

Making homework fun

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Making homework fun: The effect of game-based learning on reading engagement

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This study was based on game-based learning as an approach to engage students enrolled at a Danish gymnasium in reading parts of Herodotus' The Histories. From this study, we can conclude that game-based learning can be used to engage students and extend their motivation to read and do their homework. The study included 42 students from two classes. One class, with 27 students, was included in the experimental study, in which game-based learning was employed as part of reading the story. The other class, with 15 students, served as the control group and engaged only in an analog reading of the story. The evaluation criteria, which were assessed through a questionnaire, were based on items from the user engagement scale and a knowledge test. Further, the evaluation consisted of an interview with a teacher of classical civilization courses and interviews with nine students. The findings revealed a positive effect on students' engagement in the gaming group. The knowledge test revealed higher performance in the gaming group, with better recalls of important aspects of the story; 78% of the students in the gaming group were engaged with the story, in contrast to 27% of those in the control group. 85% of the gaming group perceived a clear understanding of the text, whereas only 33% of the control group did. Further, 90% of the gaming group read the mandatory homework, in contrast to 72% of the control group.

CCS CONCEPTS • Applied computing • Computers in other domains • Personal computers and PC applications • Computer games

Additional Keywords and Phrases: Serious games, Game-based-learning, Reading engagement, Gymnasium, Engagement.

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1 Introduction

There is an international concern about reading engagement among young adults [1]. Male students tend to prepare less for classes compared to female students, and male students struggle more with reading engagement compared to female students [1, 2]. This lack of reading engagement may partly explain why male students have a higher dropout rate, and lag behind compared to female students in Danish gymnasiums [3]. The lower grades, higher dropout rate, and lack of reading engagement poses challenges for male students in terms of later educational opportunities and access to the labor market [2-4]. In Danish gymnasiums, the average grade difference is 0.85 points (based on 7-point grading scale) in favor of female students [3]. This gap has only increased the last five years [3]. In subjects demanding more text reading, as in classical civilization, female students' grades are 1.4 points higher on average [3]. Over the past few decades, young adults have changed their habits, read less fiction, but spending more time reading online than before [5, 6]. In Denmark, 20% of young adults do not read fiction [6], which is equivalent to other international reporting [1]. On average, across OECD countries, 37% of young adults report that they do not read for enjoyment at all [1]. Reading has always been encouraged through complex and diverse practices [5, 7]. However, there is a huge concern that young adults do not read well enough to cope with the increasing literacy demands of an information society [5, 7]. Reading fiction among young adults appears to be positively associated with higher performance on reading assessments [1].

This study was aimed at supplementing a mandatory homework reading in classical civilization in a Danish gymnasium (i.e., upper secondary) with a digital serious game in contrast to a traditional analog reading. The mandatory reading was Herodotus' tale of King Candaules, Gyges and the queen, as included in book 1 (Clio) in the *The Histories* of Herodotus, written in 430 BC. The research question for this study was: Can game-based learning be engaging and improve the frequency of prepared students and their learning outcomes in reading Herodotus' *The Histories*?

Like other scholars [8, 9], we define a serious game as a game designed for a primary purpose other than pure entertainment. In this study we used the term game-based learning [18-20] as a subgenre of serious games. However, it is worth to mention that game-based learning has been practiced since at least the twentieth century [9], and used paper-based games became popular in the 1960s and 1970s. During the last decade, the use of digital game-based learning has gained popularity, as with used computer gaming for various educational aspects. There is no consensus on the definition of game-based learning, and it used in divergent ways, focusing on various perspectives depending on their purpose, players' goals, and content [18-20]. Furthermore, some categorical problems often exist within mixed terminologies (e.g., game-based learning, serious games, and gamification), and their connection to specific learning goals.

Reading is a skill with many graduations of proficiency, and comes with lots of complexity, and it is not an easy task for young adults to read the mandatory literature in classical civilization. The mandatory reading in Herodotus' *The Histories* is considered as one of the founding works of history in western literature. The story is not an easy read. This is partially due its old wording and writing style, but its complexity mainly arises from the story's narration, which presents potential barriers to reading engagement. The narration has many shifts in both characters and time. Herodotus writes with the purpose of explaining; that is, he discusses the reason for or cause of an event. Herodotus attributes cause to both divine and human agents. These are not perceived as mutually exclusive, but rather mutually interconnected. In *Herodotus' tale of King Candaules, Gyges and the queen*, Candaules (the king of Lydia) told his favorite bodyguard, Gyges, how beautiful the queen was and, thinking Gyges did not believe him, urged Gyges to contrive to see her naked. Gyges initially refused as he did not wish to

dishonor the queen. Nevertheless, Candaules was insistent and Gyges had no option but to obey his king. So Gyges hid in Candaules' bedroom and, when the queen entered, watched her undress. The queen swore revenge for her shame and provided Gyges with an ultimatum to either kill Candaules or to be executed immediately. Gyges killed Candaules in the royal bedroom, and later married the queen. Gyges was accepted as the new king by the Delphic Oracle.

