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Digital game-based learning in secondary education

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CHAPTER 5

STUDENT LEARNING BY CREATING LOCATION-BASED GAMES IN SECONDARY EDUCATION

Handheld location-based games can be used to engage students by connecting virtual worlds with real life, thereby situating learning in students' immediate environments. Two secondary school teachers worked with a game creation platform in which 74 students (8th-graders) created and played educational mobile games. Students collaborated in small groups of two to four students. We conducted a descriptive case study and closely followed the teaching-learning process to determine whether creating and playing games affected students' motivation for learning and their subject-related knowledge. In interviews, students reported that they learned to create a game and that they enjoyed creating the game, but creating the game did not seem to improve their subject-related knowledge. Students who created their own 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.

1. INTRODUCTION

One of the causes of low student motivation in schools is the incongruity between students' school environments and their personal worlds, which involve more peer interaction and the use of new media (Shaffer, 2008; Thoonen, Slegers, Peetsma, & Oort, 2011; Van der Veen & Peetsma, 2009). The use of games in education might help to enhance students' motivation by making learning more enjoyable (cf. Char-sky & Ressler, 2011; Klopfer, Osterweil, Groff, & Haas, 2009). Games have the potential to not only motivate students but also support student learning because they have been found to promote students' active learning (Gee, 2014; Shaffer, 2006; Wideman et al., 2007). Several studies on students *creating* games demonstrate that creating games may have additional benefits over playing games for learning and motivation (e.g. Kafai, 1996; Vos, Van der Meijden, & Denessen, 2011). Therefore the present research examined students who create games rather than students playing the game. Little is known about how students create games as part of their regular subject classes and how they experience this process. We followed two teachers whose students learned by creating games to understand how teachers adopt this approach in practice and whether this method of teaching affects students' classroom motivation and their perceived learning outcomes.

1.1 Game-based learning

Interest in using games for education is increasing, in part, because of their assumed effects on learning and motivation. Empirical evidence for the effects of games on learning and motivation can be found in several reviews (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Girard, Ecalle, & Magnan, 2013; Perrotta, Featherstone, Aston, & Houghton, 2013; Sitzmann, 2011; Tobias, Fletcher, Dai, & Wind, 2011; Vandercruyse, Vandewaetere, & Clarebout, 2012). Wouters, van Nimwegen, Van Oostendorp, and Van der Spek (2013) performed a meta-analysis of 39 studies comparing serious games with regular instruction methods and found that serious games were more effective in terms of learning and retention. Serious games were also associated with higher motivation, but this effect was not significant. Learners playing serious games acquired more knowledge and cognitive skills when they worked in groups, when multiple training sessions were involved, and when games were supplemented with other instructional methods. Wouters and Van Oostendorp (2013) showed that the effect of instructional support was largest for cognitive knowledge and skills and when instructional support was used for the cognitive process of selecting relevant new information. Wouters and Van Oostendorp also classified instructional support based on categories of support. They found that reflection, modeling, collaboration, modality, feedback, and personalization all affected learning positively, but other categories support (e.g., advice) did not have statistically significant effects on learning. Reflection is described as stimulation to think about answers and/or explain these answers; modeling involves describing how a problem is solved; collaboration involves discussion, often with the aim of explicating implicit knowledge; modality is the use of the audio channel to limit visual search; feedback involves information about whether and/or why an answer is correct; and personalization involves adapting a context to the personal interests of the player (Wouters & Van Oostendorp, 2013, p.414). The literature we have reviewed thus far demonstrates that game-based learning can improve students' learning and motivation, sometimes more than teaching without games (e.g., Arici, 2008; Papastergiou, 2009).

