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### Digital game-based learning in secondary education

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# CHAPTER 7

## SUMMARY AND DISCUSSION

### Digital game-based learning in secondary education

With digital games becoming available to the larger public, teachers and researchers are focusing their attention on the potential of digital games for education. A decade ago the expectations of games in education for student motivation and learning were high; however, rigorous research supporting the claims was lacking (Mishra & Foster, 2007). In light of the expected value of using games for education, I examine the potential of digital game-based learning (DGBL) for engagement, motivation to learn and (perceived) learning. My main research question is 'How do digital games contribute to learning, engagement and motivation to learn?' I conducted five studies to contribute to the existing research on DGBL and to provide insights into its benefits for secondary education.

#### 1. SUMMARY OF THE FINDINGS

In this section, I summarise the main findings of the five studies reported in this dissertation. The research questions for these five studies were as follows:

- 1) How does existing literature describe the effects of DGBL on students' engagement in the game, motivation for the subject and learning outcomes?
- 2) What are the motivational and learning effects of DGBL?
- 3) Do students' game activities explain the differences in students' motivation for learning, perceived learning outcomes and game performance?
- 4) How do teachers use game creation in their teaching practice, and does creating games affect students' classroom motivation and their perceived learning outcomes?
- 5) What are teachers' practice-based perceptions of the value of digital games with respect to students' engagement with the games, their motivation to learn and their cognitive learning outcomes?

##### *1.1 Study 1: Review of DGBL literature*

The study described in Chapter Two reviewed a decade's worth (1999–2009) of empirical research into learning and motivational effects of DGBL and described the claims regarding motivation and learning. In this systematic review of the literature, 46 studies were selected. Of these studies, I analysed the claims made by authors regarding engagement in game-play, motivation for the content of the game and the school subject, and learning factual knowledge and cognitive and metacognitive skills. Eighty-one of the 93 claims made in these studies were grounded in the de-

sign, analysis and results and discussed in this article. In general, the claims that DGBL is engaging have been proven, and students are engaged by using games. However, the results regarding motivation are more ambiguous: games seem to motivate students for the content or school subject, but not more than other ways of learning. Claims about learning are usually positive, but when game-based learning was compared with other educational interventions only for factual knowledge, students learned more with game-based learning. Regarding cognitive skills, students did not always learn more than with other educational interventions and in one case even less. For metacognitive skills, there were two claims: (1) students learned metacognitive skills, but (2) not more than the control group. In conclusion, while games are engaging, motivating and enable learning, compared to other types of educational interventions, the effects are only higher with regard to engagement and learning factual knowledge.

### *1.2 Study 2: The game Frequency 1550*

Chapter Three investigated the effects of playing a mobile city game called Frequency 1550. I examined pupil engagement in the game, historical knowledge and motivation for History, particularly for the Middle Ages. A quasi-experimental design was used to compare students playing the mobile history game Frequency 1550 with students receiving regular project-based lesson series. Of 458 students involved in this study, 232 were in the experimental group and 226 were in the control group. The results showed that pupils who played the game were engaged and gained significantly more knowledge about medieval Amsterdam than pupils who received regular project-based instruction. No significant differences were found between the two groups with respect to motivation for History or the Middle Ages. In conclusion, while the game Frequency 1550 did not lead to students being more motivated for History or the Middle Ages, students playing the game were engaged and learned more about history than students in regular project based lessons, which could be attributed to the activities students enjoyed while playing the game.

### *1.3 Study 3: The game No Credit, Game Over*

Research into the relation between what students are doing while they play a game and the outcomes of playing a game is scarce. Therefore, in the study described in Chapter Four, the effects of playing a mobile city game called No Credit Game Over (NCGO) were investigated looking at students' game activities. I related the students' game activities while they play the game NCGO to their motivation to learn, perceived learning outcomes, and game performance to see whether differences in these outcomes could be explained by the students' game activities. In NCGO, students used their tablets to combine virtual information regarding debts with assigned tasks in urban spaces. Information was gathered from 181 students who played the game and completed questionnaires concerning their game activities, motivation for learning and learning outcomes. Some variables were measured on an individual level and others on a group level (due to students sharing a tablet). The results

showed that some game activities relate to motivation for learning, learning outcomes and team game performance. These are the game activities: character immersion (students' immersion into the character of the game), doing something other than the game, visiting organisations and looking at the route. Doing something other than the game had negative effects on motivation for learning. Character immersion not only had a negative effect on motivation for learning, but also on (perceived) learning, while visiting organisations and looking at the route had positive effects on team game performance. Further research is needed to explain these effects.

