Guidelines for Choosing Serious Gaming as an Instructional Method

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ABSTRACT

Serious gaming is believed to be an effective instructional method in education. There is, however, no approach teachers and designers can follow to make a well-informed decision to use a serious game instead of traditional instruction methods. Therefore, teachers now only use their own professional judgement. This paper reports a literature review on important surrounding factors and characteristics of the serious game and curriculum design choices teachers make, resulting in a set of guidelines. Three components are relevant to support teachers: the teacher, the learning objective and the game. The teacher can classify the learning objective using the revised taxonomy of Bloom and can use the RETAIN model to score the serious game. These seven guidelines enable teachers and designers to assess if a serious game is a viable alternative to a traditional method for a certain learning objective.

1. INTRODUCTION

In the past decades there have been several studies on game-based learning, educational games, simulations and serious games (SG). Although there is a general agreement on the possible effective use of SGs, multiple articles ask for a univocal framework for evaluating them. De Smale et al. indicate that the effectiveness of a SG depends on the role of the teacher, learning objectives, the specificity of the game, and the integration in the course. This suggests that a SG is more effective in a certain task than in another and that for certain learning objectives a SG works better than for others. Bellotti and colleagues agree on this and raise the following questions:

"For what instructional objectives is a SG useful? [...] Are there disciplines that lend themselves better to SG? [...] How can teachers be trained and supported in the use of new tools?" [3]. The last question they raise is particularly interesting, because the answer could aid both the teachers and the designers of SGs.

1.1 Background

Many papers have proposed their own definition for the terms game-based learning, educational games, simulations and serious games, most often to underline their own conclusions. Until now there is no concise term to describe the concept of the games used for education. In the last few years serious gaming has become the commonly used term as a description of games that are used for educational purposes. Some papers use ‘simulations’ rather than ‘serious gaming’. This has often to do with the difference between computer games (like Zyda [34]) and non-digital games (like Lean and colleagues [20]). This paper combines the definitions of both Bellotti et al. [3] and Purarjomaldian-grudi et al. [27]: a serious game (SG) is a game that is designed to improve specific aspects of learning and teaching by using pedagogical methods for instruction.

A game that can be used for educational purposes is an instructional method. Such a game can be used by coaches and teachers to illustrate a certain problem and/or to teach the user a solution for this problem. In that sense serious gaming can be used instead of traditional instructional methods such as books, reports, case studies or lectures. However, game-based learning not is the superior learning method per se [25]. Thus per objective it has to be evaluated whether serious gaming would be a viable substitution for a traditional instruction method.

Learning objectives are fundamental in the design and validation of education [29], and so are they for designing and using a SG. For traditional instructional methods, there are many theories and models that aim to support the achieving of learning objectives. One of the most well-known theories is the taxonomy of Bloom. Bloom’s taxonomy was made two-dimensional by Krathwohl [18] in 2002 and his scheme is now widely used among teachers. This Taxonomy of Educational Objectives is a scheme for classifying educational goals, objectives and standards and can be used in two ways: (1) for classifying the learning objectives before teaching, and (2) for curriculum assessment and identifying missed educational opportunities afterwards [18].

To adopt SGs into the teachers’ curriculum, teachers do need to make choices for using technology [4]. However, teachers cannot properly assess if a technology like a SG will teach their students the objective they have set, because there is no commonly used model for evaluating SGs [29]. Lean and colleagues state that teachers now base the decision of using a technique like serious gaming upon their professional judgement [20]. So, can there be a method that supports teachers in making this decision?
1.2 Research goals
This paper aims to propose guidelines for designers and teachers to determine whether a SG is a valid alternative for an instruction method or not. These guidelines should enable designers to assess if their SG helps users achieve a certain learning objective. Teachers should be able to make an educated decision if a SG is a viable method to meet their learning objective.

In order to create these guidelines two factors are important: the surrounding factors of the game and the game characteristics, and the criteria on which teachers make choices. Therefore, the following research questions are defined.

1.a What is the role of the teacher when using a serious game?
1.b What kind of learning objectives can best be met by a serious game and how can the learning objectives be classified?
1.c What characteristics are important to meeting the learning objective best and how can teachers score games on these characteristics?

