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## Gender-inclusive game-based learning in secondary education

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Boys show a stronger preference for digital entertainment games than girls. For this reason, it may be that game-based learning is more acceptable to boys than to girls. Yet game-based learning might improve the performance of both boys and girls, depending upon the instructional design. In a quasi-experimental study with a secret-trail game, effects were examined on students' subject-matter knowledge. Analysis of covariance revealed that both boys and girls of the game intervention group showed a higher test performance, compared to students of the control group. However, different game activities mediated this effect of the secret-trail game on performance: girls seemed to profit more from searching the Internet to complete assignments and boys from competing with others. The performance of both boys and girls was negatively influenced by technical problems. The results are discussed within the framework of gender-inclusive game design.

**Keywords:** inclusive education; educational technology; curriculum and instruction

Teaching with technology in secondary classrooms might enhance students' learning outcomes as it offers the possibility to teach subject matter at different ability levels and to address students' different learning strategies (see e.g. Chen et al. 2011; Kim and Hannafin 2011). However, the use of technology in teaching might not be equally effective for all students, depending on their learning and technology preference. Boys and girls generally seem to differ in their learning preference (Sladek, Bond, and Phillips 2010; Arnup et al. 2013), as well as in the technology they like to use (Luik 2011; Grubbs 2012; Heemskerk et al. 2012). Likewise, teaching with games generally appears to be effective for students' short-term and long-term cognitive learning outcomes (Connolly et al. 2012; Wouters et al. 2013), but might not be equally effective for boys and girls. In this study, we examine teaching with a game in secondary classrooms which was designed to improve the school performance of both boys and girls. Prior to the presentation of the study, we will present the literature on gender differences in teaching with games.

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### Gender inclusiveness of games

Until recently, digital game playing has emerged as a predominately male pastime (cf. Bryce and Rutter 2003), although differences between boys and girls in time spent playing games seem to decrease (Homer et al. 2012). Boys not only spend more time playing games than girls, they also prefer to play different kinds of games. Boys tend to prefer action games (First Person Shooters, fighting, and sports games), while girls show a preference for playing simulations (virtual world and virtual life games) and puzzle games. No gender differences are found with most other genres, such as role-play games and adventure games (Bonanno and Kommers 2005; Hamlen 2011; Homer et al. 2012).

These differences in preferences between boys and girls seem to be related to a different motivation to play games. Boys tend to be more motivated to outdo other players (performance-only or performance combined with mastery-achievement goals), while girls are less motivated by both performance and mastery-achievement goals. Yet gender is strongly confounded with gaming frequency: very few females were frequent gamers and few boys were non-gamers (Heeter et al. 2011).

Even when boys and girls play similar games, they do this – if possible – in a different way. Boys generally like to compete with each other, while girls generally want to observe other players first and discover the game environment (Hartmann and Klimmt 2006; Hamlen 2011; Heeter et al. 2011). Results on gender differences in other game activities and strategies, such as collaboration with peers, social interaction, role-play behaviour, and strategic behaviour, are ambiguous. Kinzie and Joseph (2008) distinguish six play activity modes, based on their Education Game Preferences Survey. The explorative activity mode showed to be appealing for both boys and girls, referring to travelling to and exploring of a virtual or physical game environment. Furthermore, boys – compared to girls – generally showed a larger preference for both an active and strategic play mode. The active play mode is mostly present in many video games that require quick responses and dexterity. The strategic play mode emphasises the manipulation of resources over the longer term asking for a continuous process of observation, analysis, and resource gathering and allocation during game play. Girls showed larger preferences for a creative play mode compared to boys. A creative play mode offers the opportunity to create elements during play such as cars or clothes. No gender differences were found in preferences for a problem-solving play mode or a social play mode.

