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**Developing Learning Within and Across
Disciplines: Evidence from Research and
Practice**

University of Antwerp

Gender Differences and Game-Based Learning in Secondary Education

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Abstract

In the Netherlands, differences in school motivation and performance between boys and girls are a major issue in political debates. In the first years of secondary education in the Netherlands, boys tend to underachieve and to be disengaged from school. Game-based learning might improve the school motivation and performance of both boys and girls. In two studies with game-based learning, gender differences were examined in students' school motivation and learning outcomes. Both boys and girls showed an increase in motivation and learning outcomes. Only in the second study about a digital role-play citizenship game, boys additionally showed a larger increase in media literacy than girls. This means that game-based learning showed potential to solve the so-called boys problem in Dutch secondary education.

Keywords: Gender differences, game-based learning, motivation, performance

In the Netherlands, differences in school motivation and performance between boys and girls are a major issue in political debates. In the first years of secondary education in the Netherlands, boys tend to underachieve and to be disengaged from school. Boys and girls in secondary education perform differently in language and math tests, although no differences were found in other standardised tests (Driessen & Van Langen, 2010). Some politicians and educationalists claim that curriculum programs and pedagogy in the first years of secondary education cause this so-called boys problem asking for commitment, self-regulation skills, and language skills. Game-based learning might be a way to trigger commitment and scaffold students' learning process using text as well as images and video clips. This would imply that a curriculum including game-based learning might improve the school motivation and performance of both boys and girls. In two quasi-experimental studies, the inclusiveness of game-based learning is studied by examining gender differences in effects of game-based learning on school motivation and learning outcomes.

1. Game-based learning

Computer and video games can let student experience ways of learning that stress immersion in a practice, supported by structures that lead to expertise, professional-like skills, and innovative thinking. Digital games are seen as excellent tools for facilitating and supporting situated learning of students (cfr. Gee, 2005; Huizenga, Admiraal, Akkerman, & Ten Dam, 2009; Prensky, 2001; Shaffer, Squire, Halverson, & Gee, 2005; Winn, 2002). Rich virtual worlds are what make games powerful contexts for learning. In game worlds, learning no longer means confronting words and symbols separated from the things those words and symbols are about in the first place. In virtual worlds, students can experience the concrete realities that words and symbols describe. Through such experiences, across multiple contexts, students can understand complex concepts without losing the connection between abstract ideas and the authentic problems that can

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be used to solve. Games are being recognised as fruitful narrative learning environments, moving beyond fragmented information (Akkerman, Admiraal, & Huizenga, 2009; Jenkins, 2004). The developments of location-aware and mobile technology give many exciting opportunities to create such new ways of learning. These technologies can embed learning in a natural environment, using the treasures of information that the environment conceals. It is possible to merge digital and urban play spaces to connect locations, contexts, and meaning.

It can be argued that digital games – with or without location-aware and mobile technology – can transform education and change the widely shared perspective that games are “mere entertainment”. The attitude of today’s young people towards their video and computer games is the very opposite of the attitude that most of them have towards school. Yet it is the very attitude we would like all our learners to have: interested, competitive, cooperative, results-oriented, and actively seeking information and solutions. It therefore makes a great deal of sense to try to merge the content of learning and the engaging and thereby motivating strength of games. A motivated learner shows a clear interest in what he or she is doing and enjoys what he or she is doing, tries hard and persists over time (Garris, Ahlers, & Driskell, 2002).

Many studies of games and motivation are based upon the motivation work of Malone and Lepper (1987), who proposed a link between motivation and intrinsic learning. More specifically, seven factors which include both *individual* and *interpersonal* factors have been postulated to promote intrinsic motivation. The individual factors are challenge, curiosity, control, fantasy, competition, cooperation, and recognition. According to many authors, many of these factors are triggered by the use of games (see for example: Admiraal, Huizenga, Akkerman, & Ten Dam, 2011; Egenfeldt-Nielsen, 2006; Garris et al., 2002; Prensky, 2001). Other researchers examine various conditions of using games in order to trigger engagement or flow, such as user-friendly interface (Pilke, 2004), challenge matching the level of difficulty (Sweetser & Wyeth, 2005), immediate and appropriate feedback (Kiili, 2005), reflection on game experiences (Lim, Nonis, & Hedberg, 2006), competition (Jayakanthan, 2002), content creation (Kiili, 2005), and gamefulness (Inal & Cagiltay, 2007; Kiili, 2005).