#### *1.4 Study 4: Creating games*

Using games to attain engagement, motivation to learn and learning outcomes can be done not only by playing games, but also by creating games, maybe even more fruitfully, because students need to actively use their knowledge to create a game for others, and they need to reflect on their knowledge and apply it to new situations. I investigated how teachers use game creation in their teaching practices and whether creating games affects students' classroom motivation and their perceived learning outcomes. This study is described in Chapter Five. Two secondary school teachers worked with a game creation platform for 12–14 lessons. Seventy-four students (8th-graders) created and played educational mobile location-based games, and the students collaborated in small groups of two to four students. The students reported that they learned to create a game and that they enjoyed creating the game. However, creating the game did not seem to improve their perceived learning of subject-related knowledge or motivation to learn. Students who created games in small groups had higher scores on perceived learning outcomes and motivation for learning than did students who contributed to the creation of a collaborative game for their class. The students might have needed more guidance from their teachers to profit from creating games because they seemed to have problems relating the games to the subject matter.

#### *1.5 Study 5: Teacher perceptions*

Teachers' perceptions of the usefulness of digital games might be a reason for the limited application of digital games in education. The study in Chapter Six examined the perceptions of teachers. I interviewed teachers, who incorporate digital games into their classroom teaching, to find out their perceptions toward students engagement with the games, motivation for learning and learning outcomes. Semi-structured interviews were conducted with 43 secondary education teachers. The perceived effects were analysed focusing on engagement, motivation to learn and learning outcomes. Almost every teacher reported that DGBL engaged their students, students were willing to invest time in playing or creating games and that they enjoyed doing it. Most teachers also reported that DGBL influenced students' learning in various subjects. However, what the students learned according to the teachers differed: game creation was usually linked to learning programming, whereas game

playing was used to achieve a variety of goals, such as gaining insight into economic processes and understanding causes and effects. A few teachers observed positive effects on students' motivation to learn, more when students were playing the game than with students creating games. Competition seemed to have a positive role when students played games.

The aim of this dissertation is to provide an insight into how digital games contribute to learning, engagement and motivation to learn. The findings from the test results and teacher observations in the five studies indicate that DGBL can be beneficial for student's (perceived) learning because students are engaged when they play and create games. However, the results on motivation to learn are more ambiguous. In the next sections, I reflect on the outcomes and methodological issues and make some suggestions for future DGBL research.

## 2. CONCLUSIONS AND REFLECTIONS ON OUTCOMES

### 2.1 *Elements of game-based learning*

In each of the individual studies, I saw the potential of DGBL for learning, engagement and (to a smaller extent) motivation to learn. But what elements of the digital games contributed to these outcomes? Each of the five studies provided some clues about the important elements of DGBL for engagement, motivation to learn and (perceived) learning outcomes. In this section, I examine which elements of the five studies that foster motivation to learn and (perceived) learning outcomes are found in more than one of each study. Some elements are internal, such as the element of *competition*, *cooperation/collaboration* (used interchangeably here), *usability*, an *authentic context* and *feedback*, and others are external such as the *role of the teacher* and the *ability of students*.