A specific type of games are location based-mobile games. These games can be played in real-world locations, which may include historical or geographical sites, and virtual data can be added to these locations or to real-world contexts (Klopfer & Squire, 2008). In their study on the location-based mobile game Frequency 1550, which focuses on the history of medieval Amsterdam, Huizenga, Admiraal, Akkerman, and Ten Dam (2009) evaluated the effectiveness of this method of learning. Compared to students who participated in regular lessons, students who played Frequency 1550 learned significantly more about medieval Amsterdam. Although positive effects were found with playing games in other studies on mobile game-based learning as well (e.g. Ardito, Costabile, De Angeli, & Lanzilotti, 2012; Hwang & Chang, 2015), we agree with Lim that "it is only when students are empowered to take charge of their own learning by co-designing their learning experiences with teachers and other students that they are more likely to engage in their own learning process" (Lim, 2008, pp. 1002–1003).

2. GAME CREATION

Several studies on game creation demonstrate that creating games may have additional benefits over playing games. Kafai (1996), for example, showed that by designing games, students not only learned *to design* games but also learned *about the design* of games “and reached a level of reflection that went beyond traditional learning and thinking” (p. 94). Games (2010) also showed that students can learn about game design by creating games, including learning how to analyze game designs and how to articulate their own versions of design problems and solutions. Creating games and other media might help students to increase their understanding of media and to become critical participants in and designers of games (Peppler & Kafai, 2007).

In their study, Robertson and Howells (2008) used game creation as a powerful learning environment and analyzed the learning that took place during game creation with respect to the themes outlined in “A Curriculum for Excellence”. They found that students became successful learners based on their display of the following aspects of successful learning identified in the curriculum: “motivation and enthusiasm for learning; determination to reach a high standard of achievement; and skills in independent learning, learning in a group, and linking and applying learning in new situations” (Robertson & Howells, 2008, pp. 567–568). Robertson and Howells also noted the cross-curricular potential of game creation, which can be implemented in a wide curriculum through an interdisciplinary approach that incorporates subjects such as creative writing, drama, and design. Greenhill, Pykett, and Rudd (2008) demonstrated that students not only acquired scientific concepts by creating games but also developed their digital literacy and engagement in a scientific design process of creating scientific microgames. While creating these games, the students went through a cycle of designing, testing, refining and completing the design of the microgame. In the process of creating these scientific microgames, the students were “scientists” in the sense that they observed a situation, developed hypotheses, identified and manipulated variables, observed outcomes and evaluated their understanding. Furthermore, students enjoyed creating the microgames. Key factors that seem to lie at the source of this engagement were students’ authorship (they could create their own content) and ownership (the locus of control was transferred from the teacher to the student) as well as playful learning (the students enjoyed playing in the environment and liked to see what would happen while creating games) and the social value of the game. Good games were widely played and attracted the attention of other students for the author (Greenhill et al., 2008). Khalili, Sheridan, Williams, Clark, and Stegman (2011) also found that by creating, students developed a sense of ownership of their game and a responsibility to make the game aesthetically pleasing, engaging, and scientifically accurate. Furthermore, the students learned to question their own knowledge and to articulate their knowledge (Khalili et al., 2011). Therefore, it seems that creating games, like playing games, might have a positive influence on students’ motivation as well as their learning outcomes.

Vos et al. (2011) compared playing games with constructing games and found that students were more motivated and used higher-level cognitive strategies when constructing games than when playing games. These authors compared playing and

creating games as well as creating games and teaching without games. According to the teachers in the study by Owston, Wideman, Ronda, and Brown (2009), students who learned from game creation showed greater engagement than they would have showed if the teachers had not used games in their teaching. The students' understanding that classmates would play their games and the ability to play their classmates' games increased the students' motivation and desire to complete the task (Owston et al., 2009).

Wake and Wasson (2011) researched the creation of mobile location-based games by students to learn history. Students learned about local history through creating games and gained additional knowledge by playing games created by another group. Wake and Wasson are convinced that learning by creating mobile location-based games is a motivating and rich way to learn and a promising approach that should be studied further.