2. Gender inclusiveness of games

Game-based learning might be a way to engage both boys and girls (see for example: Annetta, Minogue, Holmas, & Cheng, 2009; Lim et al., 2006; Schwabe & Göth, 2005). However, the gender inclusiveness of digital games is still under-researched. Although the gender gap in the use of technology and knowledge about it has diminished, there are still indications that the use of technology in education affects girls and boys differently (Cooper, 2006). For example, boys play computer games more often than girls (Cassell, 2002), and girls take fewer technology classes than boys in high school (Pinkard, 2005), but girls use e-mail at school more often than boys (Volman, Van Eck, Heemskerk, & Kuiper, 2005). Girls tend to respond less positively than boys on items aimed at measuring computer attitude in general, whereas they report enthusiastically about applications for word processing and drawing (Volman & Van Eck, 2001).

Much has been written about the factors that might determine the gender inclusiveness of educational technology (Heemskerk, Brink, Volman, & Ten Dam, 2005). In other words, what makes digital games attractive and suitable for both boys and girls? Girls seem to prefer games and educational tools facilitating cooperation to more competitive tools. They generally tend to like games appealing to creativity more than tools that ask for dexterity, and appreciate detailed and colorful images in games and educational technological tools (American Association of University Women, 2000; Fiore, 1999),

In this paper, two studies will be reported on the gender differences in the engaging aspects of games and their learning effects. Two main hypotheses are formulated:

- H1. Both boys and girls will increase their motivation and learning outcomes by the use of a digital game.
- H2. The increase in motivation and learning caused by the game is larger for boys than for girls.

3. Study 1. A mobile city game of Amsterdam

The game studied is called ‘Frequentie 1550’, and addresses the history of the city of Amsterdam in late medieval era. The mobile game is a one day activity meant for secondary school students to actively

experience the history of Amsterdam by walking through the city, experiencing buildings, receiving messages, completing game assignments, while using UMTS/GPS video phones for communication and exchanging the information with team members.

At the start of the game day, the students gathered at the main location, The Waag of Amsterdam. Here the students were introduced into the main story line of the game, the game structure, the tasks, and the tools to be used.

The old city of Amsterdam was divided into six areas, each dealing with a different theme in medieval times. These six themes ('labor', 'trade', 'religion', 'rules and government', 'knowledge', and 'defense') were introduced to the students by means of an introductory video clip that was sent to them as soon as they entered a specific area. These clips presented words that could help the group to complete the assignments of that area.

The game was played in groups of four or five students. Each group was divided into a 'city team' (CT) of two or three students who walked through the city and a 'head quarter team' (HQT) of the other two or three group members who stayed behind the computer in the main building. The teams switched places in the second half of the day, so that each student participated in both the HQT and the CT. The CT was assigned one of the six areas as starting point for walking, and was asked to conduct small location-based media tasks in order to explore, map and master the area and its theme, before moving to the learning tasks of the next area. The CT was able to show a map of medieval Amsterdam on their phones (see Figure 1). The HQT digitally followed the route of his CT, guided them towards and through the learning tasks by using various information sources. This team also collected all the materials that were produced to complete the tasks. The HQT could use two maps: one about medieval Amsterdam and one about present Amsterdam.

At the end of the day all students gathered in the main building, where the HQTs were located. Each of the groups was invited to shortly present some of their collected media to the other groups.

Figure 1: Map of medieval Amsterdam with the six areas © Waag Society



3.1 Method

Using a post-test only control-group design with a proxy pre-test, 458 first-year (grade 7) students (251 female) from 20 classes of 5 secondary schools in Amsterdam participated in this study. Ten classes (232 students; 126 females) played the one-day mobile History game and the other ten classes attended a regular lesson series on the same topic.

In addition to student background (gender, ethnicity, age, attitude towards collaborative learning), students' motivation to attend History lessons was measured with a 6-items questionnaire (with a Cronbach's $\alpha = 0.84$) and performance in History with a 30-items test on Medieval Amsterdam (with an inter-observer agreement of Cohen's $\kappa = 0.91$ with two researchers). School motivation was measured on a 5-point Likert type scale with 1 = hardly motivated and 5 = highly motivated), and performance was measured as the proportion correct answers (from 0 to 1). The proxy pre-test for performance was a rating by the teachers on a 5-point scale of the ability in History of each of the students they teach. This score was recoded into a score between 0 and 1, with score 1 equalling the highest ability.

For school motivation repeated measures analyses were used with the difference between pre- and post-test for school motivation as within-subjects variable, and condition and gender as between-subjects factors. In additional analyses, students' ethnicity, age, and attitude towards collaborative learning were added as covariates. For performance, analyses of covariance were conducted with performance as dependent variable, condition and gender as fixed factors, and the proxy pre-test as covariate. In additional analyses, students' ethnicity, age, and attitude towards collaborative learning were added as covariates.