2. On what bases do teachers make their decision on choosing an instructional method?

These questions are answered in the remainder of this paper. In the next chapter, the research methods are described and are shown how the methods are used to conduct this research. The results of the questions 1.a to 1.c are presented in chapter 3. Afterwards, the outcomes of the last question are given in chapter 4. With the information of chapters 3 and 4 combined, the guidelines are portrayed in chapter 5, which is followed by the discussion and conclusions.

2. Research methods
This research consists of two parts. First, a literature study will be conducted to gather the necessary information to create guidelines for teachers. To carry out an extensive literature study, two studies will be combined. First, the work of Kitchenham [15] is used for the framework she proposes and secondly the grounded theory of Wolfswinkel, Furtmüller and Wilderom [32] will be used for more concrete and specific instructions. Using a structured review method requires more effort than traditional reviews. However, the structure provides evidence that the results are robust and transferable [15]. Kitchenham gives a three-step approach for doing a literature review, which are described later in this chapter:

1. Planning of the review
2. Conducting the review
3. Reporting the review

Secondly, when all information is gathered, the guidelines can be created. In order to create the guidelines properly, the Design Science Methodology of Peffers will be used [24]. This methodology gives a clear strategy to develop an artifact, in this case a set of guidelines.

The guidelines will be validated by having semi-structured interviews with teachers. By asking them if the guidelines are helpful and user-friendly, recommendations for improving the guidelines will found. The interviews give an insight in how well these guidelines assist teachers to make decisions on choosing SGs as an instructional method.

2.1 Planning
Defining the research is the first step in the process. This consists of four sub-tasks in which the criteria for inclusion and exclusion are set, the field of research is determined, the appropriate sources are found and the specific search terms are decided upon.

This paper focuses on the effectiveness of SGs on multiple criteria. As this is likely to give a broad overview in conducted research, there is a need for inclusion and exclusion criteria. All papers about serious gaming in relation to taxonomy of Bloom (whether revised or not) are included instantly. The papers about the (challenges of the) development of software, the costs (financial or not) of development and descriptions of SGs are excluded from this research. To find the most useful papers, this research limits itself to the field of computer science and the field of education. To create a broad overview in the conducted research a broad source is used: Scopus. The specific search term that was used, was: ["serious gam*" AND (taxonomy OR "learning objective")].

2.2 Conducting
Using the search term on Scopus, 106 results were found. By reading the title and abstract of each paper, a selection was made with the inclusion and exclusion criteria. Afterwards, 32 papers remained for further reading. These papers were read to assess if the papers could be used in creating the guidelines of this research. After this second selection process there remained 16 papers of interest. The 16 papers were read in detail to search for answers to the research questions and relevant material to the guidelines. In multiple papers parts of the answers to one or more questions were found and highlighted. Backtracking citations is done when this provided more specific information. Together with the papers already used in the introduction, the set of papers used is completed and used in this research.

For the most part, the papers found are on the subject of effectiveness of SGs and guidelines or best-practices to use or design them. One of the papers found, compares multiple frameworks for evaluating SGs and just six of them describe how teachers make decisions on using instructional methods.

2.3 Reporting
The outcomes of the research are presented in the following chapters in this paper. To create guidelines for teachers on choosing SGs as an instructional method, it becomes clear that there are two angles. The two angles, achieving the learning objectives with a SG and curriculum design choices of teachers, are discussed in the next two chapters.

3. Learning by playing
When using a SG, multiple characteristics need to be considered for its effectiveness. The surrounding factors and game elements that make using a SG in classrooms a success, will be described using the input-process-output model of Garris [12], see Figure 1, which gives a perfect overview of the characteristics involved using a SG. Three factors must be taken into account when looking at the effectiveness of SGs: the teacher, the learning objectives and the game. First, the role of the teacher is reviewed. The teacher is present during every stage of the model, but what does the teacher have to do in order to make the use of a SG more effective? Then the kind of instructional content, the sort of learning objectives, that SGs can effectively teach will be determined. Third, the game
characteristics of an effective SG will be discussed and the in-game elements that make a SG effective are examined. In this last section best practices of SGs and task-based learning will be described.