#### 2.1.1 *Competition*

The definition of games presented in the introduction to this dissertation included the internal element of competition: 'organized play, involving one or more players, with goals, constraints, rules, interaction, challenges, pay-offs and their consequences, and aspects of competition (with another player or oneself). A narrative, story or fantasy elements are involved and the game should provide enjoyment and pleasure' (p. 2). The five studies herein showed that the element of competition plays a role in engagement and sometimes in motivation to learn. Study 1 (review) showed that competition was important for engagement, and in Study 5 (interviews with teachers), the teachers mentioned competition as an important element for engagement and for motivation to learn. Additionally, some teachers in this study (Study 5) mentioned that when competition was not present, the students missed it and looked for ways to compete. Habgood (2007) also mentioned that students look for ways to compete in the absence of competition in the game. He added that this is

mostly in the beginning of the game, when students have similar game scores (Habgood, 2007), which might relate to the idea that challenges should be achievable.

Study 5 (interviews with teachers) also showed that, from a teachers' perspective, competition was more important in playing games than in creating games. The results of my studies regarding the role of competition in motivation to learn seem to be inconclusive. Teachers mentioned competition as an important element for motivation to learn, but in the game No Credit, Game Over, the competitive element of students watching other students' scores did not affect their motivation to learn.

Existing literature contains extensive discussions on the role of competition. Vandercruysse et al. (2013) and Boyle et al. (2016) stated that research on competition in games is inconclusive regarding the effects on learning outcomes and motivation. Boyle et al. (2016) found mixed support for whether competition contributed to learning. Cagiltay, Ozelik, and Ozelik (2015) hypothesised that it might matter who students are competing against. Vandercruysse et al. (2013) had their students compete against a virtual character and found that competition was not significantly related to student's learning gains and only partly related to students' motivation. By contrast, in their study in which students competed against each other, Cagiltay et al. (2015) found competition to be positively related to motivation and post-test scores on learning database concepts. Whether competition contributes to learning also seems depend on whether the competition is between individuals or teams. In their meta-analysis, Clark et al. (2016) found that the effects of digital games on learning outcomes were larger with single-player games without competition and with collaborative team-competition games than with single-player games with competition. Thus, competition could be considered positive when it is between groups of students rather than individuals. Our studies echoed this finding; however, in the studies described in this dissertation, competition was not mentioned in these studies as an important element for learning. Nevertheless, in the game Frequency 1550, competition does play a role in learning. The results of playing this game are not only described in this dissertation, but also in Admiraal, Huizenga, Akkerman and Ten Dam (2011), who showed that the more students were engaged in group competition while playing the game Frequency 1550, the more they learned about the medieval history of Amsterdam.

### *2.1.2 Cooperation/collaboration*

As mentioned in the above discussion about competition, teachers can have students work together while playing or creating games. In creating games using the platform 7scenes (Study 4), the students mentioned that they liked the collaborative element. In the other two field studies (Studies 2 and 3), this collaborative element was not explicitly studied. The study of Trespalacios, Chamberlin, and Gallagher (2011) showed that middle school students prefer to play multiplayer games for several reasons (in order of importance): being able to play with friends, collaborating to reach the goal, competing and because it provides more challenging situations.

My field research for this dissertation showed that teachers or designers of the game deliberately had students cooperate. For example, Frequency 1550 and NCGO

are designed to have students collaborate while playing the game, and teachers in the interviews (Study 5) mentioned deliberately having their students cooperate and that they considered collaborative skills as a learning outcome. The teachers of 7scenes (Study 4) wanted students to work together to create games so that the students would have to explicate their thoughts. Van der Meij, Albers and Leemkuil (2011) mentioned articulation and argumentation in a study on collaboration; however, while students did not learn from collaborating during gameplay, they did learn from discussing their answers on the test together.

In Study 1, I found that the studies of Ke (Ke & Grabowski, 2007; Ke 2008a, 2008c) considered cooperative learning an important element that contributes to motivation for math through DGLB. Students in a cooperative game-playing condition were more motivated for math than students in a competitive or individualistic game-playing condition. Wouters et al.'s (2013) meta-analysis also showed that playing games in a group was the most effective condition for learning. They stated that this might be because some learning activities such as the articulation of knowledge are not automatically addressed by learning games and that playing in a group might be an effective way to foster these additional learning activities (Wouters et al., 2013). As could be seen in Van der Meij et al.'s (2011) study, collaborating during gameplay does not always invoke learning. We agree with Wouters et al. (2013) that more research is needed on the guidelines for cooperation and to understand the most effective group size.