The learning outcomes for the lecture about the tale by Herodotus, were in collaboration with the teacher in classical civilization determined by the following objectives:

A: 80% of the students know: 1) Who Kroisos was. 2) Know Gyges view on the kings plan. 3) In which room Gyges hides. 4) Which ultimatum is posed. 5) Where Candaules was killed. 6) Why Gyges was accepted as the new king.

B: 40% of the students are engaged in the story

C: 80 % of the students have read the mandatory reading as their homework.

2 previous research

Scholars have described multiple principles for game-based learning [10-17], including a focus on reading engagement [10-13, 21, 22]. Important aspects of game-based learning and reading engagement include realism, feedback, discovery, repetition, guidance, flow, digital storytelling, social interaction, briefing, and debriefing [11-17, 21-23]. Furthermore, motivation is important. Reading engagement, both in game-based learning and in other media, including analog media, requires the reader to be motivated [13, 16]. This involves aspects such as important elements within the text's content, text comprehension, knowledge acquisition and social interactions that employ knowledge and lessons learned from the text [13, 16]. Scholars have also emphasized the specific aspects of intrinsic motivation as important when designing game-based learning for reading engagement [16, 17, 21, 22]. These can include elements such as curiosity, a desire for a challenge, flow, involvement, and narrative engagement [16-17]. Narrative engagement [23] seems important within game-based learning game focused on reading engagement because of its relation to the story experienced while playing the game [10, 21, 22]. Thus, it may result in imaginative immersion, narrative involvement, or narrative immersion. The desire to know how the story of *Herodotus' tale of King Candaules, Gyges and the queen* unfolds evokes curiosity, suspense and narrative engagement, making the players want to continue playing [23]. Studies have also included transmedia storytelling as a gateway to reading engagement or educational purposes by combining analog reading with parts of the story included within a game-based learning [10, 19, 21, 22]. There are still major challenges of how to measure the learning outcomes of game-based learning. The learning outcomes is often measured by self-report and knowledge tests [24]. Previous studies have reported that gamed-based learning has positive outcomes in terms of being more engaging than traditional classroom instruction [21, 22, 24-26]. However, effects of game-based learning on specific knowledge tests are more diverse and inconclusive [24].

3 methods

3.1 Participants

This study is made in cooperation with teachers in classical civilization at Allerød Gymnasium, located 30 kilometers north of Copenhagen. The study included two classes consisting of a total of 48 students in classical civilization. Both classes had the same teacher. Class A consisted of 24 boys and 6 girls, and had sports as their main profile/programme. Class A functioned as the experimental group with received video game as their preparatory material for the upcoming lecture about *Herodotus' tale of King Candaules, Gyges and the queen*. Class B consisted of 8 boys and 10 girls with music as their main profile/programme. Class B functioned as a control group for the evaluation, provided with the same reading and evaluation criteria, but without playing the game (only analog reading). The teacher in classical civilization selected which of the classes that should be in the experimental group and which for the control group. All participants gave informed consent and were informed

that they could withdraw from the study at any time and their participation did not influence their grade. In addition, all participants were provided with anonymized ID numbers, and all data were labeled with these IDs. We applied special considerations when recruiting teenagers (ages 17–19), in accordance with Danish data law, the international code of conduct and ethical approval from the gymnasium.

3.2 Procedure

An important focus of this study was to involve the teachers at Allerød Gymnasium, who taught the students about Herodotus' *The Histories* in classical civilization. This was done by following a participatory design approach [27] in which the end-users included both teachers and students; also within a substantial work of pilot testing. The pilot testing was made with seven students outside the experimental- and control group. The teachers served as gatekeepers who facilitated and controlled the reading process in areas such as the curriculum's aims, focus, knowledge, skills, and analysis. Therefore, the teachers were involved as co-designers very early in the process. This study used a mixed method approach consisting of both a questionnaire and interviews. The procedure for both the experimental group and the control group can be seen in Figure 1. The teacher provided the introduction to the module/homework about Herodotus' *The Histories*. The students on the experimental group were provided with a link (webGL) and a short questionnaire including gender and experience of gaming. Hereafter, the students could play the game (at home), as part of their homework within a flipped learning approach. After the game there was a questionnaire, started with items inspired by the User Engagement Scale - short form [28], followed by a knowledge test with included recalls for important aspects in the story.