3.1 The teacher
The role of the teacher is repeatedly described as important for achieving learning outcomes and the effectiveness of learning is strongly related to the role of the teacher [29]. Catalano et al. describe it in their best practices as 'facilitating learning task' [6]. This is divided into three components: before, during and after the game. They write: "(1) the briefing phase has the goal to raise the attention of the learners by exposing them to their learning objectives, game rules and recall of prior knowledge; (2) the facilitation during the gaming session builds on the previous stage and helps in providing the actual learning guidance; (3) the debriefing phase is designed to consolidate the learning not only via facilitated debating and assessment of the game learning experience but also by transferring it to the ordinary reality [6]." In all three phases of the input-process-output-model of Figure 1 the student is triggered to learn, but especially the debriefing phase is essential. According to Dunwell et al. the learning outcomes can be improved by stimulating learning to occur beyond the game and integrating game-based learning fully into the learning environment [10].

Furthermore, a SG is abstract to some degree and it is the teachers responsibility to translate the game world into the real world. The knowledge and/or practical skills taught by the SG are instructed in a virtual world, but are recognizable in the real world. In the debriefing phase the teacher lets the student reflect on what he or she learned from the game and how he or she can use this knowledge or skill in real world situations. The more abstract a SG is, the more the teacher is needed to achieve the learning objective in the debriefing phase. This is not unique to SGs: classroom instruction must also be translated by the teacher, but game-based learning is often unique in the extent and nature of the abstraction [9]. That the teacher is an important stakeholder is not surprising. He holds the key to making or breaking the SG in his curriculum. The integration of the SG into his curriculum is an enabling factor in the effectiveness of the SG [29].

3.2 The learning objectives
Due to their interactivity and pedagogy, SGs provide a "learning by doing" experience to players as a way to apprehend new knowledge or skills. To achieve the objectives, SGs need to be engaging and following a pedagogy targeting a set of learning objectives [5]. The method of "learning by doing" did not come newly with the SGs. This concept is written about for many years and one study does come up a lot of times [2, 5, 6, 7, 8, 9, 10, 12, 17, 25, 30, 31]: experiential learning by Kolb (1984) [16]. He proposed a four-step cycle in the 'learning by doing' method, see Figure 2.

In the four steps it is all about learning from an experience. According to this cycle a SG needs to enable active experimentation and feedback on this. The learning objectives should be cut in small tasks to be more effective, see the next section for more detail. The learning objectives should therefore be set in such a way that they are explicit, measurable [14] and the learner has to be able to experiment with them.

Another aspect of effective learning objectives is the kind of learning objectives that are instructed by a SG. As stated in the introduction, many teachers use the revised model of Bloom’s taxonomy by Kitchenham [15] to classify their learning objectives. Kitchenham created a matrix using the taxonomy of Bloom. The model uses six classifiers for learning objectives: remember, understand, apply, analyze, evaluate and create. The order here is important; the manner in which a student has to understand the objective increases in difficulty. For example, a learning objective classified as ‘remember’ should only be remembered literally. If the learner needs knowledge and understanding of the concept to apply a theory onto a situation, the learning objective should be classified as ‘apply’. On the other axis there are four kinds of knowledge: factual, conceptual, procedural and metacognitive. These also increase in difficulty and can be used to assess what kind of knowledge the learner should have; should the learner just know it in a certain specific situation or should the method be known so he can use it in all sorts of situations? For different SGs different (sorts of) learning objectives can be used.
Table 1. Summary of RETAIN rubric. (Gunter et al., 2008)
Adapted from Prinsloo and Jordaan (2014) [26]