In summary, both playing and creating games can be powerful tools for promoting students' learning and motivation for learning. However, these studies did not examine how teachers use game creation in their regular classes. In most studies, researchers have implemented games and sometimes even taught with these games. This approach might bias the findings of these studies in a positive way. Therefore, in our study, we examine how two teachers begin using game creation in four secondary school classes. Using a game creation platform, students can play and create a mobile location-based game. Our research questions are as follows:

- 1) How do teachers use game creation in their teaching practice?
- 2) Does creating games affect students' classroom motivation and their perceived learning outcomes?

3. METHOD

3.1 *Participants*

Two teachers from a school that was a partner in a former game project piloted game creation and invited the researchers to monitor and evaluate their teaching practice. The other participants were 74 eighth-grade students (35 male, 39 female) from four classes in a school for pre-vocational secondary education in a large city in the Netherlands. The students, who were 13–15 years old, created games on the subject of Care (33 students) or Physics-Chemistry (41 students) during their Computer Science classes. In the Netherlands, Care is a subject based on the traditional subjects of home economics and health education and includes topics such as relationships, the environment, leisure activities, and volunteer work (Volman & Ten Dam, 2007). Physics-Chemistry is a subject that combines the two subjects of physics and chemistry.

Two Computer Science teachers provided instruction in two classes each. One teacher had some experience using the game creation platform (see next paragraph), and the other did not. They wanted to use new media to make the educational experience fit the students' real-life experience by trying 7scenes in class. They wanted the students to collaborate while creating games because this would encourage students to explicate their thoughts by talking to each other about the assignments they

created. In this process, students needed to share information with each other. The students were required to create the assignments on paper before working on the computer because the teachers wanted the students to focus on thinking about the assignments.

3.2 *The platform used for creating games*

The teachers used a platform called 7scenes (<http://7scenes.com>), developed by Waag Society (<https://www.waag.org/en>). Students created games in a simple template (see Table 1 for the templates) into which details about the game were inserted and rules were set. They created assignments and simply dragged tasks and media onto a Google map. When the students finished their game, it could be published for others to play.

Table 1. Templates of 7scenes

Secret Trail/Free Play (simplest template)	Collect & Trade	Adventure (most complex template)
A discovery route on which various spots in the environment are visited by following hints and completing assignments that pop up on the mobile phone. In a secret trail, the order of assignments is set; in free play not.	The players have a mission to collect a specific combination of objects hidden in the environment. Players can trade objects with each other.	Set-up is a role-playing game in which teams receive certain identity characteristics at the start of the game. These characteristics determine their power and skills in the game. Various assignments for different identities are placed at certain locations.

The game platform consisted of a web-based environment and location-based phone applications (see Figure 1). Students could use the 7scenes web-based environment on their computers to create location-based games that could then be played on smart phones with a 7scenes application, GPS, and an internet connection. When playing a game, students could see where they and other players were on the map via colored dots that depicted their positions. The GPS triggered assignments to pop up when the player reached the location where the creator of the game had placed these assignments on the map. After playing the game, the students or their teacher could use a review tool (on the desktop) with a playback option to see their scores, the route that they walked, and their completed assignments. During gameplay, the game provided feedback on whether an answer was correct. The students who created the game could assign hints to be provided when the player chose an incorrect answer.

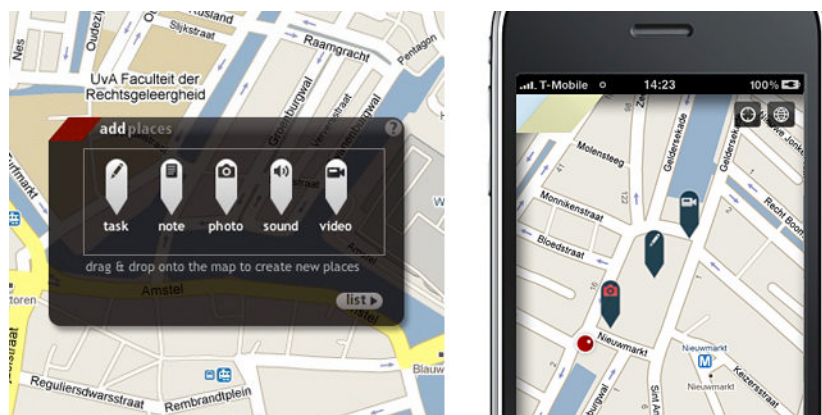


Figure 1. Map of 7scenes platform as shown on the computer (left) at the development stage when the places are entered and on a mobile phone (right) at the final stage as a playable game (source <http://7scenes.com>).