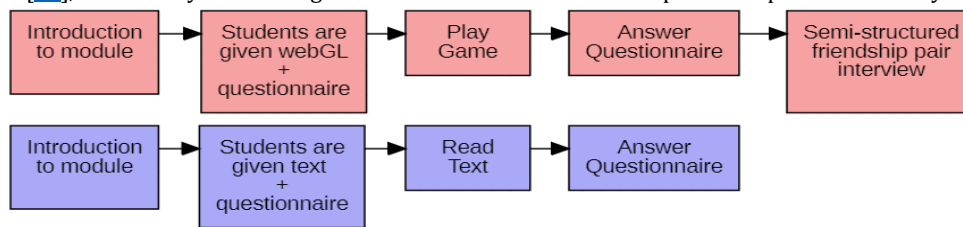


Figure 1: The procedure of the experimental group (in red) and the control group (in blue)

One week after the gaming homework, nine students from the experimental group participated for interviews. The nine students were randomly recruited by the teacher in classic civilization. The interviews were conducted as friendship pairs [29]. Friendship-pairs, which is a variation of the in-depth interview, is a method in which participants who know each other well are interviewed jointly. Friendship-pairs can have the advantage that participants feel more comfortable, thus facilitating a more open and deep discussion that might give the interview more spontaneity and surprising twists [29].

The procedure for the control group (Figure 1) used the same items in the questionnaires as within the experimental group.

3.3 Data analysis

The data derived from the questionnaire was analyzed by cumulative frequency. Descriptive statistics were performed to calculate the mean and standard deviation. The data from the teacher interview and the semi-structured friendship pair interviews [29] were analyzed by traditional coding [30] and content analysis.

4 design and implementation

The game was developed in Unity using C# and Plastic SCM Cloud. To design the game, we were inspired by the game flow principles described by Sweestser and Wyeth [31] to maintain the reading engagement. The eight

elements of game flow are as follows: concentration, challenge, skills, control, clear goals, feedback, immersion and social participation [31].

Herodotus' tale of King Candaules, Gyges and the queen was told through five scenarios. The game included both audible (voice over) as well as verbatim text (appeared as subtitles) (Figure 2) to keep the students concentrated about the story. To represent the past in the story, the characters and specific props were designed as freeze-frames (Figure 2), and by that appeared as a transparent ghost-like layer in the scene.

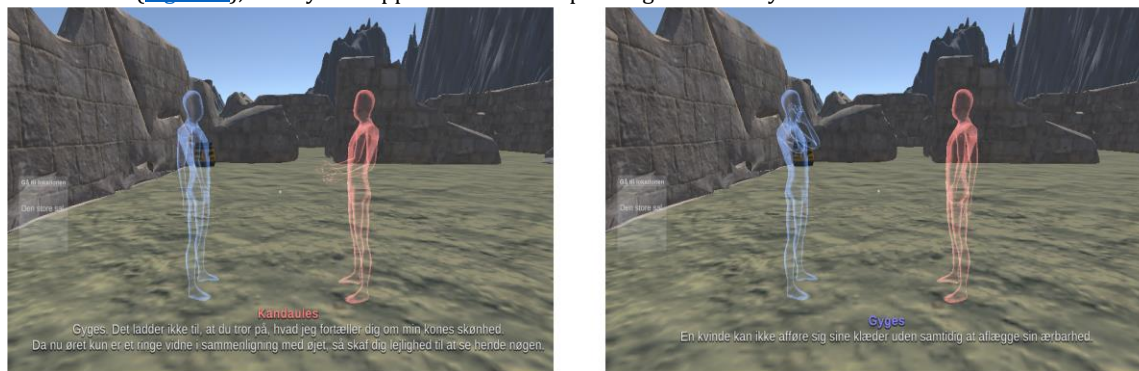


Figure 2: Freeze-frames of Gyges (blue/ right) and Candaules (red/ left) corresponding to the names in the subtitles