In earlier studies, the lack of female presence or representation, a weak depiction of females, and aggression towards female characters and players in video games were exercised as causes to explain the primarily male use of digital games (cf. Beasley and Standley 2002; Bryce and Rutter 2003). Recent discussions about gender differences in gaming focus on particularities of game design. Dickey (2006) reviewed the emergence of female-oriented game design, which has many commonalities with elements of constructivist learning environments, such as learner opportunities for exploration, interaction, and manipulation within the learning environment. She referred to the landmark study of Kafai (1994) on children's design of video games. Along with differences in feedback and competition articulated in female and male design, Kafai reported that girls preferred realistic settings and non-gender specific characters. Dickey also summarised other studies on differences in the preferences of girls and boys in game design. The most notable differences are that girls favour games with a focus on collaboration, community, rich narrative, creativity, and positive

actions and boys prefer games with a focus on competition, individual use, drill and practice, dexterity, and negative feedback (e.g. criticising someone's work or a performance that does not meet the criteria yet).

Van Eck (2006) suggests that the games with the widest appeal among both boys and girls immerse players in exploratory environments (e.g. secret-trail games, collect and trade games, or adventure games) that allow for individual control and focus on problem-solving. In this paper, a study will be reported on the effects of the use of a mobile secret-trail game on students' achievements. The designers of the game took a constructivist theoretical perspective on learning such as a rich narrative, social interaction, collaboration, positive action, immediate feedback, reflection, exploration, creativity, and fantasy. Although these elements show commonalities with a female-oriented game design, other elements that address preferences of boys were included as well, such as competition and negative feedback. The game studied was a secret trail about the history of medieval Amsterdam in a realistic setting with the help of locative technology applying explorative, social, and creative game activity modes.

Three research questions were formulated:

- (1) The use of the secret-trail game will increase students' knowledge of medieval Amsterdam;
- (2) Effect of the secret-trail game on students' knowledge is not different for boys and girls; and
- (3) Students' game activities during the secret-trail game explain in a different way the performance of boys and girls.

## Method

### *A secret-trail game on the medieval history of Amsterdam*

The mobile game is a one-day activity meant for secondary school students to actively experience the medieval history of Amsterdam by walking through the city, experiencing buildings, receiving messages, completing game assignments, while using universal mobile telecommunications system (UMTS)/global positioning system (GPS) video phones for communication and exchanging the information with team members. The game is played in groups of four or five students. Each group is divided into a city team (CT) of two students who walk through the city and a headquarter team (HQT) of the other two or three students who remain in the headquarters room with a computer. The teams switch places in the second half of the day so that each student participates in both the CT and HQT.

The old city of Amsterdam has been divided into six areas, each dealing with a different theme in medieval times. The six themes 'labour' (for the area called *De Lastage*), 'trade' (*De Kade*), 'religion' (*De Twee Zijden*), 'rules and government' (*Die Plaets*), 'knowledge' (*De Kloosters*), and 'defence' (*De Verdediging*) are introduced to the students by an introductory video clip that is sent to them as soon as they enter a specific area – with the name of that area appearing on their phones.

As soon as a CT has reached a certain location, video assignments are automatically sent to the UMTS video phone with the help of a GPS. Each assignment starts with an introductory video clip and often requires the CT and HQT to combine their knowledge to find the answer. Each group (with a CT and a HQT) can win points for these

assignments, helping them to win the game. The CT can also drop virtual medieval rats by pressing a key on their video phones to kill the communication facilities of another team with their HQT.

At the end of the day, all students gather at the main building where the HQTs are located. Each of the groups is invited to shortly present to the other groups some of their collected media from their multimedia box. The group with the most correct answers wins the most game points, which are shown in the multimedia box. The playtime includes a 30 minutes plenary introduction, a one-hour lunch break, and a one-hour presentation at the end of the day. This means that students play some two hours in both a CT and a HQT.