<table>
<thead>
<tr>
<th>CATEGORY 1: Relevance</th>
<th>Explanation</th>
<th>Level 0</th>
<th>Little stimulus for learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Level 1</td>
<td>Limited educational focus, some irrelevant content</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 2</td>
<td>Learning objectives are defined, interest is created</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 3</td>
<td>Game is relevant to learners, and challenges or adequate for learning</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CATEGORY 2: Embedding</th>
<th>Explanation</th>
<th>Level 0</th>
<th>Learning content disrupts play</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Level 1</td>
<td>Learning is exogenous to fantasy context (learning is &quot;outside&quot; the fantasy context)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 2</td>
<td>Includes intellectual challenge and problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 3</td>
<td>Content is endogenous to fantasy and fully involves learner</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CATEGORY 3: Transfer</th>
<th>Explanation</th>
<th>Level 0</th>
<th>No levels of challenge mapped to objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Level 1</td>
<td>Levels of challenge are too similar, some useful content</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 2</td>
<td>Easy progress through levels through active problem solving. Higher level knowledge should be transferable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 3</td>
<td>Authentic real life situations and after action reviews</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CATEGORY 4: Adaption</th>
<th>Explanation</th>
<th>Level 0</th>
<th>Fails to engage in interactive, unstructured information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Level 1</td>
<td>Builds upon existing cognitive structures, engages in cognitive conflict</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 2</td>
<td>Learners are encouraged to go beyond given information. Old schemas are identified and adapted to new situations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 3</td>
<td>Learning becomes an active process that integrates prior knowledge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CATEGORY 5: Immersion</th>
<th>Explanation</th>
<th>Level 0</th>
<th>No formative feedback, little active participation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Level 1</td>
<td>Elements of play are not in sync with learning objectives, players do not feel fully interactive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 2</td>
<td>Learners are involved cognitively, physically and emotionally</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 3</td>
<td>Favourites belief creation and includes opportunities for reciprocal action</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CATEGORY 6: Naturalisation</th>
<th>Explanation</th>
<th>Level 0</th>
<th>Little opportunity for mastery of facts and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Level 1</td>
<td>Replay is encouraged to improve speed of processing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 2</td>
<td>Encourages synthesis of elements and judgements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level 3</td>
<td>Learners become efficient content users and spontaneously use acquired knowledge</td>
</tr>
</tbody>
</table>

Caulfield and colleagues researched 26 SGs and classified them using Bloom’s taxonomy [7]. They found that 25 out of 26 used ‘knowledge’ learning objectives. This is in contrast to the learning by doing and the behavioural learning that others claim SGs are good at. Catalano et al. also state that SGs should probably be incorporated later in a course, so that students have had the time to gain the knowledge to make sense of what the game is trying to teach [6]. Dunwell and colleagues claim that for gaining knowledge and comprehension other instructional methods can be more effective. SGs are according to them better at teaching the higher levels (applying, analysing, evaluating and creating) of Bloom’s model [9]. This is in line with the experimental way of learning that Kolb’s ‘learning by doing’ style proposes. SGs are best at development of skills such as analysis, problem solving and interpretation [22]. The most effective learning objectives are therefore classifiable in the higher levels of Bloom’s taxonomy and preferably also in a conceptual or procedural way of knowledge.

3.3 The game
To create effective, engaging and satisfying SGs, multiple game characteristics must be taken into account. These aspects are discussed in detail in this section. The important elements can be summarized using Catalano and colleagues’ five guidelines [6]:

1. Situate the learning. The teacher is responsible for a suitable learning environment, like described in the first section of this chapter.

2. Minimize the cognitive load. By using small pieces of learning objectives, tasks, the learning objective can be achieved the best. This creates a high level of engagement and motivation.

3. Engage the learner constructively / experimentally. Creating flow is important to create the engagement needed to achieve the learning objectives. Flow is a essential concept in the game because it continuously spurs the player to improve [3]. Motivation of the learner is created by this flow and
thus the learner wants to achieve more and therefore learn more.

4. **Facilitate the learning task.** Again, the role of the teacher is important in the three phases of the game; before, during and after. It is the teacher’s (or maybe the game’s) responsibility to facilitate the learning by introducing the objectives, by giving feedback and mapping the virtual world of the game onto the real situation.

5. **Flexibility, reusability, exploitability.** The last guideline of Catalano will not be discussed, because it is less relevant to be influenced by teachers. According to Catalano and colleagues a wide variety of situations and scenarios is needed to keep high level of engagement in the game. The game should also provide choices to the learner. However, this could lead to a game which contains too many learning objectives.