### 2.1.3 *Authentic context*

In the studies in this dissertation, several aspects relate to an authentic context for learning; that is, students are either performing authentic tasks or studying in the real world, an authentic environment. The pedagogical approach that situates learning tasks in the context of real-world situations, providing opportunities for learning by encountering the same problem-solving challenges as in daily life, is called authentic learning (Herrington, Reeves, & Oliver, 2014). Examples of students doing tasks in the real world are Frequency 1550 (Study 2) and NCGO (Study 3). Students learned about medieval Amsterdam (Study 2) while walking through the authentic city centre with historic buildings, and they learned about debt (Study 3) by visiting organisations that play a role when someone is in debt. Study 3 faced students with a problem they could encounter in daily life and is in line with what Herrington et al. (2014) called authentic learning. The designers of the game NCGO chose to have students visit real organisations in the game with the aim of lowering the threshold to enter these organisations if needed (when in debt) later in life. Learning in an authentic context in the sense of an authentic environment, as we saw with Frequency 1550 and NCGO, was made possible by the portability of mobile location-based games and their possibility to add an extra layer to the environment by connecting assignments to the players' location in an authentic environment (Avouris & Yianoutsou, 2012; Wake, 2014). This link with the environment seemed to be missing in many of the games students created in the study about creating games (Study 4). The students created games that could have been played without the element of

portability and context sensitivity and hence did not use the strength of learning with mobile location-based games. This might be one reason students failed to learn much, but more research is needed to see if this is a suitable explanation.

The review (Study 1) showed that in game making, authorship and ownership of the game, involvement in real research and development and making games for a particular group were important characteristics for engagement. These game characteristics make creating games a more positive experience than regular school assignments; students feel they are doing something authentic because the game they create will be played by other students. Prater (2016) showed in her dissertation that creating a game for a real audience made many students feel like an actual game designer or programmer. In Study 4 on creating games, the aspect of authorship and ownership was important. Students appreciated the creative aspect of the game because they were able to decide on the subject, what assignments to create and where to place them on the map as they would in real life, without consulting the teacher.

The teachers mentioned the importance of an authentic context, such as starting their own company, with regard to motivation to learn (Study 5) because students started to realise the value of the theory in practice. Therefore, by playing the game, students realised that what they had learned in school was meaningful if they wanted to start their own companies. They learned this without the real-life risks of having a company (learning in a safe environment).

#### *2.1.4 Usability*

Aspects of games such as quick progress, ease of use, amount of technological problems and the reading of instructions can be captured under the name usability, which is a term used in the software industry referring to delivering a user experience with as few unnecessary interruptions or challenges as possible (Laitinen, 2015). The review (Study 1) showed that quick progress in the game and easiness of the game are important for engagement. Study 1 also showed that engagement is negatively influenced by technological problems and by having to read instructions; these are also reasons teachers mentioned for disengagement (Study 5). In Frequency 1550, students located in the headquarters were more engaged than those in the city, which is likely because they had fewer technological problems, or because they had to spend less time waiting and they had many different tasks and more overview over the tasks in the game. All these aspects might have contributed to this higher engagement.

#### *2.1.5 Feedback*

Many definitions of games include the element of feedback. It is also implicitly included in our definition under 'pay-offs and their consequences', which provide players with feedback about their actions. The teachers stated in their interviews (Study 5) that direct feedback from the game helped students realise the consequences of their actions and thus contributed to learning. The role of feedback is also mentioned in the review study (Study 1) and in other review studies such as that