3.2 Results

The results of the analyses are summarised in Table 1. First we describe the results of the repeated measures analysis with school motivation. Both boys and girls are significantly more motivated by game-based learning (experimental condition) compared to attending the lesson series (control condition; $F(1,273) = 4.54$; $p = 0.034$; $\eta^2 = 0.02$), although boys' motivation tends to decrease slightly – although not significantly – in the lesson series. These results (effect of condition, no interaction effect of gender and condition) persisted after adding covariates such students' ability, age, ethnicity and attitude towards collaborative learning.

Table 1: Results of the repeated measures analysis with condition and gender for school motivation and of the co-variance analysis for performance

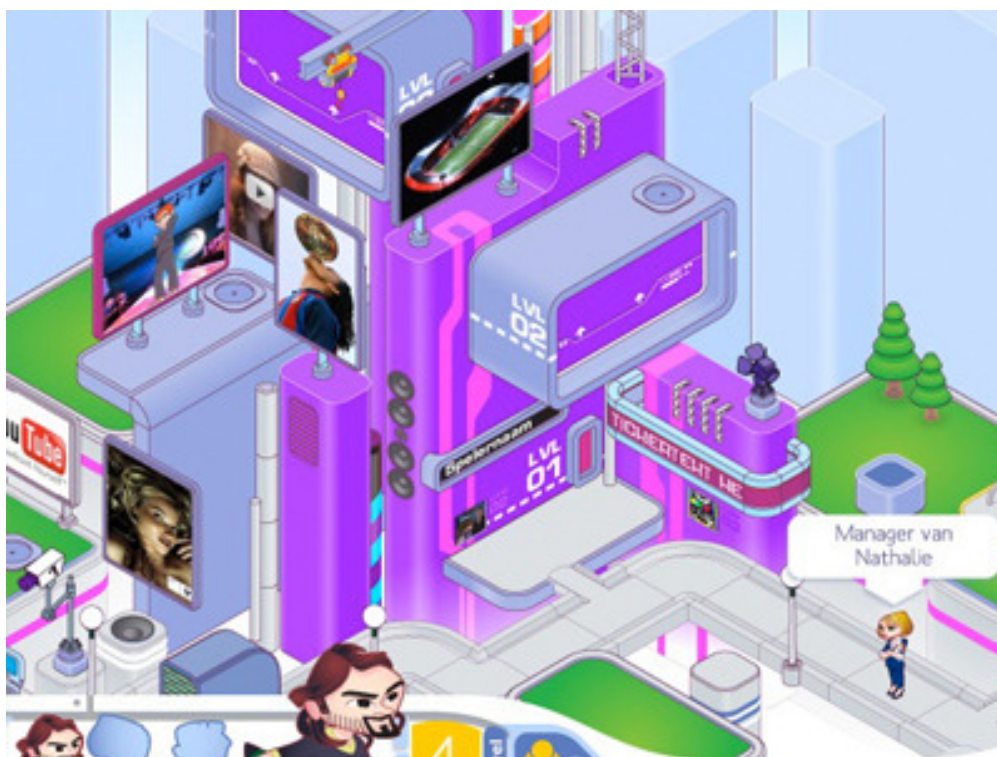
	Experimental condition		Control condition		<i>N</i>
	Pre-test	Post-test	Pre-test	Post-test	
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	
School motivation					
Boys	2.96 (0.79)	3.02 (0.80)	3.03 (0.84)	2.89 (0.84)	124
Girls	2.88 (0.76)	2.95 (0.83)	2.63 (0.88)	2.65 (0.97)	153
All	2.91 (0.77)	2.98 (0.82)	2.81 (0.88)	2.75 (0.92)	277
Performance					
Boys	0.51 (0.27)	0.57 (0.24)	0.54 (0.24)	0.37 (0.13)	192
Girls	0.56 (0.30)	0.62 (0.23)	0.54 (0.30)	0.35 (0.14)	231
All	0.54 (0.28)	0.60 (0.24)	0.54 (0.27)	0.36 (0.14)	423

Both boys and girls performed better with game-based learning compare to the regular lesson series ($F(1,423) = 151.97$; $p < 0.001$; $\eta^2 = 0.27$), with a trend that for girls the difference with the control group was larger than for boys ($F(1,423) = 3.34$; $p < 0.068$; $\eta^2 = 0.01$). This gender difference was confounded with ability: girls are also the better performers in general. After including the proxy pre-test scores, the main effect of condition resided: Both boys and girls performed better in the experimental condition (i.e., game-based learning) than in the control condition (i.e., regular lesson series; ($F(1,422) = 154.70$; $p < 0.001$; $\eta^2 = 0.27$). There still was a –smaller – trend that for girls the difference with the control group was larger than for boys ($F(1,422) = 2.85$; $p = 0.092$; $\eta^2 = 0.01$). Including other covariates such as students' age, ethnicity and attitude towards collaborative learning did not change this outcome.

