This resulted in a couple of improvement statements. To increase the motivation (research question 2) more action must and an agenda can be included. To increase the appeal (research question 3) the serious game will include a second story line concerning the private life, more problems (e.g. broken phones), the name “de beste business boss”, selling better phones, the choice for background music

and colors, and the possibility to adapt the character (e.g. accessories). To increase learning (research question 4) players must be supported in the argumentation for a decision and writing down and articulating what they think.

This study resulted in a prototype that can be further developed. But there are some limitations that must be taken into account for developers that will set this next step. Firstly, the restriction of only one teacher that evaluated the first level. Although several teachers were asked to participate in this study, only one teacher gave consent to perform. In order to solve this, it is recommended to include more teachers in the evaluation to get a more broad opinion on the training of SRL skills and the included assignments to do so. Secondly, the use of a written paper-prototype to perform the formative evaluation. Since the research time in the class was limited and technology (such as iPads) for each student was not available, the choice was made to use written instructions for the formative evaluation. This limited the possibility of testing whether the feedback that will be given can be understood and will be seen as effective. This is important, since feedback is included in order to support learning (Wouters & Van Oostendorp, 2013). Thirdly, the effectiveness of this serious game on the use of SRL skills is not tested. Since this study ends with a prototype due to a lack of resources, the effectiveness on the transfer of trained skills is not assessed. In order to do so, a cognitive consequence approach can be used (on the developed serious game). This approaches focuses on the question what people learned from serious games (Mayer, 2011 as cited in Wouters et al., 2013). In order to test whether students learned students from a serious game, the difference in SRL pre- and post the serious game will be tested (Mayer, 2014f). Several (mainly English) questionnaires exist to measure motivation and self-regulation in secondary education (Wij-leren, 2017). This study requires a (qualitative and validated) Dutch questionnaire aimed at primary school students. By using a questionnaire pre- and post the serious game, it will be clear to what extent the serious game can contribute to training SRL skills.

Besides limitations are there also some implications for practice and research. This study was the first step in the development of a serious game to train SRL skills. If this serious game will be developed it can be tested on its effectiveness. This can contribute to (scientific) knowledge on the use of serious games to train (SRL) skills. When the serious game is effective in the training of SRL skills, it can help teachers training students SRL skills. But also at home, the serious game can be used to prepare students for secondary education and the changing society. This requires a process of development, evaluating, adapting and again evaluating, before a serious game (that is able to train SRL) can actually be implemented. The design requirements that were formulated during this study were general in terms of serious game characteristics, but specified in terms of the target group (11-13 year old) and content (the training of SRL skills). These characteristics do not match the preferences of the target group in terms of design. The formative evaluation showed that the target group prefers a realistic design, whereas the research Wouters and Van Oostendorp (2013) suggested that an instructional support in a schematic designed serious game improved learning. This decreased interest in cartoons is typically for the target group, as described by Nikken (2016), see “Gaming and media use in 12 year olds”. This contradiction between learning support and preference of target group has not been solved yet. To take a decision on this, the consideration must be made between effectiveness of the serious game on one hand and the appeal with the design (of the target group) on the other. This types of decisions that involve a contradiction between effectiveness and appeal can be solved by a study that compares the content of the contradiction. In this case for example, a study can be performed with two conditions. Both conditions get the same game, but one condition plays the game with realistic figures, the other condition plays the game with basic/cartoonlike figures. Assuming that everything (except for the figures) is the same, the influence of the type of figure on SRL skill learning and motivation to play the serious game can be assessed.

References

Akhtar, M. (2008, 08 November). What is Self-Efficacy? Bandura's 4 Sources of Efficacy Beliefs [Weblog post] Retrieved from http://positivepsychology.org.uk/self-efficacy-definition-bandura-meaning/

Allen, W. C. (2006). Overview and Evolution of the ADDIE Training System. *Advances in Developing Human Resources, 8*(4), 430-441. doi:10.1177/1523422306292942

Balans Digitaal. (n.d.). Plannen en organiseren. Retrieved from https://www.balansdigitaal.nl/emotionele-ontwikkeling-kinderen-leer-en-gedragsproblemen/

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review, 84*(2), 191-215.

Bandura, A. (1994). Self-efficacy (Vol. 4, pp. 71-81). Encyclopedia of human behavior. Retrieved from https://www.uky.edu/~eushe2/Bandura/BanEncy.html.

Bentvelsen, Y., & Pijlman, R. (n.d.). Initiatief. Retrieved from http://www.carrieretijger.nl/functioneren/professionele-eigenschappen/initiatief

Berk, L. E. (2013a). Cognitive Development: An Information-Processing Perspective In L. E. Berk (Ed.), *Child Development* (Ninth ed., pp. 276-317). Boston: Pearson.

Berk, L. E. (2013b). Self and Social Understanding In L. E. Berk (Ed.), *Child Development* (Ninth ed., pp. 446-483). Boston: Pearson.

Bhat, A. (n.d.). Cluster sampling vs stratified sampling Retrieved from https://www.questionpro.com/blog/cluster-sampling-vs-stratified-sampling/

Boekaerts, M. (1999). Self-regulated learning: Where we are today. *International Journal of Educational Research, 31*(6), 445-457. doi:10.1016/S0883-0355(99)00014-2

Bureau Avant Huiswerkbegeleiding. (n.d.). Huiswerkbegeleiding Retrieved from http://www.bureau-avant-huiswerkbegeleiding.nl/producten.html

Childress, M. D., & Braswell, R. (2006). Using massively multiplayer online role-playing games for online learning. *Distance Education, 27*(2), 187-196. doi:10.1080/01587910600789522

concentration. (2018). *Merriam-Webster.com,* Retrieved from https://www.merriam-webster.com/dictionary/concentration

CSG Augustinus. (n.d.). Huiswerkbegeleiding. Retrieved from http://www.csgaugustinus.nl/op-school/augustinus-leerlingen/huiswerkbegeleiding/

De Praktijk 4 Kids. (n.d.). LEFT - Leer je Executieve Functies Trainen Retrieved from https://www.depraktijk4kids.nl/left-leer-je-executieve-functies-trainen/

De Stimulans. (n.d.). Concentratietraining is verweven met de geheugentraining Retrieved from http://www.destimulans.nl/concentratietraining.html

De Vos - van der Hoeven, T. (2010). Concentreren, soms heel lastig. Retrieved from http://www.opvoedadvies.nl/concentratie.htm

De Vos - van der Hoeven, T. (2012). Leren doorzetten. Retrieved from http://www.opvoedadvies.nl/doorzetten.htm

Definition of cartoon. (2018). *Merriam-Webster.com* Retrieved from https://www.merriam-webster.com/dictionary/cartoon

Department of the air force. (1993). *AF Manuaal 36-2234: Instructional System Development* Retrieved from http://www.au.af.mil/au/awc/awcgate/edref/afman36-2234.pdf

Desoete, A. (2008). Multi-method assessment of metacognitive skills in elementary school children: how you test is what you get. *Metacognition Learning, 3*(3), 189-206. doi:10.1007/s11409-008-9026-0

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). *From game design elements to gamefulness: defining gamification.* Paper presented at the Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments, Tampere, Finland.

Dick, W., & Johnson, R. (2002). Evaluation in instructional design: The impact of Kirkpatrick's four-level model. In R. A. Reiser & J. V. Dempsey (Eds.), Trends and issues in instructional design and technology (pp. 145-153). Upper Saddle River, NJ: Pearson Prentice Hall. Retrieved from http://jhollenbeck.com/courses/hrd480/pdf/handouts/06b_dick_eval.pdf.