by Jabbar and Felicia (2015), which mentioned scaffolding as an important element for gameplay and learning and that ‘feedback and many forms of support tools are inherent to DGBL, as users are on their own and need support to achieve their goals’ (Jabbar & Felicia, 2015, p. 766). Wouters and Van Oostendorp (2013) also mentioned in their meta-analysis that feedback improved learning. Johnson, Baily, and Van Buskirk (2017) also reviewed the role of feedback on learning. They originally set out to research the role of feedback on learning *and* motivation; however, they were unable to find enough empirical evidence about how feedback affects motivation and thus focused solely on learning. Overall, process (explanatory) feedback tended to be more beneficial than outcome (corrective) feedback. Johnson et al. (2017) also looked at modality (visual or auditory), timing (immediate or delayed) and adaptation to individual differences. However, the results were inconclusive because the studies in the review had widely varied domains and types of games and there were limited studies available, but there was a trend towards immediate feedback. Johnson et al. (2017) advocated a value-added approach to understand the relationship between feedback and learner characteristics and advised that future research should focus on long-term retention and transfer.

Feedback can also be provided by the game itself, as in Frequency 1550 (Study 2) where students knew instantly whether their answers were right or wrong, but it can also be provided by the teacher. The next section examines the role of the teacher.

#### 2.1.6 *The role of the teacher*

External elements also influence learning, motivation to learn and engagement. The review (Study 1) and interviews with teachers (Study 5) on their practice-based perceptions of the effects of games showed an important role of the teacher in DGBL, for learning outcomes and engagement. Teachers facilitate and coach students, give feedback, teach skills that are necessary to play the game and guide conversations. The importance of the teacher’s role could be observed in our study on creating games (Study 4). In Frequency 1550 and NCGO (Studies 2 and 3, respectively), the game master assumed the role of the teacher as a facilitator of student reflection. The importance of the role of the teacher (or someone taking this role, such as a game master) is addressed in many other studies as well (e.g. Gabriel, 2016; Hämäläinen & Oksanen, 2014; Marklund & Taylor, 2016; Owston et al., 2009; Prater, 2016). In his dissertation, Wood (2011) concluded that participants gain little in cognitive ability outcomes without the guidance of a teacher providing reflection and collaboration (Wood, 2011, p. 177). Marklund’s (2013) dissertation also pointed out the important role of the teacher. The teacher should connect the gameplay to the subject matter, encourage reflections and direct the debriefing sessions. This is an important requirement of the teachers because games do not always automatically teach players what they need to learn for school; thus, teachers can help guide the learning process of students towards the intended specific educational goals.

### 2.1.7 *Ability of students*

A student characteristic that was mentioned several times in all five studies was the student's ability. The role of ability was mentioned mostly for learning; however, the results regarding what that role exactly are inconsistent. In our review (Study 1), Banerjee, Cole, Duflo, and Linden (2007) showed that the learning of the weaker students improved the most, whereas Greenhill et al. (2008) claimed that the moderate students learned the most. Additionally, in our study using Frequency 1550, the students with a higher educational level learned the most, even though the intention of the game was to provide an effective tool mainly for students from a lower educational level. However, when looking specifically at the students' history of ability, those with an initial low level gained the most in knowledge.

### 2.2 *Concluding remarks*

The five studies have shown that using games in education can be beneficial for learning, engagement and, to a lesser extent, motivation to learn. The overall research question was 'How do digital games contribute to learning, engagement and motivation to learn?' Using games in the lessons can be a way of fitting into students' personal worlds by using new media and peer interaction. Game play can make students more willing to put effort into what they have to do for school and help them to learn. The five studies presented in this dissertation show that several internal and external game elements might contribute to the benefits of games for learning, engagement and motivation to learn: competition, collaboration, an authentic context, usability, feedback, the role of the teacher and ability of the student. More research is needed to find out how these elements exactly influence learning, engagement and motivation to learn and interact with each other.

## 3. REFLECTIONS ON MY RESEARCH APPROACH IN THE EVOLVING FIELD OF DGBL AND FUTURE DIRECTIONS

In this section, I discuss the strengths and limitations of the study in light of the developing field of DGBL-research and provide future research suggestions.