4. Study 2. A digital role-play citizenship game

A digital role-play game (SplitsZ!) with an online workspace was used in which students completed assignments, both within class and at home, with the aim to develop their media literacy. Media literacy can be understood as the ability to participate in the virtual world in a reflective, critical, and responsible way. The intervention included a series of some 18 lessons in which 6 levels of the educational game SplitsZ! were played (on average, 3 lessons for each level). Students played this role game with the aim of promoting a fictional celebrity. In each level, the students played different roles (e.g., celebrity, manager, marketing manager, and journalist). The SplitsZ!-environment resembled a media site with towers built with bill boards and monitors (see Figure 2 for a snapshot of one of the towers). Each tower was owned by a couple of students, who constructed their towers with media products that they had created in the workspace. The assignments in each level were prepared by the teacher and completed by the student in class and at home (e.g., with their parents). Each level was played within one lesson. The other two lessons in each level were set up with reflections on the assignments and a class debate. In sum, students learnt how to present themselves and others online, to assess online sources critically, and become aware of the influence of multimedia on their behaviour and on society, with a focus on the presentation of and communication with images and video clips.

Figure 2: Screenshot of one of the towers in SplitsZ!



4.1 Method

Using a one-group pre-test-post-test design data was collected of 12 classes (with 235 first-year (grade 7) students (59% female) from 7 secondary schools) in the Western part of the Netherlands. Students played this citizenship role-game SplitsZ! during 8-16 weeks. Only 80 students from 4 classes completed the post-test; the data of one student was removed after outlier analyses.

Students' media literacy was measured with a 15-items questionnaire, indicating behaviour about and attitude towards downloading information (images, clips and text) from the Internet (7 items, Cronbach's $\alpha = 0.71$) and uploading information on the Internet (8 items, Cronbach's $\alpha = 0.73$). All items were formulated in statements and students had to indicate how applicable the statements were on their own situation (1 = not at all to 5 = to a large extent). This questionnaire was based on media literacy of Hargittai (2005, 2009) and Cameron, Wise, and Lottridge (2007). We also measured students' use of social software, communication software, games and virtual worlds (all items on a 5-point scale with 1 = low frequency and 5 = high frequency) as well as their gender and age.

Repeated measures analyses were used with the difference between pre- and post-test for both measures of media literacy as within-subjects variables, and condition and gender as between-subjects factors. In additional analyses, students' age and technology use were added as covariates.

4.2 Results

The results of the repeated measures analyses are summarised in Table 2. For media literacy in terms of downloading information from the Internet we found a small main effect of time and an interaction effect of gender. Students generally showed a higher score on media literacy in the post-test than in de pre-test ($F(1,67) = 3.28$; $p = 0.075$; $\eta^2 = 0.05$). This main effects was caused by a difference between boys and girls: Boys increased significantly more than girls ($F(1,67) = 3.82$; $p = 0.055$; $\eta^2 = 0.05$). A similar, yet stronger, outcome we found with media literacy in terms of uploading information on the Internet. Students had increased significantly in media literacy at the post-test ($F(1,67) = 6.79$; $p = 0.011$; $\eta^2 = 0.09$). Again this main effects was caused by a gender difference: Boys increased significantly more in media literacy than girls ($F(1,67) = 5.04$; $p = 0.028$; $\eta^2 = 0.07$).

Both interaction effects with gender became even somewhat stronger (with $\eta^2 = 0.08$ for downloading information and $\eta^2 = 0.11$ for uploading information) after controlling for students' ages and their use of social software, communication software, gaming and virtual worlds.

Table 2: Results of the repeated measures analyses with gender for uploading and downloading web-based information

	Pre-test		Post-test		N
	M	(SD)	M	(SD)	
Uploading information					
Boys	2.36	(0.69)	2.82	(0.77)	30
Girls	3.25	(0.72)	3.28	(0.78)	39
All	2.86	(0.83)	3.08	(0.80)	69
Downloading information					
Boys	3.10	(1.04)	3.45	(0.72)	30
Girls	3.86	(0.66)	3.84	(0.75)	39
All	3.53	(0.92)	3.67	(0.76)	69

5. Discussion and conclusion

The outcomes of both studies only partly confirmed our hypotheses. With respect to our fifth hypothesis, for both school motivation (Frequency 1550) and learning outcomes (Frequency and SplitsZ!) both boys and girls showed an increase in scores. This means that in both cases game-based learning generally improved student motivation and learning outcomes. However, the second hypothesis was only confirmed in the second study: Boys showed a larger increase in media literacy (both downloading and uploading information) than girls, in addition to the main effects. The results of study 1 even tend to be the opposite with girls profiting more than boys. In addition, the pre-test scores of boys generally were not significantly lower than girls, which would be expected on the basis of debate about the 'boys problem'. However, both studies included a limited number of students and the games used were quite different in focus and content. Even so, game-based learning seems to work out for both boys and girls.

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