Dignath, C., Buettner, G., & Langfeldt, H.-P. (2008). How can primary school students learn self-regulated learning strategies most effectively?: A meta-analysis on self-regulation training programmes. *Educational Research Review, 3*(2), 101-129. doi:10.1016/j.edurev.2008.02.003

Dinsmore, D. L., Alexander, P. A., & Loughlin, S. M. (2008). Focusing the conceptual lens on metacognition, self-regulation, and self-regulated learning. *Educational Psychology Review, 20*(4), 391-409. doi:10.1007/s10648-008-9083-6

Dondlinger, M. J. (2007). Educational video game design: A review of the literature. *Journal of applied educational technology, 4*(1), 21-31.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological review, 95*(2), 256-273.

Enschede geeft 4,5 ton voor huiswerkbegeleiding arme kinderen. (2016). *Twentse Courant Tubantia* Retrieved from https://www.tubantia.nl/nieuws/audio-enschede-geeft-4-5-ton-voor-huiswerkbegeleiding-arme-kinderen~abfdedd1/

European Commission. (2002). *European report on quality indicators of lifelong learning* Retrieved from http://www.aic.lv/bolona/Bologna/contrib/EU/report_qual%20LLL.pdf

Fernandez-Duque, D., Baird, J. A., & Posner, M. I. (2000). Executive attention and metacognitive regulation. *Consciousness and cognition, 9*(2), 288-307. doi:10.1006/ccog.2000.0447

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & gaming, 33*(4), 441-467. doi:10.1177/1046878102238607

Goswami, U., & Bryant, P. (2007). 6. METACOGNITION AND EXECUTIVE FUNCTION. In U. Goswami & P. Bryant (Eds.), Children's cognitive development and learning. Retrieved from https://www.cne.psychol.cam.ac.uk/pdfs/publication-pdfs/Primary_Review_2-1a_report_CogDevLearn_Goswami-Bryant_2007.pdf.

Greven, J., & Letschert, J. (2006). *Kerndoelenboekje* Retrieved from http://www.slo.nl/primair/kerndoelen/Kerndoelenboekje.pdf/

Harvey, P., & Martinko, M. J. (2009). Attribution theory and motivation. *Organizational behavior, theory and design in health care*, 143-158.

Hendriks, M. (2013). *Doelgericht Leren binnen het Basisonderwijs. Een onderzoek naar de effecten van doelgericht leren op het gebruik van de zelfregulerende vaardigheden en de leerresultaten van leerlingen uit groep 7 en 8 van het basisonderwijs binnen het vakgebied rekenen.* (Unpublished master's thesis). Retrieved from https://dspace.ou.nl/bitstream/1820/4958/1/OWMHendriks-21052013.pdf.

Hense, J., & Mandl, H. (2012). Learning in or with games? Quality criteria for digital learning games from the perspectives of learning, emotion, and motivation theory. In J. M. S. D.G. Sampson, D. Ifenthaler & P. Isaias (Ed.), *Proceedings of the IADIS International Conference on Cognition and Exploratory Learning in the Digital Age* (pp. 19-26). Madrid, Spain: IADIS.

Holden, J. T. (2015). *An Introduction to the ADDIE Instructional Systems Design Model [PDF file]*. Retrieved from http://www.fgdla.us/uploads/White_Paper--Introduction_to_the_ADDIE_ISD_Model.pdf

Hornstra, L., van der Veen, I., Peetsma, T., & Volman, M. (2013). Developments in motivation and achievement during primary school: A longitudinal study on group-specific differences. *Learning and Individual Differences, 23*, 195-204. doi:10.1016/j.lindif.2012.09.004

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). *MDA: A formal approach to game design and game research.* Paper presented at the Proceedings of the AAAI Workshop on Challenges in Game AI.

Inspectie van het Onderwijs. (2007). *Aansluiting voortgezet onderwijs op het basisonderwijs* Retrieved from https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/kamerstukken/2007/05/15/bijlage-aansluiting-van-het-voortgezet-onderwijs-op-het-basisonderwijs/16196d.pdf

Inspectie van het Onderwijs. (2017). Staat van het onderwijs: onderwijsverslag 2015/2016. Retrieved from https://www.onderwijsinspectie.nl/documenten/rapporten/2017/04/12/staat-van-het-onderwijs-2015-2016.

Kallinen, K., Salminen, M., Ravaja, N., Kedzior, R., & Sääksjärvi, M. (2007). Presence and emotion in computer game players during 1st person vs. 3rd person playing view: Evidence from self-report, eye-tracking, and facial muscle activity data. *Proceedings of the PRESENCE*, 187-190.

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of instructional development, 10*(3), 2-10.

Kennispunt Twente. (n.d.). Aantal inowners gemeente Enschede naar wijk in 2017. Retrieved from http://www.kennispunttwente.nl/cijfers-trends/cijfers-trends-enschede/106-inwoners-enschede/217-4-inwoners-enschede

Kickmeier-Rust, M. D., & Albert, D. (2012). *A domain model for smart 21st century skills training in game-based virtual worlds.* Paper presented at the IEEE 12th International Conference on Advanced Learning Technologies (ICALT), Rome, Italy.

Kolb, D. A. (1984). The process of experiential learning In D. A. Kolb (Ed.), *Experiential learning: Experience as the source of learning and development* (pp. 20-38).

Laamarti, F., Eid, M., & El Saddik, A. (2014). An overview of serious games. *International Journal of Computer Games Technology, 2014*, 15. doi:10.1155/2014/358152

Leemkuil, H., & De Jong, T. (2012). Adaptive advice in learning with a computer-based knowledge management simulation game. *Academy of Management Learning & Education, 11*(4), 653-665. doi:10.5465/amle.2010.0141

Legault, N. (n.d.). An Introduction to the ADDIE Model for Instructional Designers. Retrieved from https://community.articulate.com/articles/an-introduction-to-the-addie-model-for-instructional-designers

Lim, S., & Reeves, B. (2009). Being in the game: Effects of avatar choice and point of view on psychophysiological responses during play. *Media Psychology, 12*(4), 348-370. doi: 10.1080/15213260903287242

Lindley, C. A. (2004). Narrative, game play, and alternative time structures for virtual environments. In S. Göbel, U. Spierling, A. Hoffmann, I. Iurgel, O. Scheider, J. Dechau, & A. Feix (Eds.), *Technologies for Interactive Digital Storytelling and Entertainment* (Vol. 3105, pp. 183-194). Heidelberg: Springer Berling.

Lucas, K., & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. *Communication research, 31*(5), 499-523. doi:10.1177/0093650204267930

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive science, 5*(4), 333-369. doi:10.1207/s15516709cog0504_2

Mayer, R. E. (2014a). Theory: applying cognitive science to games for learning In R. E. Mayer (Ed.), Computer games for learning: an evidence-based approach [Kobo e-book]

Mayer, R. E. (2014b). Value-added approach: which features improve a game's effectiveness? . In R. E. Mayer (Ed.), Computer games for learning: an evidence-based approach [Kobo e-book].

Mayer, R. E. (2014f). Preface. In R. E. Mayer (Ed.), Computer games for learning: an evidence-based approach [Kobo e-book].

McCarty, P. A. (1986). Effects of feedback on the self-confidence of men and women. *Academy of Management Journal, 29*(4), 840-847. doi:10.2307/255950

Meusen-Beekman, K. D., Joosten-ten Brinke, D., & Boshuizen, H. P. (2015). Developing young adolescents' self-regulation by means of formative assessment: A theoretical perspective. *Cogent Education, 2*(1), 1071233. doi:10.1080/2331186X.2015.1071233

Michael, D., & Chen, S. (2006). *Serious games: games that educate, train and inform* Retrieved from http://www.politicalavenue.com/108642/GAME-DESIGN-BOOK-COLLECTION/Thomson%20Publishing%20-%20Serious%20Games.%20Games%20that%20Educate,%20Train%20and%20Inform.pdf

Miller, R. P. (2013). Inductive Coding. Retrieved from http://rosspmiller.weebly.com/inductive-coding.html

Mitgutsch, K., & Alvarado, N. (2012). *Purposeful by design?: a serious game design assessment framework.* Paper presented at the Proceedings of the International Conference on the foundations of digital games (FDG '12), North Carolina: Raleigh.