### ***Participants***

Using a pre-test post-test control group design, 458 Grade 7 students (251 female) from 20 classes of five secondary schools in Amsterdam participated in this study. Ten classes (232 students; 126 females) played the one-day mobile secret-trail game and the other 10 classes attended a regular lesson series on the same topic. The students ranged in age from 12 to 16 years old; most of them were 13 years old and they varied in educational level from lower secondary vocational education to pre-university education. In the experimental condition with the secret-trail game, each school class was randomly divided into groups of four or five students, forming two teams (a CT and a HQT) of two or three students for each group. In total, 54 groups of students played the game, spread over 10 game days (one school class per day).

### ***Measures***

#### *Student performance*

Students' performance referred to the historical knowledge of medieval Amsterdam. It was measured using three multiple-choice questions and two open-ended questions for each of the six themes concerned with medieval Amsterdam: a total of 30 test items. All answers on the open-ended questions were scored (as correct or not) by one researcher with a satisfying interobserver agreement of Cohen's  $\kappa = 0.91$  (with a 95% confidence interval of  $0.82 < \kappa < 1$  for two researchers). The internal consistency of the five items for each of the six themes in terms of *KR-20* equalled 0.97. None of the student groups played the game for all six themes by the end of the game day. As a consequence, the test score for each student was corrected for the themes and assignments each student had completed. So, only the scores for those questions for which the students had received the necessary information were considered in the test score on knowledge of medieval Amsterdam. The test score measuring students' performance was the proportion correct answers, ranging from 0% to 100% with a mean of 48.0 and a standard deviation (SD) of 22.7.

#### *Team game activities*

Data about the game activities of 54 CTs and 54 HQTs were gathered by structured observations. Because of incomplete data, three student groups (with a CT and a HQT each) were deleted from the analyses. Each HQT was observed by one observer and each CT was accompanied by a guide who conducted the observations, along with assisting with small technical issues and protecting the students' safety in the busy traffic of Amsterdam. These observers and guides had experience with guiding students

Table 1. Team game activities.

CT ( <i>N</i> = 51)			HQT ( <i>N</i> = 51)		
	<i>M</i>	SD		<i>M</i>	SD
<i>Handling tools</i>					
Video phone and GPS in CT	3.7	0.6	Searching the Internet in HQ	3.5	0.7
<i>Off-task activities</i>					
Technology problems in CT	2.6	0.8	Technology problems in HQ	2.8	0.8
Navigation problems in CT	2.0	0.8			
<i>On-task activities</i>					
Completing assignments	4.1	0.7	Completing assignments	4.2	0.6
Navigating urban space in CT	3.1	0.8			
<i>Collaboration and competition</i>					
Competing with other student groups	3.3	0.9	Competing with other student groups	2.9	0.8
Collaborating within CT	3.6	0.9	Collaborating within HQ	3.7	0.7
Collaborating with HQ	3.9	0.7	Collaborating with CT	3.8	0.6

and were informed about their role at the beginning of each game day. Observation forms were used for each assignment in each area and include items on how students in each team were engaged in a certain game activity (on five-point Likert scales with 1 = not at all and 5 = very often/very strong). In Table 1, we present these items for both CT and HQT, along with some descriptive statistics.

The observation of the activities of the CT and HQT was based on various items, some of which were similar between CT and HQT (e.g. ‘How actively engage is the team with defeating another team’ measuring competition) and some were different (e.g. ‘How actively engaged is the HQT with searching the Internet’ or ‘How actively engaged is the CT navigating the urban environment (students look around and discuss what they see)’). On the items that were similar, no differences in mean scores have been observed between the CT and HQT.

### *Students’ background*

The school administration provided students’ background information (age, gender, and cultural background) and their level of education. In the Netherlands, secondary education includes three main stream curricula offering different levels of education (from low to high): pre-vocational with a four years curriculum for students aged 12–16, upper secondary with a five years curriculum for students aged 12–17, and pre-university with a six years curriculum for students aged 12–18.