3.3 Procedure

We observed the lessons from the first lesson, in which the students received the assignment, to the last lesson, in which they played the games that had been created. In total, 12–14 lessons of 50 minutes were observed. The teachers were free to choose how they would approach working with the platform. Our observation focused on how the platform was used in practice and students' motivation for learning.

3.4 Measurements

For this descriptive study, a mixed-methods research design was used. All lessons were videotaped, observation notes were taken, and the games that were created were saved with screenshots. Students were asked to answer questions about their background (e.g., their age) prior to the project and to complete a questionnaire at the end of the project measuring three topics: their perceived learning outcomes of the lessons, their motivation for learning, and their attitudes toward schoolwork collaboration with their peers. The questionnaire included 28 statements that could be answered on a five-point Likert type scale, with “1” indicating “does not apply at all” and “5” indicating “applies completely”. All of the statements on perceived learning and motivation for learning had to be answered twice. In the first half, the statements referred to the lessons in which students created and played a game; in the second half, students answered the same statements with reference to the school period before the project. In this way, we were able to compare students' motivation and learning experiences between game creation and regular teaching. To prevent a sequence effect, half of the students answered the statements in reverse order. More information on the scales of the questionnaire can be found in Table 2. To compute

the reliability for scales with five items, we used Spearman-Brown's correction for test length (lengthened to six items).

Table 2. Questionnaire on learning, motivation, and collaboration

Scale	No. of items	α *	Example statement
Perceived learning outcomes of lessons with 7scenes	6	0.74	I felt the lessons with 7 scenes were useless
Motivation for the lessons with 7scenes	5	0.83	I liked 7scenes
Perceived learning outcomes of lessons in this past school year	6	0.82	I felt the lessons this past school year were useless
Motivation for lessons in this past school year	5	0.76	I liked school this past school year
Attitudes toward collaboration with peers	6	0.75	I prefer to work alone

* *Alpha after Spearman Brown's correction for test length.*

Students worked in groups of two to four students, with 11 groups in the two Care classes and 17 groups in the two Physics-Chemistry classes. One student from each group was randomly selected for a short interview (max. 15 minutes) about his/her experience with creating and playing games. In the interview, we asked the students about their motivation and perceived learning, such as, "What did you like or not like about the project?" and "Why?" The topics of the interview were the attractiveness of working with 7scenes, ease of use, technical issues, the time needed for creating games, the integration of subject matter in the game, perceived learning and collaboration. In total, 27 students from the 28 groups were interviewed because one group (from a Care class) could not be reached before the summer break.

Both teachers were also interviewed regarding the extent to which they liked working with 7scenes, why they began using 7scenes, and their opinions about their students' learning and motivation during the project.

4. ANALYSES

The first research question, about how teachers use the platform for creating games in practice, was answered by summarizing the observation notes and teacher interviews. Videotapes were used as backup for the researchers' field notes. The second research question, about whether creating games affects students' classroom motivation and perceived learning outcomes, was answered by analyzing the questionnaire and the interview data. Descriptive statistics were used for the questionnaire data. Differences between the students' perceptions of learning with 7scenes and school learning in general were tested with a paired-sampled t-test ($\alpha = 0.05$). The interviews were transcribed. Each question was directly related to a topic, and these topics were used to summarize the interviews, so each question topic received a code

(e.g., answers to the question about whether it was easy or difficult to place assignments were coded “ease of use”). Finally, screenshots of the games were used to check whether the assignments were about the subjects involved and whether they were related to the physical environment because one would expect a relationship in location-based games between the assignments and the environment.