Nederlands Jeugdinstituut. (n.d. a). *Factsheet Mediagebruik 9- tot en met 12-jarigen [PDF file]*

Nederlands Jeugdinstituut. (n.d. b). Over het Nederlands Jeugdinstituut. Retrieved from https://www.nji.nl/nl/Over-het-Nederlands-Jeugdinstituut/Werkwijze

Nikken, P. (2016). Ontwikkelingskenmerken 10-12 jaar Retrieved from https://www.mediaopvoeding.nl/leeftijdsgroepen/10-12-jaar/

Onderwijsraad. (2011). *Maatschappelijke achterstanden van de toekomst* Retrieved from https://www.onderwijsraad.nl/upload/documents/publicaties/volledig/maatschappelijke-achterstanden-van-de-toekomst.pdf

Onderwijsraad. (2014). *Een eigentijds curriculum* Retrieved from https://www.onderwijsraad.nl/upload/documents/publicaties/volledig/Een-eigentijds-curriculum-1.7.pdf

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning [PDF]Handbook of self-regulation (pp. 451-502). doi:10.1016/B978-012109890-2/50043-3

Poort, A. (2017). *The Development of Guidelines to Design Collaborative Serious Games for a New Educational Game Platform.* (Master's thesis). Retrieved from http://essay.utwente.nl/74230/1/Poort_MA_BMS.pdf

Prensky, M. (2001). Fun, play and games: What makes games engagingDigital game-based learning (pp. 105-144). New York: McGraw-Hill.

Renkl, A. (2014). Chapter 16. The Worked Examples Principle in Multimedia Learning. In R. E. Mayer (Ed.), *The Cambridge handbook of Multimedia Learning* (Second ed., pp. 391-412). Cambridge: Cambridge University Press.

Richards, D., Fassbender, E., Bilgin, A., & Thompson, W. F. (2008). An investigation of the role of background music in IVWs for learning. *ALT-J, 16*(3), 231-244. doi:10.1080/09687760802526715

Romero, M., Usart, M., & Ott, M. (2015). Can serious games contribute to developing and sustaining 21st century skills? *Games and Culture, 10*(2), 148-177. doi:10.1177/1555412014548919

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist, 55*(1), 68-78. doi:10.1037110003-066X.55.1.68

Santrock, J. W. (2011). Chapter 7: Behavioral and social cognitive approaches *Educational Psychology* (Fifth ed.). New York: McGraw-Hill

Schell, J. (2008). Chapter four: the game consists of elements In J. Schell (Ed.), The Art of Game Design: A Book of Lenses Retrieved from http://www.uhma.net/gd.htm#LinkTarget_10705.

Schunk, D. H. (1990). Goal setting and self-efficacy during self-regulated learning. *Educational psychologist, 25*(1), 71-86.

Simons, P. (1994). 5 Leren leren: naar een nieuwe didactische aanpak. In P. Simons & J. Zuylen (Eds.), *Handboek huiswerkdidactiek en geïntegreerd studievaardigheidsonderwijs* (pp. 46-59).

SLO. (2017a, 22 November). Een voorbeeldmatig leerplankader zelfregulering. Retrieved from http://curriculumvandetoekomst.slo.nl/21e-eeuwse-vaardigheden/zelfregulerend-vermogen/voorbeeldmatig-leerplankader

SLO. (2017b, 22 November). Zelfregulering. Retrieved from http://curriculumvandetoekomst.slo.nl/21e-eeuwse-vaardigheden/zelfregulerend-vermogen

SLO. (n.d.). *Levensfase 10-12 jaar, groep 7-8 [PDF]* Retrieved from http://downloads.slo.nl/Documenten/Groep%207-8%20download.pdf

Smith, P. L., & Ragan, T. J. (2005a). Chapter 1. Introduction to Instructional Design In P. L. Smith & T. J. Ragan (Eds.), *Instructional Design* (Third ed., pp. 3-16). Hoboken, N.J.: John Wiley & Sons.

Smith, P. L., & Ragan, T. J. (2005b). Chapter 2. Foundations of instructional design. In P. L. Smith & T. J. Ragan (Eds.), *Instructional Design* (Third ed., pp. 17-37). Hoboken, N.J.: John Wiley & Sons.

Smith, P. L., & Ragan, T. J. (2005d). Chapter 13. Strategies for cognitive strategy instruction In P. L. Smith & T. J. Ragan (Eds.), *Instructional Design* (Third ed., pp. 243-258). Hoboken, N.J.: John Wiley & Sons.

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in cognitive sciences, 9*(2), 69-74. doi:10.1016/j.tics.2004.12.005

The Collorado Education Initiative. (2014). Grades 6-8 Goal Setting Retrieved from http://www.coloradoedinitiative.org/wp-content/uploads/2014/10/GS-6-8-model.pdf

Thijs, A. M., Fisser, P. H. G., & van der Hoeven, M. (2014). *21e eeuwse vaardigheden in het curriculum van het funderend onderwijs*. Enschede: SLO.

Tzetzis, G., Votsis, E., & Kourtessis, T. (2008). The effect of different corrective feedback methods on the outcome and self confidence of young athletes. *Journal of sports science and medicine, 7*(3), 371-378.

van der Meij, H., & van der Meij, J. (2014). A comparison of paper-based and video tutorials for software learning. *Computers & Education, 78*, 150-159. doi:10.1016/j.compedu.2014.06.003

Veenman, M. V. J., Van Hout-Wolters, B. H., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and learning, 1*(1), 3-14. doi:10.1007/s11409-006-6893-0

Virtuwijs. (n.d.). Online huiswerkbegeleiding. Retrieved from https://virtuwijs.nl/diensten/online-huiswerkbegeleiding/

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. doi:10.2190/FLHV-K4WA-WPVQ-H0YM

Weil, L. G., Fleming, S. M., Dumontheil, I., Kilford, E. J., Weil, R. S., Rees, G., . . . Blakemore, S.-J. (2013). The development of metacognitive ability in adolescence. *Consciousness and cognition, 22*(1), 264-271. doi:10.1016/j.concog.2013.01.004

Weiner, B. (2000). Intrapersonal and interpersonal theories of motivation from an attributional perspective. *Educational psychology review, 12*(1), 1-14.

Weinstein, C. E., & Mayer, R. E. (1983). The Teaching of Learning Strategies. *Innovation abstracts, 5*(32), n32.

Wij-leren. (2017). Is er een meetinstrument om doelen als zelfregulering en motivatie te meten? Retrieved from https://wij-leren.nl/meetinstrument-gepersonaliseerd-leren.php

Wijzer over de basisschool. (n.d.). Begrijpend lezen oefenen Retrieved from https://wijzeroverdebasisschool.nl/kennisbank-rekenen/begrijpend-lezen/

Wouda, J. (2017, 27 November). Tips om je kind te helpen met concentreren Retrieved from https://www.heutinkvoorthuis.nl/nl/tips-om-je-kind-te-helpen-met-concentreren/news/168/

Wouters, P., Van der Spek, E. D., & Van Oostendorp, H. (2009). Current practices in serious game research: A review from a learning outcomes perspective. In T. Connolly, M. Stansfield, & L. Boyle (Eds.), *Games-based learning advancements for multi-sensory human computer interfaces: techniques and effective practices* (pp. 232-250).