Most of the important effective game characteristics are combined by Gunter and colleagues in 2008. The RETAIN model they propose evaluates a SG on six different aspects: relevance, embedding, transfer, adaption, immersion and naturalisation [13]. On each of these faces the game can be scored on four levels in which level 0 is poor and level 3 is perfect. In Table 1 an overview on the RETAIN model can be found. After scoring a SG on these aspects the scores are weighted with Table 2. The score found can be combined by Gunter and colleagues in 2008. The RETAIN model they propose evaluates a SG on six different aspects: relevance, embedding, transfer, adaption, immersion and naturalisation [13]. On each of these faces the game can be scored on four levels in which level 0 is poor and level 3 is perfect. In Table 1 an overview on the RETAIN model can be found. After scoring a SG on these aspects the scores are weighted with Table 2. The score found can be used to compare SGs to each-other. Prinsloo and Jordaan compared this RETAIN model to two alternatives [26]. They found that one of them was to some extent better than the RETAIN model. However, the RETAIN model gives an easy table to fill in and therefore is easy to use without prior knowledge about the model. This makes the RETAIN model perfect for using it in guidelines that do not require prior knowledge. Teachers can use the model the instance they want to use the guidelines set by this paper.

The most relevant relations between game elements [31], characteristics from the guidelines of Catalano et al. and the RETAIN model will be discussed in more detail below. The other aspects, like fantasy, mystery, control, interaction and rules/goals are important to the game as well, but the learning objectives are less influenced by those elements and therefore not discussed here.

### 3.3.1 Involving students by experimentation

Serious games are used as learning tools as they develop competences, knowledge and practical skills [8], because it is possible to simulate the real world in the virtual world of a SG. This is why SGs are places for students to trial new ideas and to experiment with established theories; to replay these theories as many times as needed; places where time and space can be contracted or expanded and places where it is acceptable just to try different things and where more might be learned from failure than success [3, 7]. A SG can replicate real contexts or situations that occur in very specific circumstances to learn from them and even change the behaviour of the learner [8]. Wilson and colleagues underline this in one of their propositions [31]: a game needs to be a place in which a student acquires knowledge by making mistakes over and over again. By creating these concrete, compelling contexts, the player will get concretely involved. This is important to motivate learners and also to show the concrete relevance to everyone’s life of subjects (e.g., maths and physics) that are frequently considered as cold and abstract, but whose applications to improve our understanding (and prediction) of the world and its processes are surprising and give satisfaction to students [3]. SGs are by nature suited to engage the learner and encourage active construction of meaning and development of skills [2].

#### 3.3.2 Task-based learning

To more effectively complete the learning objective(s), the learning goals should be broken into parts [14]. Every part of the learning objective can be taught in the game by using tasks. Tasks embody units of knowledge that are discovered and accessed by the player in order to construct meaning, build lasting memories and/or deepen understanding [2]. To complete the game the player needs to complete certain objectives (or better said: storylines within the game) which exist of a number of missions, that also consists of a number of tasks. Effective SGs follow the concept of completing tasks to complete a mission, to complete a learning objective, as is shown in Figure 3.

| Table 2. RETAIN weighting chart. Adapted from Gunter, Kenny, Vick (2008) [13] |
|---------------------------------|--------|--------|--------|--------|--------|
| Order of importance | Level 0 | Level 1 | Level 2 | Level 3 |
| Relevance | 1 | 0 | 1 | 2 | 3 |
| Embedding | 3 | 0 | 3 | 6 | 9 |
| Transfer | 5 | 0 | 5 | 10 | 15 |
| Adaption | 4 | 0 | 4 | 8 | 12 |
| Immersion | 2 | 0 | 2 | 4 | 6 |
| Naturalization | 6 | 0 | 6 | 12 | 18 |

Figure 3. Task-based game. Adapted from Belloti, Berta, De Gloria and Primavera (2009) [2]

#### 3.3.3 Flow

Effectiveness is, however, not the only reason to break the learning objectives into tasks. These tasks are, most of the time, sequential and have to be dealt with to complete a mission. This creates the possibility to vary the difficulty in the tasks for the player to make the game fun and challenging. The ‘flow’ in the game is of major im-
portance to the success of the game and is thus discussed by many authors [1, 2, 3, 6, 12, 14, 21, 22, 31]. Garris and Ahlers define flow as follows: "Flow represents an optimal state of performance at a task, a sense of enjoyment and control, where an individual’s skills are matched to the challenges faced." [12]. By creating a good flow the player will be engaged and challenged by the game. When the challenge increases the learning will also increase, but too much challenge will hinder this and have the opposite effect [31]. This also means that the game should adjust itself to the amount of skill and knowledge shown by the players. If this is not done properly, the game will be too hard or too easy for a group of players and this will block the learning experience [31].