Student ability was estimated by the school teachers by marking each of their students on knowledge and skills regarding the subject of History on a five-point Likert type scale with higher scores indicating greater ability. This teacher classification was based on students’ previous marks in History. The marks themselves could not be used as schools applied different grading systems.

Motivation for History lessons was measured using a six-items questionnaire. Example items are: ‘I like the subject of History’ and ‘I learn a lot from the subject

of History'. As the game studied here draws quite heavily upon collaborative learning students' attitude towards collaborative learning was measured with a five-item questionnaire. An example of an assessment statement is: 'When I collaborate, I understand things more quickly'. The questionnaire items were responded along a five-point Likert scale with 1 = (almost) never and 5 = (almost) always. The homogeneity of both questionnaires (Motivation and Preference for collaborative learning) was found to be satisfactory with a Cronbach's  $\alpha$  of .78 for both questionnaires.

### Analyses

Analyses of covariance were conducted with performance as dependent variable, condition, gender and condition by gender as fixed factors, and ability in History as covariate. In additional analyses students' age, cultural background, level of education, motivation for the subject of History, and attitude towards collaborative learning were added as covariates. Subsequently, multilevel regression analyses were performed for boys and girls separately, with performance as a dependent variable and the nine team game activities and student ability as independent variables.

### Results

The results of the covariate analysis are given in Table 2. Both boys and girls performed better with game-based learning compared to the regular lesson series ( $F(1422) = 154.70$ ;  $p < .001$ ;  $\eta^2 = .27$ ), with a non-significant trend that for girls the difference with the control group was larger than for boys ( $F(1422) = 2.85$ ;  $p < .092$ ). This trend on gender differences was confounded with ability: girls were also the better performers in general. Including all other covariates (students' age, cultural background, motivation for History lessons, and attitudes towards collaborative learning) removed the trend on gender differences, but did not change the main effect of condition. So, we found a large positive effect of game-based learning on the performance of both boys and girls.

In order to examine whether the game activities explain the effect of performance of boys and girls in a different way, multilevel regressions analyses were performed on student data in the game condition. The results are given in Table 3.

For both boys and girls, experiencing technical problems with the tools, connections, and the interface negatively affected their performance on the knowledge test ( $B_{\text{boys}} = -7.82$  and  $B_{\text{girls}} = -8.68$ ). We found some differences between boys and

Table 2. Covariance analysis of historical knowledge test.

	Condition		N
	Regular lesson series	Game-based learning	
	M (SD)	M (SD)	
<i>Gender</i>			
Boys	0.37 (0.13)	0.57 (0.24)	192
Girls	0.35 (0.14)	0.62 (0.23)	231
All	0.36 (0.14)	0.60 (0.24)	423

Table 3. Multilevel regression analyses of historical knowledge test for boys and girls.

	Boys		Girls	
	Variance components	Final	Variance components	Final
	$N = 98$ $B$ (SE)	$N = 96$ $B$ (SE)	$N = 117$ $B$ (SE)	$N = 114$ $B$ (SE)
<i>Fixed effects</i>				
<i>Handling tools</i>				
Video phone and GPS in CT		<b>-9.18 (3.88)</b>		-1.30 (3.95)
Searching the Internet in HQ		1.28 (3.76)		<b>7.35 (3.64)</b>
<i>Off-task activities</i>				
Technology problems in CT and HQ		<b>-7.82 (3.46)</b>		<b>-8.68 (3.47)</b>
Navigation problems in CT		-5.12 (2.98)		4.80 (3.40)
<i>On-task activities</i>				
Completing assignments		0.50 (7.33)		-2.50 (7.93)
Navigating urban space in CT		2.14 (3.23)		3.87 (3.75)
<i>Collaboration and competition</i>				
Competing with other groups		<b>8.58 (3.88)</b>		6.72 (3.81)
Collaborating within CT or HQ		-0.36 (5.15)		-8.70 (5.58)
Collaborating with CT or HQ		5.99 (5.73)		9.16 (6.06)
<i>Covariate</i>				
Ability		2.24 (2.06)		3.27 (1.80)
<i>Random effects</i>				
Level 2 (group) $\sigma^2 u_{0j}$	147.35 (80.92)	8.72 (51.11)	122.33 (67.23)	43.82 (51.29)
Level 1 (student) $\sigma^2 e_{0ij}$	407.84 (80.24)	385.00 (74.54)	416.62 (70.75)	405.83 (69.27)
2*loglikelihood	893.23	846.07	1063.44	1019.06