Wouters, P., Van Nimwegen, C., Van Oostendorp, H., & Van Der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of educational psychology, 105*(2), 249-265. doi:10.1037/a0031311

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. doi:10.1016/j.compedu.2012.07.018

Wu, W. H., Hsiao, H. C., Wu, P. L., Lin, C. H., & Huang, S. H. (2012). Investigating the learning-theory foundations of game-based learning: a meta-analysis. *Journal of Computer Assisted Learning, 28*(3), 265-279. doi:10.1111/j.1365-2729.2011.00437.x

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary educational psychology, 11*(4), 307-313. doi:10.1016/0361-476X(86)90027-5

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of educational psychology, 81*(3), 329-339.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational psychologist, 25*(1), 3-17. doi:10.1207/s15326985ep2501_2

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into practice, 41*(2), 64-70. doi:10.1207/s15430421tip4102_2

Zimmerman, B. J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American educational research journal, 45*(1), 166-183. doi:10.3102/000283120 7312909

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American educational research journal, 29*(3), 663-676.

Zyda, M. (2005). From visual simulation to virtual reality to games. *IEEE computer, 38*(9), 25-32.

Appendix A

Design Requirements

Theoretical background

1. The serious game is based on the social-cognitive theory of SRL training (DR V), existing of behavioral processes, environmental processes and personal processes (Zimmerman, 1989).

Target group

2. The serious game supports students in applying SRL knowledge on the use of these SRL skills (DR XI), which suits the developmental of 12 year olds, which implies support
3. The serious game challenges the player, which fits the preferences of an average 12 year old (DR XIII, DR VIIIe) by involving problems that must be solved (DR XVg)

Serious game characteristics and elements

4. The serious game is a mental contest (DR XIV)
5. The serious game includes an interesting learning experience (DR VIIIe, XVI)
6. The serious game is competitive (DR XIV)
7. The serious game is based on clear rules and mechanics (performable actions) (DR XIV, XVb)
8. The serious game is goal-directed (DR XIV) and based on goals (besides winning the game) (DR XVa), requiring higher order thinking skills such as decision making or creative problem solving (DR XVI)
    a. The serious game involves multiple goals that are clear and can be achieved by the execution of particular actions (DR XXI)
    b. The serious game involves sub-goals (steps towards the goals) (DR XXI)
    c. The serious game involves the opportunity for the player to repeat a task when a better solution can be performed, which will be triggered (DR XXI)
    d. The task complexity is adaptable in order to improve and/or acquire skills (DR XXI)
9. The serious game includes interaction with other players (DR XVf)
10. The serious game involves an underlying story that involves characters/avatars, a scenario and narrative context that promotes fantasy, curiosity and challenge (DR XVc, XVI).
11. The serious game involves rewards (XVI)
12. The serious game will be added with at least one of the following additional support forms:
    a. Collaboration (DR VII, XVIII)
    b. feedback and guidance (DR XVIII, XVI) as reaction to what the player did (DR XVd)
        i. The serious game involves feedback that provides hints in the direction of the solution and correct performance (DR XX)
        ii. The feedback involves showing the score composition and score range during the game (DR XX)
        iii. Data out of the game will be used for monitoring and as feedback (DR XX)
    c. modality (DR XVII, XVIII)
    d. modeling, scaffolding (gradually decreasing guidance) and worked examples (DR VIIIf, XVIII, IXb, Xa,d) which involves the verbalization of SRL skills (DR VIIIb)
    e. personalization of (by the player chosen) characters, topics, ideas and messages (DR XVII, XXII)
    f. reflection, assignments (prompts to investigate variable relations), elaboration and self-explanation (DR XVII, XVIII)
13. The serious game involves coaching (DR XVII)
14. The serious game is based on aesthetics, an idea behind the audiovisual part of the game (DR XVe) and has a schematic design (DR XIX)
15. The serious game involves a match of actions and theme in and of the environment to the goals (DR XXII)
16. The serious game is motivational (DR XII) by the inclusion of the attribution theory, an orientation on the goal, choices, internal rewards, support and movement (DR XVI)
17. The serious game involves pre-training in order to support learning (DR XVII)

Self-regulated learning training

18. The serious game involves a ‘trainer/teacher’ that is an external monitor of chosen learning activities (DR Xc) and stimulator of positive self-evaluations (DR Xe) in order to train motivational strategies
19. The serious game combines learning strategies with SRL skills (DR VIIIa)
20. The serious game provides information (DR XVh), hints about how SRL skills can help (DR VIIId)
21. The serious game involves cognitive (learning) strategies that will be trained by (guided) discovery, guided participation, prepackaged strategy instructions, direct explanations, dyad instruction and self-instruction training (DR IXa-g)
22. The serious game involves a ‘trainer/teacher’ that stimulates active learning by focusing on metacognitive skills (DR Xb)

Appendix B

Questionnaire (in Dutch) for the Formative Evaluation

Over jou…

1. Ik ben…. een meisje / een jongen (omcirkel het goede antwoord)
2. Ik ben…. …….. jaar oud (vul in)

Achtergrond verhaal

Dit verhaal heb je net gehoord (je mag het nog eens lezen als je wilt)

In het computer spel werk je in een kleine telefoonfabriek. Je start met het inpakken van dozen met spullen die de klanten online hebben besteld (orderpicker). De fabriek groeit en jij mag de baas gaan helpen door zijn agenda bij te houden en zijn mails te beantwoorden. Dan krijgt een andere fabriek in Nederland problemen en meer klanten willen de telefoons van jouw fabriek. Daarom zijn er meer mensen nodig in jouw fabriek en je moet deze mensen gaan aannemen. De fabriek wordt steeds groter en jij mag de planning voor de spullen die naar het buitenland gaan doen. Maar opeens kunnen er geen telefoons meer naar Frankrijk en zo zitten jullie met veel te veel telefoons. Ondertussen heeft iemand in de fabriek telefoons gestolen. Dan krijg jij de vraag of jij de baas wilt opvolgen. En zo ga jij leren om de baas van de fabriek te worden. Uiteindelijk wordt jij de baas. En dan als alles beter gaat dan ooit te voren, komen er meerdere mensen die voor veel geld de fabriek willen kopen. Jij praat met alle mensen en komt tot de conclusie dat….

1. Wat vind je leuk aan het verhaal van het spel?

   ……

   ……

   ……

2. Wat kan ik veranderen om het spel leuker/ interessanter te maken?

   ……

   ……

   ……

Ervaringspunten

Tijdens het spel kun je punten verdienen door doelen te behalen. Het aantal behaalde punten kun je terugvinden in je ‘punten portemonnee’. Deze punten zijn nodig om naar het volgende level te kunnen of spulletjes in het spel te kopen. Door op de punten portemonnee te klikken kun je zien hoe je deze punten hebt verdient.

3. Wanneer zou jij op de portemonnee klikken?

   ……

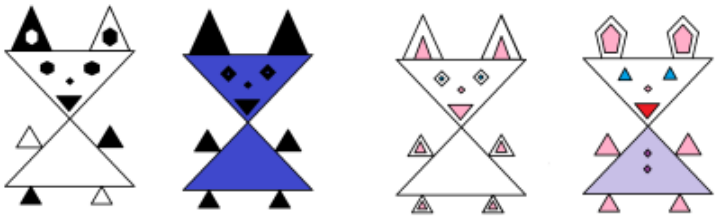
   ……

   ……

Jouw figuurtje in het spel

Aan het begin van het spel kun je kiezen hoe jij eruit ziet

4. Welke figuur zou jij kiezen? (omcirkel jouw keuze)



5. Wat zou jij willen veranderen aan jouw gekozen figuurtje?

   ……

   ……

   ……

Over het spel

6. Het spel heet “Becoming the business boss”, dat betekent “de baas van het bedrijf worden”. Hoe zou jij het spel in het Nederlands noemen?