3.3.4 Feedback
Besides creating a challenge, flow is also about giving feedback to the player. Feedback is an in-game tool for players to learn from previous actions and adjust accordingly [1]. By using feedback the future performance of the player will improve [3]. This means that after feedback the tasks given can be more difficult and the player can learn more. The specificity and immediacy of the feedback in the game can positively influence the learners motivation and the learning itself [31].

4. INSTRUCTION DESIGN CHOICES
For SGs to be used in the classroom, teachers have to choose them as an instructional method. Many educators believe that the use of SGs has benefits in education [28]. Their use depends largely on the teachers personal initiatives and experiences [29]. Games can unfortunately not be incorporated in the curriculum easily. Teachers have all kinds of concerns and barriers to overcome before a SG is chosen as an instructional method. Boschman et al. describe these challenges with a conceptual framework, in which practical concerns, external priorities and existing orientations are considered [4]. The framework, see Figure 4, will be used to describe the curriculum design decision-making of teachers. It is important to keep in mind that teachers use, adapt, or (re)design curriculum material to fit their practice. They make decisions based on (1) their practical knowledge, the personal knowledge base accumulated through experience in teaching, and (2) their knowledge and beliefs related to how curriculum material is designed, adapted or used [4].

4.1 Barriers in instruction design
The most important issues felt by teachers are the practical issues. The preparation time needed for using a SG is a large practical constraint and also the class-time needed to use the SG is often a problem for teachers [20]. Furthermore, most teachers are not comfortable enough to use technology in their teaching. In the research of Boschman et al. one teacher stated that she lacked the skills in technology-use to manage the technology in the classroom [4]. This is, however, a problem that can be overcome by changing the attitude of the teacher. Teachers do not need to become tech-savvy, they need to change their paradigm from "I'm-the-teacher-and-I-know-everything" to a Community of Learners paradigm where the teacher is the facilitator of the learning experience [28]. Besides the practical issues, teachers (often implicitly) have all kinds of external priorities to keep in mind. There are multiple different stakeholders that influence the decision-making in curriculum-design like governments, publishers of textbooks, school boards and colleagues [4]. Difference in opinion about the practical issues make the decision harder. There also has to be enough funding to make using SGs worth the time [20].

Lastly, the existing orientations of teachers, their experiences and beliefs, can make change harder. As stated above, the teacher uses his personal knowledge, experience and beliefs as basis of the decision. This may be caused by the lack of information about SGs [20] or because the learning objective is not fit for the SG.

4.2 Recommendations on decision-making
When introducing games in their practice, teachers engage in a decision-making process. In this process they should select an existing game that fits with the curriculum objectives or repurpose an existing entertainment game, which has maybe not being designed initially with an educational objective but which could be used as part of a learning activity [28]. The teacher should take advantage of the existing resources available [23] and he or she can do this by using a existing SG that fits the learning objectives or to fit the learning objectives to a certain (serious) game. When a teacher is looking for a SG, he or she should not be overly prescriptive [23] and not be overly enthusiastic about a game. At all times the teacher should stay focused on the learning, not the technology [23]. The in-game challenges should be in line with the learning objectives set by the curriculum of the teacher [21]. As discussed in the previous chapter, this can be done best by dividing the learning objectives into tasks. For each topic in the curriculum one or more levels can be assigned [21].

5. GUIDELINES
Now that is determined that (1) the role of the teacher is essential, especially in the debriefing phase, (2) that the learning objectives have to be divisible in explicit and measurable tasks and (3) that a game should engage students by enabling experimentation, by creating flow and giving feedback, the knowledge to create an artifact is gathered. The next phase in the design science methodology of Peffers and colleagues is designing the artifact [24]. The artifact, the guidelines, given in the first section are the enumeration of the knowledge from the two chapters above.

In the second section of this chapter, the guidelines will be validated for use by 6 teachers from The Netherlands. This evaluation will be the last phase of Peffers et al. that will be done.