5. RESULTS

Both teachers had the same main set-up for the lessons. The teachers wanted their students to create and play an educational game about part of their curriculum (either Care or Physics-Chemistry). They wanted their students to work on their knowledge in an appealing way.

The teachers grouped the students into small subgroups based on the underlying idea that the students should match socially. The teachers stated that the students had to create the assignments about the subject on paper before working on the computers.

5.1 Implementation of game creation in the lessons

In the Care classes, the students focused on the theme of love. In the Physics-Chemistry classes, the subject matter was organized around subthemes related to the subject, including traffic, movement, sound, electricity, weather, temperature, light, and shadow. Students could choose one of these subthemes, but they could also choose to focus on the subtheme of collaboration, which is a general school theme at their school.

The first two or three lessons were used to introduce students to game design and to play a small mobile game created with 7scenes as an example. In the remaining lessons, the students worked on the assignments in the teacher’s presence. The teacher monitored the groups of students to observe what they were working on and asked questions. In addition to the lessons dedicated to working in small groups, the students spent one morning testing their games and playing a game created by another group. At the end of that morning, in two classes (one Care and the other Physics-Chemistry), the games were briefly reviewed using the playback option of the review tool in the platform. In the other classes, the teachers decided to skip the review of the game sessions because of the high temperatures in the classroom.

One important difference was identified in the way the teachers worked with the platform. In the Care classes, each group of students created their own game, whereas in the Physics-Chemistry classes, each group of students chose a theme and worked on a set of assignments to create one overall class game. Thus, in this collaborative game, all themes were represented. In each Physics-Chemistry class, one group acted as a coordination group and did not work on a theme. Instead, the group coordinated the assignments of the other groups and, together with the teacher, added these assignments in 7scenes. Because this difference in approach (as well as the differences between the subjects and teachers) might lead to different student experiences, we present the results as two separate cases.

5.2 Case 1: each student group creates a game

The following results are related to the two classes in which each student group created a game on the subject matter of Care.

5.2.1 Evaluation of the implementation

Most students (seven out of the ten interviewed) indicated in their interviews that the software was quite easy to use and that they could easily add text and pictures to the game template. Of the students who thought it was difficult to work with the software, one had a hard time deciding where to place the assignments, and another did not initially know how to place the assignments. Regarding the game play, four students found working with the game phone to be difficult, mostly because adding media worked differently than on their own smartphones.

Six students thought that playing a small game before they began creating their game helped them to create their game in 7scenes and to play others' games. The example game helped them to understand what a game should look like, what the player was supposed to do in a game, and how the game phone worked. The students liked collaborating with their peers because they were able to generate and share more ideas and because doing so involved less work. They also reported that collaborating was more fun than working alone. The quantitative data show that students agreed with the statement that they enjoyed collaborating (mean = 3.99, sd = 0.72). All but one of the students who were interviewed liked having to work on paper before using a computer. The students explained that this approach helped them to focus on thinking about the assignments, and it was easy to show to the teacher what they had produced.

In choosing locations, the students searched for assignment locations that were close to their starting locations. In general, the students did not actually select locations on the basis of their relevance to the subject matter. Six students attempted to incorporate the subject matter into their assignments by asking questions about what they learned in their Care classes; some of these students (re)read their Care textbook to facilitate this process. Eleven games were created. The screenshots show that the games were all related to the theme of love, such as assignments about romantic things to do, homosexuality, and loverboys (boys that seduce girls, with presents and attention, to prostitute herself for him), but not all of the games were related to the material on Care. For example, there was a game with the goal of winning the love of Sandy, a female character in the *Spongebob Squarepants* cartoon series, by answering questions about her. These assignments, like most assignments in the games, seemed to be unrelated to the location and could have been used in a game anywhere. The few assignments that involved location were mostly not about the theme of love but were about non-relevant facts, such as the number of busses passing by or the date of a slavery monument in a park.