   ……

   ……

7. Hoe zou jij in het spel willen bewegen (rondlopen/rondkijken)?

   0 Muis

   0 Toetsenbord pijlen

   0 Met de vinger over het scherm gaan

Eerste level van het spel

Je wekker gaat en je gaat voor het eerst werken bij een nieuw smartphone bedrijf. Je krijgt een korte video te zien van je nieuwe baas die het achtergrond verhaal vertelt. Daarna kies je jouw figuurtje en een naam. Hiermee verdien je je eerste ervaringspunten, deze punten heb je nodig om naar het volgende level te gaan. Dan krijg je je eerste opdracht: bereid jezelf voor op je eerste werkdag. Wat heb je nodig? Hoe ga je met de bus naar je werk? Als je op je werk bent, heb je een gesprek met je baas en een collega die hetzelfde werk doet als jij.

Die collega (mevrouw Tonki) laat jou zien wat je moet doen. Ze print de lijst met spullen die jij moet verzamelen uit en laat zien hoe je die verzamelt. Daarna ga je beginnen met het pakken van de spullen. Een van de dozen staat te hoog, hoe ga je dat oplossen? Als je een oplossing hebt bedacht, komt de baas met een paar vragen... In de pauze begint een andere collega (meneer Kito) over zijn schooltijd en hoe hij de vaardigheid plannen gebruikte (zie vraag 16).

8. Wat vind je leuk aan het eerste level?

   ……
   ……
   ……

9. Wat kan ik veranderen om het eerste level leuker/ interessanter te maken?

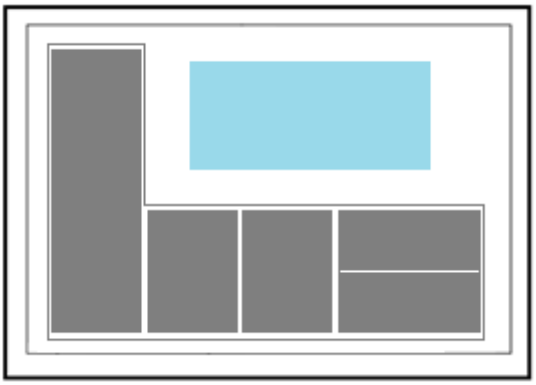
   ……
   ……
   ……

10. Wat denk jij dat jij in het eerste level gaat leren?

    ……
    ……
    ……

Voorbereiden op werkdag

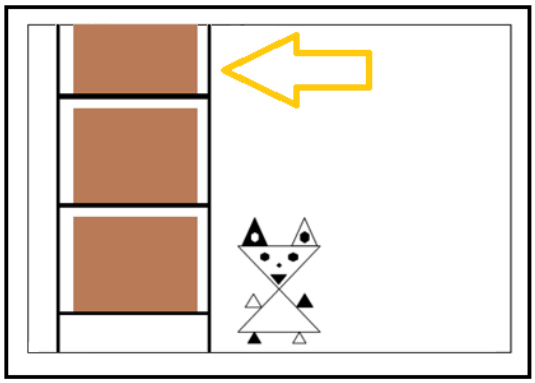
Je staat in de keuken en moet je voorbereiden op de werkdag.



11. Wat moet je meenemen naar je werk?

    ……
    ……
    ……
    ……
    ……

Je hebt een oplossing bedacht voor de te hoge doos.



12. Welke oplossing heb je bedacht?

    ……
    ……
    ……
    ……
    ……

13. Waarom heb je deze oplossing gekozen?

    ……

    ……

    ……

14. Welke andere mogelijkheden (of oplossingen) kun je nog meer bedenken?

    ……

    ……

    ……

15. Wat vond je moeilijk aan de vragen 11 tot en met 13 ?

    ……

    ……

    ……

Je praat met meneer Kito over plannen.

Meneer Kito vertelt: "Ik was 12 toen we naar Nederland verhuisden. Ik wilde graag Nederlands leren, maar moest ook nog naar school, huiswerk maken, voetballen met mijn tweelingbroer en speelde piano. Daarom moest ik goed kijken naar mijn tijdsverdeling. In het begin vond ik het moeilijk om alles op een dag te kunnen doen en was ik bezig met voetballen waardoor ik geen tijd meer had voor mijn huiswerk. Na een tijdje kreeg ik van school een agenda en legden ze uit dat ik daarin bij moest houden wat ik moest doen en hoe lang dat duurde. Ze zeiden dat plannen belangrijk was. Na een paar weken merkte ik dat ik daardoor mijn huiswerk en Nederlands huiswerk kon doen en ook nog kon voetballen en piano spelen".

16. Wat zegt meneer Kito over het gebruik van plannen en agenda gebruik? Leg het uit in je eigen woorden.

    ……

    ……

    ……

17. Hoe moeilijk is dit verhaal? Wat maakt het moeilijk?

    ……

    ……

    ……

Ordenen

De spullen die het magazijn binnenkomen zitten allemaal door elkaar. Jij moet de spullen die bij elkaar horen verzamelen.

18. Hoe ga je dat doen? (leg uit)

    ……

    ……

    ……

Motivatie om te spelen

19. Wat maakt jou enthousiast om het spel te spelen?

    ……

    ……

    ……

20. Wat kan ik veranderen om jou nog enthousiaster te maken om het spel te spelen?

    ……

    ……

    ……

Ontwerp

21. Welke kleuren moet de achtergrond hebben?

    ……

    ……

    ……

22. Welke muziek zou jij op de achtergrond willen hebben?

    ……

    ……

    ……

Appendix C

Prototype

Deliberately removed, please contact the author for the prototype via k.tonis2018@gmail.com

Appendix D

Lesson Plan

The lesson plan below can be found below in Figure 44. This lesson plan is an adapted form of the example that was published on the Blackboard page of the University of Twente. This lesson plan is written in Dutch, because it is aimed for Dutch sixth grade primary student teachers.

Doelgroep	Groep 8 leerlingen (11-13 jaar)
Titel van de les	Een serious game om zelfregulerend leren strategieën te trainen
Vak:	Interdisciplinair
DOEL EN GEBRUIK	
Doel:	De training van zelfregulerend leren strategieën, waaronder: ✖ metacognitieve strategieën (reflecteren, plannen en monitoreren van het leerproces) ✖ motivatie strategieën ✖ strategische strategieën (leeromgeving keuze) ✖ cognitieve (leer) strategieën (zoals samenvatten) Elk (van de vijf) levels richt zich op delen van dit doel.
Nut van de training:	Zelfregulerend leren is nodig in het middelbaar onderwijs en de 21ste eeuw die veel veranderingen met zich mee brengt.
Methode & rol docent:	De leerlingen kunnen zelfstandig aan de slag met de serious game om zelfregulerend leren strategieën te verbeteren, daardoor is de docent slechts een ondersteuner bij technische problemen.
Timing:	De serious game bestaat uit 5 levels, die elk tussen de 30 en 45 minuten kosten.
VOORBEREIDING EN BENODIGDHEDEN	
Materialen:	Voor het spelen van de serious game heeft iedere leerling een computer of tablet nodig.
Voorbereiding:	✖ Installeren van de serious game op de tablets of computer. ✖ Korte introductie geven over zelfregulerend leren en het nut van deze vaardigheden (duur: 5 minuten, zie bijlage A voor deze informatie).
TIJDENS HET SPELEN	
Aanvullend materiaal:	Niet nodig voor de serious game
Rol van de docent:	De serious game kan worden gespeeld zonder assistentie van de docent tijdens het spelen. De docent kan door rond te lopen in de klas kijken of er leerlingen zijn die problemen met het systeem ondervinden of anderszins uitleg nodig hebben. Indien leerlingen vragen naar oplossingen voor problemen die leerlingen tegenkomen in het spel stimuleert de docent de leerling om zelf een oplossing te bedenken voor het probleem.
NA HET SPELEN VAN EEN LEVEL	
Rol van de docent:	Wanneer een level afgerond is kan de docent de leerlingen stimuleren om na te denken over het opnieuw spelen van een level of werkdag wanneer de leerling denkt dat hij/zij het beter kan doen.
BIJLAGEN	
A. Uitleg over zelfregulerend leren	Zelfregulerend leren is een vaardigheid die je al regelmatig hebt gebruikt, in bijvoorbeeld … [noem een voorbeeld die op de leerlingen van toepassing is, bijvoorbeeld zelfstandig een spreekbeurt maken]. Hierbij kun je reflecteren op wat je hebt gedaan, kun je problemen oplossen, je aandacht richten op de taak, maar ook op een rustige