Note: Significant fixed effects (with  $\alpha = .05$ ) are given in bold.

$N$  = number of students included in the model and SE = standard error.

girls in the way game activities in a team affected the performance on the knowledge test. For boys, competing with other teams (including dropping virtual medieval rats to block off communication) was positively related to their performance ( $B_{\text{boys}} = 8.58$ ), while handling the tools as member of the CT (using the video phone and GPS) was negatively related to their performance ( $B_{\text{boys}} = -9.18$ ). For girls, searching the Internet (including navigating the CT and collecting all multimedia materials for the final group website) was positively related to their performance on the knowledge test ( $B_{\text{girls}} = 7.35$ ). No significant relationships were found for the other game activities. This is especially remarkable for the covariate student ability, which was an assessment of the History teacher of the ability in History of each student (based on their marks). For all students of the experimental condition (secret-trail game), the correlation between Ability and Performance was not significant and low ( $r_{\text{exp}} = .02$ ), while for the students of the control condition (regular lesson series) students' ability and



Table 4. Means on game activities of groups clustered on the basis of the percentage of girls.

	Percentage of girls								
	0	20	25	40	50	60	75	80	100
<i>Handling tools</i>									
Video phone and GPS in CT	3.6	–	3.0	3.9	3.6	3.6	3.5	4.3	3.3
Searching the Internet in HQ	3.1	–	3.7	3.7	3.3	3.7	3.4	3.8	3.1
<i>Off-task activities</i>									
Technology problems in CT and HQ	2.7	–	3.2	2.6	2.5	2.8	2.8	4.0	2.7
Navigation problems in CT	1.9	–	4.5	1.8	1.8	2.0	2.1	2.1	3.3
<i>On-task activities</i>									
Completing assignments	3.5	–	4.2	4.3	4.2	4.2	4.0	4.1	4.0
Navigating urban space in CT	2.0	–	2.5	3.0	3.3	3.2	3.2	3.5	2.7
<i>Collaboration and competition</i>									
Competing with other groups	2.4	–	3.4	3.2	3.1	3.4	2.7	3.2	2.6
Collaborating within CT or HQ	3.5	–	3.8	3.6	3.6	3.9	3.5	4.1	3.9
Collaborating with CT or HQ	3.7	–	2.8	4.0	3.8	3.8	3.6	4.2	3.7
Number of groups ( $N = 51$ )	2	0	1	10	17	10	6	3	2

performance on the knowledge test were significantly correlated ( $r_{\text{con}} = .31$ ). So in the secret-trail game condition, the ability in History as assessed by the teachers was not related to student test performance.

These differences in the way game activities of a team explained differences in test performance of boys and girls might be caused by number of boys and girls in each group. In Table 4, we present the descriptive statistics for the groups clustered by gender (from 0% to 100% girls) on all nine team game activities.

Most groups playing the secret-trail game were mixed with boys and girls, although there were some boys-only and girls-only groups (two groups of both types). Irrespective of the way groups were clustered on the basis of the percentage of girls, no significant differences were found between mainly-boys and mainly-girls groups with respect to their team game activities. This means that the ‘gender constellation’ of a group does not seem to be an explanation of the differential effect of team game activities on test performance of boys and girls.