The teacher of these two classes was involved in the development of 7scenes and had previously worked with the software. He argued that there was no time available in class to reflect on the issues raised in the games. The teacher also did not believe that the review tool in 7scenes sufficiently stimulated reflection because the infor-

mation was not arranged by assignment. Therefore, the tool was not helpful in discussing specific assignments. The students in the class in which the teacher had used the review tool liked it because they were curious about their scores and enjoyed seeing everyone's pictures and the routes that they walked. The teacher reported a desire to work with 7scenes again in closer cooperation with the subject-matter teacher in order to better integrate the subject matter into the game that students created.

5.2.2 *Motivation and learning*

Except for one student who did not like computers and games, all of the students stated that they would like to work with 7scenes again for other school subjects. They thought that learning for school by using 7scenes was fun. The observation notes show that the students particularly enjoyed being allowed to determine the subject and the assignments, to place the assignments on the map and to collaborate with each other. They asked several times if they were completely free to make these decisions.

Six students reported in the interviews that creating the game taught them how to create a game, use the 7scenes software, use a map, and collaborate with other students. Furthermore, they said that they learned more about the theme of love. Three students explicitly stated that they had learned more by using 7scenes than in regular lessons because it was a more active way of learning. However, four students indicated that they did not learn anything by creating games.

Five students felt that creating a game could be more effective for promoting learning than playing a game. The students who elaborated upon their answers explained that when creating a game, they had to search for information to create a question for each assignment. However, four students reported that playing a game could be more effective than creating a game. One student elaborated that when he played someone else's game, he was asked questions to which he did not know the answers.

The mixed results from the interviews are confirmed by the t-test (Table 3). No significant differences (with $\alpha = 0.05$) in reported motivation or perceived learning were found between the game lessons and the regular lessons.

According to the teacher, the students learned how to use the technology. Moreover, the teacher reported that students spent a substantial amount of time on the theme of love, with fruitful discussions. The students were somewhat demotivated because they expected a game resembling the commercial computer games they played at home. However, after this initial disappointment, the students worked hard and for long periods of time on their games, and most of them enjoyed illustrating their games with pictures.

Table 3. *T*-test of perceived learning outcomes and motivation for the past school year versus the 7scenes lessons for students creating individual games

Scale	Past year	Scale	7scenes	<i>t</i>	<i>p</i>
Perceived learning outcomes	3.72 (0.91)	Perceived learning outcomes	3.42 (0.85)	1.34	1.90
Motivation for the lessons	3.42 (0.85)	Motivation for the lessons	3.72 (0.88)	0.57	0.58

Note. *df* = 32 for both analyses. Standard deviations appear in parentheses below means.

5.3 Case 2: student groups create a collaborative game

The following results are related to the two classes in which the student groups worked collaboratively on one class game on the subject matter of Physics-Chemistry.

5.3.1 Evaluation of the implementation

With the exception of the students of the coordination group, the students barely used the 7scenes tool. Students were allowed to place a few assignments in the 7scenes environment, mostly with the help of the teacher and the coordination group. All of the interviewed students felt that it was not difficult to place the assignments in 7scenes. Some students reported difficulties with the game environment and the map in particular (while playing the game, not everything in the park was shown on the map, or it was not clear which dot represented their group).

The screenshots show that in one class, all of the assignments were about the subthemes (in the other class, two assignments were not), although not always in the way the teacher intended. The subtheme of traffic, for example, was meant to include issues related to Physics-Chemistry, such as velocity and acceleration. However, the students created assignments on traffic rules and traffic signs. Compared to the Care classes, most assignments in the Physics-Chemistry classes seemed to be more closely related to the location, such as the temperature of a pond in the shade and in the sun.

In general, the students reported that they had sufficient time to create their assignments. Two of them mentioned they could have successfully created their assignments with less time, but two other students felt that they needed more time to complete the assignments properly. The teacher mentioned that it was helpful to play the example game first because she could subsequently refer to that experience.