Figure 4. Conceptual framework of design choices by teachers. Adapted from Boschman, McKenney and Voogt (2014) [4]
5.1 Requirements for choosing a SG

The guidelines consist of three parts: the teacher, the learning objectives and the serious game itself. In the previous chapters these aspects are discussed and now the requirements for choosing a SG as an effective instructional method are presented.

5.1.1 The teacher

**Guideline 1.** The teacher should be confident using a serious game as an instructional method.

As teachers base their decision primarily on their own experiences and thoughts, the teacher should be confident in introducing a SG. The teacher should be convinced that using a SG makes his curriculum better and makes learning for students more effective and more engaging. This is the basis on which a SG could become part of the teaching.

**Guideline 2.** The teacher should be the facilitator of learning, this means that he or she:

- should be part of the game as an instructor before the game, as a guide during the game and afterwards as a teacher that debriefs the game.
- should not have to know everything about the technology.
- should not focus on using a serious game, but on teaching the objectives.

The role of the teacher is different when using a SG. Normally the teacher is an instructor who is in charge of spreading knowledge and teaching students. When a teacher uses a SG as an instructional method, he or she becomes a facilitator of learning. This means that he or she should let the game do the teaching and that he or she does not have to know every detail. The teacher just has to explain what is learned and how this can be used in the real world. This may be hard for teachers to do, but only then the SG will be the real instructor.

5.1.2 The learning objectives

**Guideline 3.** The learning objective(s) should fit within the curriculum of the teacher.

A SG should always be part of the teachers curriculum. The teacher should never use a SG because he or she thinks that the game is ‘cool’. The learning objectives can be set in two ways: before finding the SG and after finding it. Looking for a SG to perfectly fit the learning objective could be difficult, but it could work perfecting the curriculum. A SG could also change the curriculum and the learning objectives to some extent. The teacher should always assess whether the SG fits or not.

**Guideline 4.** The learning objective(s) should be classified as apply, analyze or evaluate according to Bloom’s taxonomy and be placed as conceptual or procedural knowledge in the table of Krathwohl.

The revised taxonomy of Bloom by Krathwohl [18] can perfectly be used to assess the learning objective(s). Preferably the learning objectives are in the higher segment of the table, as SGs can best be used to experiment and change behaviours. Therefore learning objectives that aim to apply and analyze a objective are most suitable for using in a SG.

**Guideline 5.** The learning objective(s) can be (or are) broken into small parts and formulated as explicit and measurable tasks.

Effective SGs and effective learning objectives are small. Many small tasks can be taught by SGs best, because the tasks can be done repeatedly and the sum of these tasks teaches a larger objective. Of course, the learning objectives need to be explicit and measurable, only than can a teacher assess whether the learning objective is achieved or not.

5.1.3 The game

**Guideline 6.** The game should score a minimum of 35 points in the RETAIN model.

The RETAIN model values a SG on six terrains and scores them. As stated before, four out of the six elements are of great importance: embedding and adaption have a lower priority. Some games will score higher on certain elements than others, but the most important elements according to this paper and according to Gunter and colleagues are transfer and naturalisation (they have the biggest weight, see Table 2). For a game to be of value the elements need to be of a minimum level. Relevance should be at least level 2, embedding level 1, transfer level 2, adaption level 1, immersion level 2 and naturalisation should score level 2 as well. Therefore the game should score a minimum score of 35 points in the RETAIN model.

**Guideline 7.** The game should offer feedback to the learner so he can experiment with his knowledge and skill(s).

One important characteristic that is little discussed in the RETAIN model, is feedback. The feedback that the game gives is essential to the success of the game, because feedback enables the player to experiment and do better. In-game feedback is needed for the engagement of the learner and thus to motivate the learner.

5.2 Validation

To assess how well the guidelines support teachers in making a decision about using SGs, teachers are asked to evaluate the guidelines. This step in the design science methodology of Peffers and colleagues is done to measure how well the artifact supports a solution to the problem [24]. Six teachers have been asked to read and evaluate the usability of the guidelines.