### 3.1 *Combination of methods and perspectives*

This dissertation used quantitative and qualitative methods. Each method has its advantages and disadvantages, and using several methods helps to obtain a clear picture of the field. The quantitative data were obtained through objective test scores, questionnaire scores on perceptions and some data from the game (e.g. scores), while the qualitative data were obtained by interviewing teachers and students. As these studies were short-term studies without any follow-ups, future DGBL research should conduct longitudinal and follow-up studies (recommended by All et al., 2016) to examine the long-term effects of DGBL and rule out that the possibility of novelty effects (temporary effects due to something new being intro-

duced, which wear off once the novel intervention is no longer novel). Additionally, the tests should be designed to match what the students learn via DGBL because traditional tests might not always capture what is being learned.

As well as combining methods, we studied DGBL from several perspectives: the perspectives of teachers and students, and students playing and creating games. The perspective of the game designer would also have been worth investigating (for instance looking at what the designer intended to bring about by creating the game) and might be a direction for future research.

### *3.2 The growing field of DGBL research*

Because the field of DGBL is a rapidly growing field, this might raise questions about whether the results of my research are still valid, especially because my review relates to research published in 1999–2009. However, looking at more recent research, for instance the reviews of Clark et al. (2016), Jabbar and Felicia (2015) and Wouters et al. (2013), the research results on engagement, motivation for learning and learning resemble those found in this review. While the results remain somewhat ambiguous, overall, the use of games can be beneficial for learning, engagement and, to a lesser extent, motivation to learn. Boyle et al. (2016) updated Connolly, Boyle, MacArthur, Hainey, & Boyle's (2012) review about the positive impacts and outcomes of computer games. The updated review shows that little has changed regarding whether games positively influence learning and behavioural outcomes. They also found that games are still used mostly to support knowledge acquisition. However, there were some changes in the field. Progress has been made in understanding how specific game features such as competition engage players and support learning, and the understanding of features that make games more engaging has progressed in the sense that more precise definitions of constructs such as flow and engagement have been proposed and measures have been developed to differentiate more between these constructs (Boyle et al., 2016).

When I look back at my review and other reviews that have appeared in the meantime, the strength of my method of reviewing lies in systematically checking the minimum quality of the studies included and looking at the groundedness of the conclusions, which I did to include new research not published in peer reviewed journals and to subject all articles (peer reviewed or not) to the same analysis. Even in peer reviewed journals, some of the conclusions were not grounded in the design or results of the studies. I think it is important when writing reviews to scrutinise articles for groundedness and to not only look at conclusions, even when only using peer reviewed articles.

### *3.3 Moving beyond effects*

Much research focuses on the effects of DGBL, which was important when little data was available on the effects and empirical studies on DGBL were needed. The effects of DBL were also something I focused on when starting this dissertation project. As the body of research on DGBL is growing, I suggest looking not only at the

effects, but also at the process of using the game and examining what happens when students play or create games to establish why certain effects occur. All, Castellar and Van Looy (2016) recommended evaluating the process of the game intervention itself, using a naturalistic design with observational data collection for determining what makes a DGBL intervention effective. Evaluating the process of the game intervention aims at understanding the underlying mechanisms that might contribute to the effects that were found. I also emphasise the importance of collecting process data. For example, in Study 4, I observed teachers and students in their process of creating games for learning to see what they did. While the questionnaire data in this study showed that students did not perceive to have learned, observations of the students and the games they created showed that this might be because the game creation assignments were not related to their learning content. Nevertheless, the students had fruitful discussions in the process of creating games, which their teachers interpreted as student learning. It might be that the students' definition of learning is more limited than that of the teachers. I recommend that future research focuses not only on the effects of gaming, but also includes data collection on the process of gaming to establish what students and teachers do and think while a game is being played or created. By doing so, researchers can look beyond whether games work, and look at how they work, why they work, for what content, in what context and for whom.

#### 4. PRACTICAL IMPLICATIONS

In this section, I discuss the practical implications of the results of the research in this dissertation. I address implications for teacher preparation and what should be done to facilitate game use in curricular contexts.