	plek zitten of bijvoorbeeld samenvatten om dingen te leren (SLO, 2017a). Zelfregulerend leren betekent dus dat je zelfstandig iets kunt leren. Dit kan huiswerk op de middelbare school zijn, maar ook later in je werk. Als je bijvoorbeeld een nieuw programma op je werk moet gaan gebruiken dan kun je zelfstandig opzoek gaan naar hoe je hiermee kunt werken. In het computer spel dat jullie gaan spelen, zullen al deze dingen terug komen. Daarmee oefenen jullie het zelfstandig leren dat jullie het aankomende jaar op de middelbare school nodig hebben.

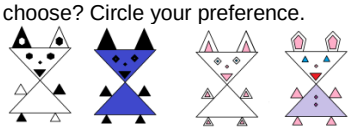
Figure 45. Lesson plan. Adapted from the Blackboard page of the University of Twente. Retrieved May 02, 2018 from blackboard.utwente.nl.

Appendix E

Conceptualization of the SGDA Framework and ARCS Model

Table 3.

Conceptualization of the six elements of the SGDA framework

Element of the SGDA framework	Meaning of the element (Mitgutsch & Alvarado, 2012)*	Application of the element in the SG	Question
1. Purpose	A specific purpose that underlies the game	The assignments	[Assignment description] 1.1.1 How will you perform this assignment? Write down the steps you take to perform this assignment. 1.1.2 How would you rate the difficulty of the assignment?
2. Content and information	All (for players) approachable and visible words and data	Given information about the SRL skills	[A conversation with a colleague about the application of SRL skills in real life] 2.1.1 What is meant by this instruction? Write down in your own words. 2.1.2 How would you rate the difficulty of the text?
3. Framing	The framing of the other five elements in terms of the (broader) game topic, target group and play literacy of the target group	Serious game topic (combined with (6), the background story)	[see 5. Background story]
4. Mechanics	The actions players can perform in the game, such as trick-taking, betting and shuffling for card games (Hunicke et al., 2004)	Performable actions	[Instruction of performable actions] 4.1.1 How would you move the player in the serious game? [instruction on experience points] 4.1.2 When would you click on the point wallet?
5. Graphics and aesthetics	The audiovisual language of the game (e.g. used imagery, artistic media or aesthetic characteristics)	5.1 Colors 5.2 Background music	5.1.1 Which colors must the background in the serious game have? 5.2.1 Which music (song/sound) would you prefer in the background?
6. Fiction and narrative	The fictional context (scenario, narrative, setting, story, characters, problem and back story) (Charsky, 2010 as cited in Mitgutsch & Alvarado, 2012)	6.1 Narrative	[Background story] 6.1.1 What do you like about the background story? 6.1.2 What can I change to make the story nicer/more fun? [First level] 6.1.1 What do you like about the first level? 6.1.2 What can I change to make the first level nicer/more fun? 6.1.3 What do you think you will learn from this first level?
		6.2 Figures	6.2.1 Which of the figures below would you choose? Circle your preference.  6.2.2 What would you adapt to your chosen figure when you could?

Note. The words between the brackets (e.g. 'assignment description') mean that this instruction is fully described in words and (if relevant) he corresponding images added.
* = When another source is used, this (exception) is mentioned behind

Table 4.

Conceptualization of the ARCS model of Keller (1987)

Element of the ARCS	Included strategy	Question*
7. Attention	7.1.Participation (A6.1)	7.1.1What makes that you feel enthusiastic to play the game? 7.1.2What could increase your enthusiasm to play the game?
	7.2. Activities that require problem-solving (A5.2)	See question about the assignment
	7.3. Variation in instruction format (A3.2)	*Not asked [is included]*
	7.4. Examples of strategies (A2.2)	*[level 2] not asked*
	7.5. Content-related anecdotes (A2.3)	See question about conversation
8. Relevance	8.1. Stimulating interest (R 1.3)	See question about the interest in the narrative and topic
	8.2. Relate to existing skills (R 1.1)	*Not asked, too abstract*
	8.3. Presenting the value for the future (R 3.1)	*Described but not asked*
	8.4. Inclusion of a model that is enthusiastic (R 5.3)	*Not asked, in printed version not possible*
	8.5. Inclusion of alternative road to accomplish a goal (R6.1)	See question about the assignment
9. Confidence	9.1. Evaluation tool (C1.2)	
	9.2. Increased difficulty (C2.1)	
	9.3. Help students with the formulation of realistic goals (C3.3)	
	9.4. Internal attribution (C4.1)	
	9.5. Increasingly independent (C5.1)	*Not asked, can be evaluated*
10. Satisfaction	10.1. Verbal rewards (S1.2)	*with the developed serious game*
	10.2. Reward both interesting and boring tasks (S2.1, S2.2)	
	10.3. Give verbal rewards and personal attention(S3.1, S3.3)	
	10.4. Increase self-formulated evaluation (S4.3)	
	10.5. Experience points in order to reward right actions (S5.1)	10.5.1.What would motivate you to click on the point wallet?

Note. ARCS stands for Attention, Relevance, Confidence and Satisfaction ; * = where ‘see question…’ is written is referred to a question that is part of the SGDA framework, see Table 3

Appendix F

Results of the Formative Evaluation

Notes during the formative evaluation

- At the end during the question round, the students asked:
    - When it would be on the marked
    - What it would cost
    - Whether I would make money out of it
    - Why I choose cartoonlike figures instead of humanlike figures?

About the respondents

Table 5.

The number of respondents per age and gender

Age	Boys	Girls	Unknown
11		5	
12	2	4	
13		1	
Unknown			7

Codes per question and number of answers

- (1) What do you like about the story in the SG?
    - (learning to) becoming the boss (1-,4, 12,13,15) 7x
    - The growth or improvement a player makes (8,9,16,17) 4x
    - Being important in the game and being responsible (5,7) 2x
    - The smartphone factory (4,6) 2x
    - The connection within the story (10, 11) 2x
    - Other, less concrete opinions:
        - "It makes it just more exciting" (14)
        - "Everything" (18)
        - "Nice" (19)

- (2) What can I change to make the serious game more fun/interesting?
    - More problems/action/exciting, e.g. with money, phones not working (as boss) (2, 4, 6, 10, 14, 15) 6x
    - Winning things or rewards, earning money (1, 11, 16) 3x
    - Adding bonus games to become more successful and make it more fun(7,14) 2x
    - Adding more levels (and getting a higher title) (8, 12) 2x
    - Making the character more realistic (8) 1x
    - Working together with other factories (9) 1x
    - Becoming the boss in some other place than a factory, such as a school or sportsclub (13) 1x
    - Being able to buy/make a car and house (3) 1x
    - Selling better phones (1) 1x
    - Performing (nice) jobs to become the boss (2) 1x
    - Other, less concrete ideas for change
        - Nothing/ I don't know (sounds nice) (5, 17, 18)
        - Less problems (19)
        - Go online (1)