5.3.2 Motivation and learning

Of the 17 students who were interviewed, eight reported that they would like to work with the platform again for another subject. The reasons they mentioned for

wanting to work with the platform again were that they liked working with it and thought it was instructive or a combination of these two reasons. They noted that they particularly enjoyed the creative part of the game creation (inventing the assignments and, for the coordination group, inventing the story). Other positive effects that were mentioned by more than one student included being outside, working on computers, and collaborating with peers. Six students reported that they did not want to use 7scenes for other subjects because they did not think the game would be useful for other school subjects. Three students did not know whether they wanted to use the game for other subjects.

Of the 17 students interviewed, ten mentioned that they learned from creating the game. They acquired knowledge of temperature (becoming aware that they could measure water temperature and learning how to do so), traffic signs, and information and communication technology (becoming aware that they could create a location-based game, learning how to do so and learning that these games work with a satellite). They also reported that they acquired general skills, such as working together and listening to each other. Seven students reported that they did not learn anything.

Most students indicated that creating a game was more instructive than playing one. During the creation process, the students had to search for information to design a specific assignment.

All of the interviewed students thought that playing the short example game was helpful and that it clarified their goals. For several students, playing the example game also helped because it allowed them to learn how the game phone worked. In these classes, all of the students but one enjoyed collaborating. The students provided different reasons for enjoying the collaboration: working together was perceived as more pleasant, less work, faster, more informative, or better for creating assignments. The quantitative data show a mean of 3.73 ($sd=0.79$) for the question of how much students enjoyed collaborating.

The quantitative data do not confirm the positive results from the interviews regarding perceived learning and motivation. Table 4 shows that the students perceived that they learned less during this lesson series by creating and playing games than they did during regular lessons. We found similar results for students' school motivation.

Table 4. T-test of perceived learning outcomes and motivation for the past school year versus the 7scenes lessons for students creating a collaborative game

Scale	Past year <i>M (sd)</i>	Scale	7scenes <i>M (sd)</i>	<i>t</i>	<i>p</i>
Perceived learning outcomes of lessons past school year	3.49 (0.86)	Perceived learning outcomes of lessons with 7scenes	2.96 (0.80)	4.08	<0.001
Motivation for lessons in the past school year	3.37 (0.74)	Motivation for the lessons with 7scenes	2.99 (0.97)	2.62	0.01

Note. $df = 40$ for both analyses. Standard deviations appear in parentheses below means.

The teacher of the Physics-Chemistry classes had no previous experience with the 7scenes platform. She had to become familiar with the platform by using in class, which made it difficult for her to follow her students and support their learning process. Nevertheless, she reported a desire to use the platform again with more training. She noted that most of the students liked the project, although some were demotivated by spending too much time working at the computer or on paper. She reported that her students learned that location-based games could be easily made, but the students did not learn much about the subject-related themes on which they were supposed to base the assignments. In discussing the assignments, the teacher primarily taught the students how to phrase their assignments, and there was little discussion of the subject matter. When using the platform in the future, the teacher noted that she would more clearly indicate the subject matter the students needed to use and that she would monitor the process of game creation more strictly.

We tested differences in perceived learning and motivation between the two different approaches of working with the platform. The students who created a game in a small group with 7scenes felt that they learned more than the students who created a collaborative game with 7scenes ($t(72) = 2.38$; $p = .02$). The students who used the small group approach scored higher on motivation as well, as indicated by the significantly different means between the groups ($t(72) = 3.46$; $p = .001$).

6. CONCLUSIONS AND DISCUSSION

6.1 Implementation

Our first research question asked how teachers use a platform for creating games in educational practice. The platform was used in two ways: 1) each group of students created their own game, and 2) groups of students worked toward the creation of one collaborative game. In both approaches, collaboration was considered important, and the teachers asked their students to work on paper before working on their computers. Moreover, in both approaches, a small example game was used and was perceived as helpful. Games were created in 12–14 lessons, but the teachers suggested that the games could have been created in a shorter amount of time.