## Discussion and conclusion

In the secret-trail game on medieval Amsterdam, both boys and girls performed better on a knowledge test on medieval Amsterdam, compared to students who attended a regular lesson series on the particular topic. For boys and girls, different team game activities were important to explain differences in students’ test performance. Competing with others and handling the video and GPS were important for explaining differences in the performance of boys, while exploring the Internet was important for explaining differences between girls. For both boys and girls, encountering technical problems also explained differences in their test performance.

The secret-trail game examined in the current study was set up to attract both boys and girls to immerse them in an exploratory environment about medieval Amsterdam.

The combination of a realistic setting and virtual world allowed explorative, social, and creative player modes which are similarly attractive for both boys and girls. The design of the game included aspects of engaged learning described by Dickey (2005), such as a rich narrative, social interaction, collaboration, positive action, immediate feedback, reflection, exploration, creativity, and fantasy, in addition to other traditional game elements, such as competition and negative feedback. The results about the effect for boys and girls contradict the common notion that games in education are a waste of time or serve only motivational purposes. This study makes clear that gender-inclusive games can affect cognitive outcomes, if they are equally appealing to boys and girls and allow for a variety of game activities.

The *explorative play mode*, which was found by Kinzie and Joseph (2008) to be preferred by both boys and girls, was a central feature of the one-day secret trail in Amsterdam. Students had to find their way in Amsterdam, had to discover locations with the assignments, and had to find out historical sources and their connections to the modern city of Amsterdam. Yet student teams could do this in different ways, using competition, collaboration, and on-task and off-task behaviour. The results confirmed earlier studies on gender differences in gaming that competing with others seem to be an important game feature for boys and that discovery and exploration might be more crucial for girls. As for both boys and girls, encountering technical problems (lost connections and hard- and software failures) had negative consequences for their test performance, learning with digital games, and technology-enhanced learning; in general, should be carefully prepared and supported with technology. Technology failures may block off any potential learning effect.

With respect to the *setting*, Kafai (1994) reported that girls preferred realistic settings. In the game studied here, mobile technology was used to embed learning about medieval Amsterdam in the natural environment, the modern city of Amsterdam. However, this realistic setting with real players, a real environment, and real school tasks was combined with a virtual world with a medieval back story, a bailiff as narrator, Days of Burghership as game points, and virtual rats to obstruct fellow competitors. This meant that game play was real and virtual at the same time attracting both boys and girls.

With respect to the *genre*, Bonanno and Kommers (2005) found in their study with Maltese and Swedish Grade-12 students that, among other gender differences, males preferred role-play games and strategy games and females preferred puzzle games. The authors also found that females preferred mobile phones to play a game, which was argued to be confounded with the fact that most puzzle games can be played on mobile phones. Other studies also found gender differences in the preferences for a particular game genre, which showed that boys generally prefer action games such as sports game, First Person Shooters, and fighting games and girls prefer simulations and educational games (Hamlen 2011; Homer et al. 2012). The secret-trail game that was studied can be understood as an exploratory environment as in the genre of adventure games, which is found to be equally appealing to boys and girls (Van Eck 2006). It allowed for an open-ended play using different strategies such as inquiry-based, collaborative, creative, and situated problem-solving, which is understood to support student learning in games (Dickey 2005).

With the limitation in mind that our conclusions on gender differences in game-based learning were based on the investigation of this particular educational game with mobile technology, we would like to close with implications for game-based learning and gender-inclusive game design. In line with the viewpoint of

Gansmo (2009) about a gender-inclusive use of technology in education we would advocate to see game-based learning as a not-one technology. Using multiple hardware and software as well as varying themes, characters, and layout of games could make game-based learning a fruitful experience for both boys and girls. The use of variety and multiplicity also holds for *how* games are used in education. Assignments that solely ask for activity, strategy, or creativity might benefit either boys or girls, whereas problem-solving tasks or game tasks that require student exploration with various student cognitive activities can create meaningful learning opportunities for both boys and girls, to move the discussion beyond toys for boys and girls games.

### Notes on contributors

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