- (3) When would you click on the point wallet?
    - If I want buy something/need (bigger) (8, 9,10, 14, 16, 19) 6x
    - When I want to know how much I saved/have (1, 9, 12,15) 4x
    - When I saved much (2,11) 2x
    - When I go to the next level (16,17) 2x
    - When I achieved a goal/finished a level (4,7,13) 3x
    - When phones are stolen, when employees are needed (5,6) 2x
    - When its told to do so (13) 1x
    - Other, less concrete ideas
        - Always (3) 1x
        - When I would like to (18) 1x

- (4) Which figure would you choose (out of the four)?
    - Nr. 1: the black and white 2/19
    - Nr. 2: the black and blue 4/19
    - Nr. 3: the pink and white 9/19
    - Nr. 4: the pink and purple 4/19

- (5) What would you like to change on your chosen figure?
    - Nr. 1: the black and white
        - Make it more humanlike (4)
        - Adding clothes (8)
    - Nr. 2: the black and blue
        - Changing color: a bit lighter blue, more color (1,5)
        - Making it more realistic (6,18)
        - Making the figure a bit more cool (18)
    - Nr. 3: the pink and white
        - Making it more realistic/humanlike (3,7,10,13,17)
        - Don't know/nothing (9,12)
        - Less corners/triangles (11,13)
        - A 3D figure (14)
        - Choosing clothes in the serious game (14)
    - Nr. 4: the pink and purple
        - Making it more humanlike (2)
        - Editing the figure as player (2)
        - Choosing clothes in the serious game (2)
        - Eyes + mouth pink and eyes round (15)
        - The shape/less corners (16, 19)

- (6) The serious game is called "Becoming the business boss", which means 'de baas van het bedrijf worden'. How would you call the serious game in the Dutch language?
    - Don't change it (4)
    - Don't know (3, 9)
    - "Bedrijfsbaas (worden)" (7,17, 19) 3x
    - "Baas (worden/zijn)" (10, 12, 13, 14,18) 5x
    - (Best) business boss (2, 11) 2x
    - "De grote kleine baas" (16) 1x
    - "Groei groot" (8) 1x
    - "Van beginner tot baas" (1) 1x
    - "Het wereld bedrijf" (5) 1x
    - "De fabriek simulator" (6) 1x
    - "Word je eigen baas" (13) 1x
    - "Van een kleine fabriek naar een grote fabriek" (15) 1x

- (7) How would you like to move (walking around/looking around)?

Table 6.

Answers concerning the control of movement

	All answers	**Reduced double ones***
Computer mice	9/19	7/17
Keyboard arrows	7/19	6/17
Swiping	6/19	4/17

*Two students gave more than one answer

- (8) What do you like about the first level?
  - Everything,okay, nice (6, 14, 15, 17,19) 5x
  - That you can do things; taking the bus, walking around, performing assignments (from the beginning), the assignment with the box, collecting things (2, 3, 9, 12, 13, 16) 6x
  - "That you have to prepare yourself" (4, 7, 10) 3x
  - That you start with a tutorial/instruction/"That Mr. Tonki shows what you have to do" (1,8) 2x
  - Making choices (5) 1x
  - That you have (and can communicate with) colleagues (11) 1x
  - Experiencing the first workday (14) 1x
  - "That you start as you would do in real live" (18) 1x

- (9) What can I change to make the first level more nice/fun?
  - Nothing/I don't know (1, 5, 8, 9,12, 17) 6x
  - More excitement/opportunities: being too late, you can't find something (4, 6, 15, 14, 19) 5x
  - Include more assignments, a job interview, driving to the job (18, 10, 7) 3x
  - Having contact with others via the phone, Tips from other colleagues (11, 16) 2x
  - More exuberant (3) 1x
  - Firstly changing the home (before going to the job) (2) 1x
  - Changing the figures (13) 1x
  - Changing the names (13) 1x

- (10) What do you think you are going to learn in the first level?
  - Everything (1)
  - Nothing (yet) (3, 10)
  - I don't know (5, 7)
  - How to come up with a solution (8, 13, 16, 19,2) 5x
  - Which stuff you need (12,18,6) 3x
  - To prepare yourself (for secondary education) (4,9,14,16) 4x
  - How to play the serious game and how it is (15, 19,14) 3x
  - Planning (11) 1x
  - Learning about the business (8) 1x
  - Saving (17) 1x

- (11) What do you need to take to your work?
  - Food (and drinks)/lunch (everybody, except for 7, 15) 17x
  - Books (1, 9) 2x
  - Phone (4, 6, 7, 11, 14) 5x
  - Money, wallet, (3, 6, 7) 3x
  - Laptop (5, 13, 18) 3x
  - Bag (12, 14, 19) 3x
  - Papers (14) 1x
  - Pastery (8) 1x
  - *"Everything you think you need" (15)* 1x
  - Jacket (19) 1x
  - Folder, pencil case, notebook (13) 1x

- (12) Which solution did you come up with?
  - Using a ladder/stool (Dutch: krukje) or standing on something (1 - 7, 10-14, 17-19) 14x
  - Standing on other boxes (8,9, 15) 3x
  - Jumping really high (5) 1x
  - Climbing on someone's back (13) 1x
  - "Set it lower" (18) 1x
  - "Taking the boxes below out" (16) 1x

- (13) Why did you choose this solution?
  - I don't know (2,7) 2x
  - It is handy/easy/more simple (1, 3-6, 8, 11-14,18) 11x
  - Logical (10) 1x
  - "Then you come higher" or can touch it (7,17, 19,15) 4x
  - Because you are afraid to communicate with others (16) 1x

- (14) Which other solutions/options could you think of?
  - Throw a lasso ball against the box (10) 1x
  - I don't know/no/no answer (1,5,7, 17,15) 5x
  - Flying (6) 1x
  - Asking others (3,11,18,9,12) 5x
  - Ask a ladder (16,8) 2x
  - Take a stool or box (19,8, 9,13) 4x
  - Making a growth serum (8) 1x
  - Ideas that were not related to the solution (such as getting money, coming up with a more nice idea/adding more figures) (2,14) 2x

- (15) What was hard about the questions 11-13?
  - Nothing (18, 17, 3, 6, 8, 10, 12, 13) 8x
  - To tell what I think/don't like (11,16,14,5) 4x
  - That I had to come up with a solution/I did not know an answer (9, 15,7,1) 4x
  - Other: what could be changed (2) 1x

- (16) What is Mr. Kito telling about the use of planning and the use of an agenda? Explain in your own words.
  - That planning is really important/handy (8, 15, 17, 5, 2, 13) 6x
  - That you can do more when you plan (9, 16) 2x
  - "Planning what you want to do and when" and how long it is (18,19, 12, 14) 4x
  - The use of agenda (11, 13) 2x
  - About Kito: "that it worked out", "that he can plan better now", "that everything perfectly fitted" (7,10,3) 3x
  - "That you don't become so busy as Kito" (1) 1x

- (17) How hard is this story? What made it hard?
  - Nothing/not hard/don't know (2, 3, 5, 6, 11-13, 15-19) 7x
  - No answer (4,7, 9) 3x
  - "It is really easy" (10) 1x
  - That he could not plan (1) 1x
  - "The questions and that you had to come up with answers to write down" (14) 1x

- (18) How are you going to order the things? (explain)
  - To sort, order or categorize (by giving it a color or on alphabet) (3, 9, 6, 16, 13, 14, 12, 19, 5, 7, 8, 17, 18, 11, 15) 15x
  - Program a machine to do so (10) 1x
  - Using a crane (1) 1x
  - Asking others to help and pay them (2) 1x
  - Teleporting (4) 1x