##### *4.1 Teacher preparation*

The use of games in secondary education is lagging behind the interest in games. This research highlighted the importance of the teacher in DGBL because they need to decide what games they can use practically (e.g. whether it fits in the schedule and whether the infrastructure is appropriate) and educationally (e.g. what goals need to be reached, whether it fits in the curriculum), they need to guide the gaming process and help with more technical questions (Marklund & Taylor, 2016). Teachers need to match technology, pedagogy and content knowledge (Koehler & Mishra, 2008; Mishra & Foster, 2007, 2009). The European Schoolnet report on how digital games are used in schools (Felicia, 2009) mentioned that the majority of teachers willing to incorporate games lack the knowledge and skills to do this successfully. Teachers do not feel prepared for using games in education (Verheul & Koops, 2013), which teachers in our interviews also mentioned. This problem is broader than the use of games: teachers do not feel prepared to effectively use ICT in their classroom (Tondeur, Pareja Roblin, Van Braak, Voogt, & Prestridge, 2016); therefore, it is expected that they will have problems effectively using games in the classroom. An important practical implication is that teacher education should prepare

student teachers for using ICT and teaching with games and educate teachers how to match technology, pedagogy and content knowledge. The pedagogical use of ICT is not modelled enough for pre-service teachers. Therefore, prospective teachers need good role models to use ICT and games in education (Martinovic & Zhang, 2012; Tondeur, Van Braak, Voogt, Fisser, & Ottenbreit-Leftwich, 2012). Prospective teachers need to know how to use games in education and understand the characteristics of effective games. They also need to know how to find good games, which is a problem (Van Eck, 2015). In subject teaching, prospective teachers should be taught how to find good games for the subject, how to create games that fit their curriculum (Vallet et al., 2014) or alter existing games, either by changing the game or by adding information to the game. When finding and creating good games, teachers should carefully consider the elements that are present in a game, such as competition and authentic context, and check whether these elements contribute to engagement, motivation to learn and (perceived) outcomes.

Prospective teachers should be taught what the demands for game-based learning are, how to decide if using a game the best tool for their learning objectives and learners, what game to choose and whether the infrastructure is sufficient. They should then plan their didactic approach, communicate about the use of game and reflect on their role in DGBL. Prospective teachers should also have the opportunity to practice drafting lessons around digital games, using games in an authentic setting and receiving feedback on these actions (Gabriel, 2016; Tondeur et al., 2012).

#### *4.2 Game use in curricular contexts*

As mentioned earlier in this thesis, digital games are not always suitable for use in curricular contexts. Wake (2013) concluded in his dissertation that technology ‘should align with existing technological practices and institutional constraints to be successful’ (Wake, 2013, p. 105). Several things can be done to stimulate the use of games in the curriculum, and game designers should consider the curricular context and the goals that need to be reached when creating educational games for secondary education.

For teachers, there are also ways to facilitate the use of games in a curricular context. Often games take more time than the lessons that are dedicated for a certain subject. By working in an interdisciplinary manner, teachers can create time for playing games beyond the scheduled hours of the teachers’ subject. As most games address more than one subject, they offer opportunities to learn beyond a specific subject. Therefore, if games are not used to teach one specific subject, but to teach more thematically, teachers will be able to create more opportunities to use games. Another opportunity to deal with the restrictions of class hours is having students play (partly) at home and use class time for debriefing sessions.

### 5. FINAL REMARKS

This dissertation has shown that DGBL has the potential for improving (perceived) learning outcomes, engagement and (to a lesser extent) motivation for learning. For

learning and engagement, the results were more positive than for motivation for learning. Many elements play a role in DGBL: competition, collaboration, an authentic context, usability, feedback, the role of the teacher and ability of the student. Mobile location based-games enable on-site learning and can make it possible to place the learning in an authentic environment. While it was difficult to locate teachers who currently use games in the classroom, there is much to be gained by preparing teachers to incorporate games into their teaching. However, considerable research is still needed to investigate the conditions in which games work best for whom and how student activities relate to the benefits of game. So: to the next level of DGBL-research.