6.2 Motivation and learning

Our second research question asked whether using a platform for creating games affected students' school motivation and perceived learning outcomes. Most students and both teachers reported positive experience working with 7scenes. The students liked the creative aspects of creating a game, including developing a story, creating assignments, and thinking about where to place these assignments on the map. The students positively evaluated the collaboration with other students on the assignments. The software was easy to use; most students liked working with it and expressed that they would like to use it for other school subjects. However, analyses of the quantitative data did not show positive effects for students' motivation or perceived learning of subject knowledge, especially for the students who created a col-

laborative game. This lack of a positive effect differs from the findings of other studies about game creation (e.g., Greenhill et al., 2008; Vos et al., 2011). Another difference is that Greenhill et al. (2008) found evidence that students' attitudes toward the subject (in this case, Physics) improved through the creation of the microgames, and Vos et al. (2011) found that students showed higher intrinsic motivation when creating games than when playing games. In our study, the results regarding motivation were less positive. The significantly lower motivation of the students who created a collaborative game might have been caused by contributing to a collaborative game instead of creating a game of their own. Greenhill et al. (2008) showed that authorship and ownership are important elements for promoting engagement. However, the students who contributed to the creation of a collaborative game also had a different teacher and focused on a different subject. Thus, it may be difficult to determine whether the students lacked motivation because of the different approach or because of other factors. The subject might have played a role in how well assignments were aligned with the physical environment. The selected park is a romantic spot and thus is an appropriate setting for a game on the theme of love, but in the Care classes, very few assignments were explicitly connected to this physical location. Most assignments could be completed anywhere. The Physics-Chemistry classes were different because there were more assignments tied to a specific location, such as a question about an electricity pole.

The students in the classes that created a collaborative game were less motivated and perceived that they learned more during their regular lessons preceding the project than during the project itself. For the students who created a game of their own, there were no significant differences regarding motivation and perceived learning between the game creation project and the regular lessons. However, among the students who were interviewed, approximately 40% of the students in both approaches felt that they had not learned anything from creating the game. The students may not have recognized what they had learned as learning because students sometimes believe that learning is only what is tested in class, as illustrated by the students who explained that they had not learned anything because they were previously tested on this school subject. Students may not have experienced talking about loveboys and homosexuality as learning about the subject, whereas the teacher felt that these were discussions with an important pedagogical goal. We did not obtain statements from the students on this issue, and our information from the interviews was less informative than we had hoped. The students easily answered the closed questions of the interview, but they had trouble answering the follow-up questions. They often answered "I don't know" when asked to explain their answers.

The majority of the students who were interviewed thought that creating games was more informative than playing them because they had to search for information in the former situation. However, several students almost exclusively used information that they already knew, thereby missing the opportunity to learn new information. Wouters and Van Oostendorp (2013) showed that the largest increase in learning occurred when students learned cognitive skills or knowledge and when the instructional support aimed to select relevant new information. In the process of creating games, the students might have needed more instructional support from the teacher in selecting new information for the assignments. When the students played

the game, the only feedback provided was whether the answer was correct. More elaborative feedback might have helped the students learn by playing the game. In addition, approximately half of the students did not incorporate the subject matter into their assignments, and sometimes the assignments seemed completely unrelated to the subject. The students may have needed more guidance from their teachers to relate their games to the subject matter in the way the teacher intended. The literature shows that the role of the teacher is important in game-based learning to facilitate the game-based learning process and to create opportunities for reflection (Williamson, 2007; Robertson & Howells, 2008; Solomou & Vrasidas, 2008; Owston et al., 2009; Hämäläinen & Oksanen, 2014). The teachers did not have time to reflect on the activities with the students, and one teacher felt that the review tool of the software was not useful. A lack of sufficient opportunities for students to reflect on their learning experiences may be detrimental to students' learning (Rieber, 2005). Teachers need to explicitly state what has been learned, and they need to mediate the learning process to ensure that the learning goals are integrated into the learning process (Brom, Šisler, & Slavík, 2010; Ulicsak, 2010).

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