- (19) What makes you excited to play the SG?
  - It is new (1) 1x
  - Everything (6) 1x
  - Nothing (10, 3) 2x
  - That you can perform assignments and these assignments (2, 12, 19, 13, 14) 5x
  - That you can become the boss and getting responsibility (17, 15,16, 4) 4x
  - That you can earn and save points (13, 15, 4) 3x
  - The (nice) story in it (11, 18) 2x
  - That you have to come up with a solution (5, 16) 2x
  - That you can continue playing (7) 1x
  - The simulation (19) 1x
  - Being able to talk to others (16) 1x
  - That I can learn to plan(8) 1x
  - Having an excuse to play longer on the computer (8) 1x

- (20) What can I change to make you more enthusiastic to play the SG?
  - I don't know (9) 1x
  - Nothing (1, 5, 17) 3x
  - More action and problems, firing people (4, 6, 18, 14, 2, 15) 6x
  - Including real people/changing the figures (6,8,13) 3x
  - Getting an euro for every point or reward when you finished a level (3,12) 2x
  - Including nice games in between (11) 1x
  - A larger world/factory where you can perform things (19) 1x
  - Coming up with nicer things (14) 1x
  - Another workplace instead of a factory (13) 1x
  - 3D (10) 1x
  - Having an agenda in the serious game (16) 1x
  - Your own home (6) 1x

- (21) Which colors should the background have?
  - More than one color (2, 4, 5, 8, 11, 13, 14, 15, 18) 9x
  - The factory (3, 10, 9, 1) 4x
  - Customized by the player (6, 12, 16) 3x
  - White or grey (17, 19) 2x
  - That changes (7) 1x

- (22) Which music would you like to have on the background?
  - Don't know (10, 17)
  - Specific songs (15, 14, 6, 4, 3, 8) 6x
  - Quiet (7, 1, 5, 12, 19) 5x
  - Choosing it yourself (4, 6) 2x
  - Something that changes with every level (9, 11) 2x
  - "Quiet or exciting" (13,9) 2x
  - One that is made for the game (2) 1x
  - No music (18) 1x
  - Guitar (16) 1x
  - One-tone (8) 1x

Appendix G

Conclusion per question

Table 7.

Results of the formative evaluation per question

Element	Question	Conclusion
SGDA/Fiction and Narrative	(1) What do you like about the story in the serious game?	Becoming the boss is for most (7x) interesting, others find the growth of the player (4x), the factory (2x), the responsibility (2x) and connection of the story (2x) interesting.
SGDA/Fiction and Narrative	(2) What can I change to make the serious game more fun/interesting?	Several options for improvement are mentioned. The following things were mentioned more than once: more action/problems, such as money and broken phones (6x) against one who mentioned less problems, winning things/rewards (3x), adding bonus games (2x), and adding more levels (2x). The following points were mentioned once: more realistic characters, working with other factories, becoming the boss outside the factory, having a car/house, selling better phones and performing jobs to become the boss.
ARCS/Satisfaction	(3) When would you click on the point wallet?	Most students mentioned the use of the points (to buy things) (6x), followed by wanting to know how much they saved (4x), when they saved a lot (2x), when they go to the next level (2x), when I achieved a goal/finished a level (3x), when phones are stolen or employees needed (2x), when it is told to do so (1x) or when he/she would like to (1x).
SGDA/Fiction and Narrative	(4) Which figure would you choose (out of the four)?	All figures are chosen, so none of them must be removed due to being unappealing for the students.
SGDA/Fiction and Narrative	(5) What would you like to change on your chosen figure?	Making the figure more realistic/humanlike (9x). Adding the option to give the player the opportunity to choose (1x) the clothes (3x), color (3x). Change the figures to have less triangles/corners (5x), 3D figures (1x) and a more cool figure (1x).
	(6) The serious game is called "Becoming the business boss", which means 'de baas van het bedrijf worden'. How would you call the serious game in the Dutch language?	Most students mentioned 'baas worden/zijn' (5x), 'bedrijfsbaas (worden)' (3x), '(best) business boss' (2x). The following ideas were mentioned once: 'de grote kleine baas', 'groei groot', 'van beginner tot baas', 'het wereldbedrijf', 'de fabriek simulator', 'word je eigen baas' and 'van een kleine naar een grote fabriek'. Overall the element boss seems to be crucial and the majority came up with a Dutch name.
SGDA/Mechanics	(7) How would you like to move (walking around/looking around)?	Most students preferred the use of a mice, although several students asked at the end of the session (where space was given for questions and comments) whether it could be available on smartphone or tablet. So it is recommended to make two versions of the game, one for laptops and one for tablets.
SGDA/Fiction and Narrative	(8) What do you like about the first level?	Doing things (6x), preparing yourself (3x), the introduction (2x), making choices (1x), communication (1x), experiencing first workday (1x) and 'as in real live' (1x).
SGDA/Fiction and Narrative	(9) What can I change to make the first level more nice/fun?	More excitement was mentioned five times, followed by more assignments (3x) and contact and tips from others (2x). Changing names, figures, home and more exuberant were mentioned once.
	(10) What do you think you are going to learn in the first level?	Several answers focused on learning specific things, solutions/coming up with goals (5x), needed stuff/where to find something (3x), preparation (4x), planning (1x), about the business (1x), saving (1x). Three answers focus on the serious game self. This means that learning skills must be

		explicitly described in the introduction.
SGDA/Purpose	(11) What do you need to take to your work?	The list of ideas shows that this assignment was not too hard for the students.
SGDA/Purpose	(12) Which solution did you come up with?	Most students came up with the idea to use a ladder or climb on a box. One came with a creative idea, namely jumping really high. This indicates that the assignment is not too hard.
SGDA/Purpose	(13) Why did you choose this solution?	Not all students can reason why they chose this option, therefore a short instruction on reasons for choses must be given.
SGDA/Purpose	(14) Which other solutions/options could you think of?	Not all students were able to come up with another solution, this requires some instruction
SGDA/Purpose	(15) What was hard about the questions 11-13? ➔ must be 12-14	Some students mention that they find it hard to describe what they think, since this is an important element of the serious game, this needs to get extra intention in terms of instruction.
SGDA/Content	(16) What is Mr. Kito telling about the use of planning and the use of an agenda? Explain in your own words.	The answers indicated that students focus on the importance of planning, the content of planning, the effects of good planning, the use of an agenda as part of planning and mention Mr. Kito.
SGDA/Content	(17) How hard is this story? What made it hard?	The answers suggest that the text was not too hard for the students .
SGDA/Purpose	(18) How are you going to order the things? (explain)	Most students had an idea on how to categorize (15/19), the others mentioned help, a machine, others and a crane (3/9) and the last person mentioned 'teleporting'. This indicates that students have an idea on how to deal with this problem and that the assignment is not too hard.
ARCS/Attention	(19) What makes you excited to play the serious game?	Overall, students mentioned elements from the serious game such as the assignments (5x), the becoming the boss element (4x), the rewarding element (3x), the story in it (2x) as motivators to play. Others mention coming up with solutions (2x), continuing (1x), the simulation (1x), being able to communicate (1x), an excuse to play longer on the computer (1x) and learning to plan (1x).
ARCS/Attention	(20) What can I change to make you more enthusiastic to play the serious game?	The mentioned improvement points mainly involve more action (6x), and changing the figures into real people (3x), more rewarding (2x), including games in between (1x), larger world (1x), coming up with nicer things (1x), another workplace (1x), 3D (1x), having an agenda as player (1x) and including own home (1x).
SGDA/Graphs and Aesthetics	(21) Which colors should the background have?	Most students opt for more than one color (9/19). Three students mentioned the idea of giving the student the opportunity to choose the color, whereas four mentioned the idea of having the factory as background. That rest mentioned with (1/19), grey (1/19) or a changing one (7/19).
SGDA/Graphs and Aesthetics	(22) Which music would you like to have on the background?	Specific songs (6x), quiet (5x), quiet or exiting (2x), changing with every level (2x), choosing it yourself (2x). The following ideas were mentioned once: one that is specifically made for the game, no music, guitar or a one-tone.