The majority of the teachers (5 out of 6) were positive about the usability of the guidelines. They reported that the guidelines are understandable and easily applicable. One of the teachers stated that he did not see the need for these kind of guidelines because he believed more in his own judgement. That same teacher, however, mentioned that he already used (most of) these guidelines subconsciously.

The teachers do not agree with each other on the usability of the RETAIN model. Two of them felt like the model supported their choices well and claimed it did not require any prior knowledge. Two others reported the contrary: they lacked knowledge of using the model straight away and felt blocked by the work that they had to put in for evaluating the SG.

Unanimously, the teachers declared that the teacher is the central figure in the guidelines and that the guidelines are to support them. Although the difference in opinion about the RETAIN model, the teachers felt supported by the guidelines about the teacher and the learning objectives.
6. DISCUSSION
In this paper certain assumptions are made and conclusions are drawn. Not all of them are necessarily true at all times. In this section these possible shortcomings are discussed.

First of all, SGs are assumed to be effective and fun. Although the evidence is present, there are also papers that indicate otherwise. Gale and Van Dijk describe that there are learning objectives that can be better met by traditional instruction methods, like lectures and textbooks [11, 30]. Both of these papers use learning objectives that can be classified as remember or understand with Bloom’s taxonomy. Therefore, the suggestion of using learning objectives in the higher section of Bloom’s taxonomy (applying, analyzing, evaluating) is essential.

Fantasy is little discussed as an important game element in this paper. Wilson et al. emphasize that fantasy relates to motivation of the learner in two of their propositions [31]. A game should not follow reality perfectly, because this would be boring. To the learning objectives fantasy is less important, but the teacher should think about it. When he or she uses a SGs with a lot of fantasy their role is more important as the students will not learn the objective perfectly in the game. How teachers can evaluate this tradeoff should be researched.

The papers found suggested that using task-based learning is essential to effective learning in a game. However, there has not been searched for alternatives on creating effective learning objectives for a SG. There could be other approaches that offer the same positive outcomes.

This research was done in the context of Dutch schools and the Dutch school system. The way Dutch teachers think about their curriculum, like described by Boschman et al. [4], could be very different in other countries. Validation is also done by Dutch teachers and thus not necessarily true for teachers in other countries.

Furthermore, the number of teachers that evaluated the guidelines is small and they were not all high school teachers. This asks for more evaluation of the guidelines to improve them. The teachers already suggested to review the use of the RETAIN model used by these guidelines.

7. CONCLUSIONS
In this paper a literature review has been conducted on using serious games as instructional method in classrooms. This has resulted in 7 guidelines that aid teachers and designers to make a decision about using a serious game for a certain learning objective.

The teacher should be wanting to use a serious game in the classroom, as his role is important. He or she should be a facilitator of learning which is especially needed at the de-briefing phase of the serious game to translate knowledge and/or skills of the virtual world of the serious game into real world situations.

To use serious games in the classroom, the learning objectives that should be achieved with the instruction of the serious game, are crucial. The learning objectives should be formulated as explicit and measurable tasks, that combined lead to the desired learning outcome. These tasks should preferably be of a higher level in Bloom’s taxonomy (applying, analysing, evaluating and creating). The revised taxonomy of Bloom can be used by teachers to evaluate the learning objective.

In a serious game there are multiple important elements. By using small tasks in the game the involvement of the learner becomes high and there is the possibility for experimenting. The player is triggered to play more and this is exactly what the flow and feedback in the game should aim for. The RETAIN model enables teachers to evaluate and compare serious games without any prior knowledge of the model on the mentioned elements above. This permits the teacher to compare multiple serious games easily.

For choosing a serious game as an instructional method the teacher has to cope with three kinds of barriers: practical concerns, external priorities and existing orientations. The practical concerns, like class-time needed or not feeling comfortable with technology, are often the biggest issue. Yet, there are enough possibilities and recommendations to use a serious game. Teachers should still use their own practical knowledge and experience at all time to decide upon the use of different instructional methods.

8. ACKNOWLEDGEMENTS
I would like to thank my supervisor from the University of Twente, dr. ir. Ton Spil, for his patience and feedback on this paper. Furthermore, I am grateful for the teachers who contributed to the validation of the guidelines and I thank my family and friends for their support and feedback.

9. REFERENCES