The freeze-frames were developed by using a transparent shader. The human characters were developed as 3D models making it possible to see details and facial expressions. To make it easy for the players to comprehend the storyline and provide no doubt of which of the characters who were speaking, we outlined very specifically who was talking. In center we outlined the name of the speaking character (Figure 2), and added different colors of the characters providing e.g. Gyges in blue (Figure 2, right), Candaules in red (Figure 2, left), and the queen in purple. To affect the concentration, it was important to provide challenge for the players to keep them from getting bored or be disengaged [32]. Due various game proficiencies among the students, it was difficult to optimize the game to be challenging for everyone. We developed a phase and collection system, which made it possible to tweak the difficulty of the scavenger hunt, such as locations, desired play time, and number of collectables. The system was designed to differentiate story- and scavenger scenes into different phases. Starting from phase zero and going to ten, each even-numbered phase provided a story, while odd-numbered phases enabled new set of collectables to find. To create a cohesive story world (Figure 3), the implemented rooms were interconnected via corridors. The story world took place in ruins, as to provide perceived remains of a civilization's architecture. Efforts was made in making the environment as historical correct as possible, which also was the reason for not including buildings or interior, as it remains with uncertainties how this looked like in 430 BC. The game world was first outlined in Unity by using cubes (Figure 3), making sure that proportions of each room would match the gameplay in a normal 3D geometry. All 3D assets were created using Blender and reference images (Figure 3). The walls of the ruins were made by using an addon called Cell Fracture to cut a shape into multiple fragments. Most of these models were acquired from Textures.com. For the environment outside the ruins (hills and mountainlike landscapes), a Unity asset named Gaia was utilized. Gaia uses stamps and stencils to generate an environment that is organic, with possibilities of constructing mountains range and grasslands efficiently.

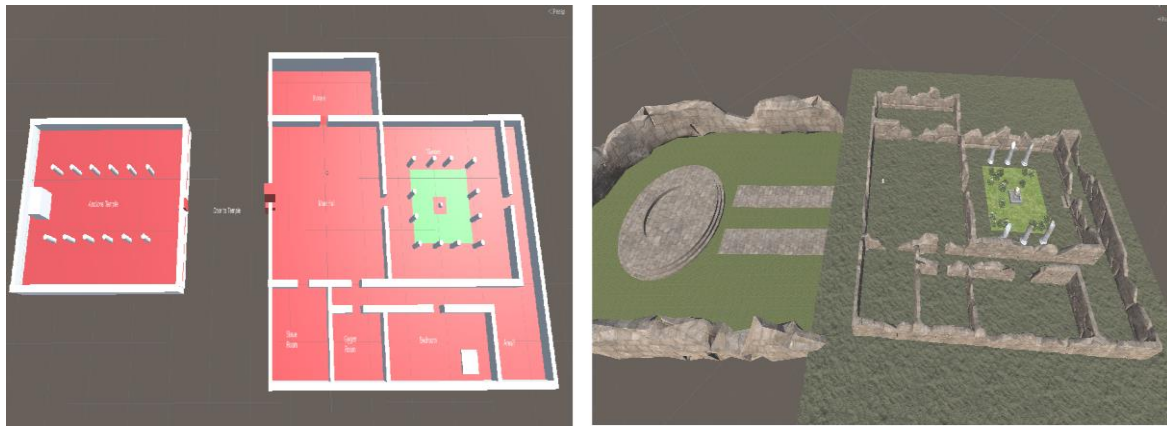


Figure 3: The story world and used template for designing the ruins. Early Unity Cubes (left) and the final 3D asset (right)

The collectable objects (Figure 4) were our own designed 3D assets, and was implemented as scriptable intractable objects that would contain any information necessary.



Figure 4: Collectable objects designed for the game

The scriptable objects (Figure 4) received a custom editor in Unity with scalability and potential expansion. By defining the type of the objects to be either collectable, door, non-playable characters or miscellaneous, the relative variables changed in the inspector and would become accessible. The students were able to start playing the game without reading a manual and learned the game controls in an introductory tutorial. At the very start of the game, instructions appeared showing the keys to use for in-game navigation (Figure 5). As the players discovered interactive objects, hints were indicated by sound – getting louder when approaching the task. The tasks (objects) needed to be completed in a specific order (Figure 5) to ensure that the students read the story in order and followed the plot and original story. The tasks were visible (Figure 5), and when completed a task there was a clear visual indication of completed, as an indicator of the progression of completed tasks.



Figure 5: Visible tasks (left), and instructions for navigation (centered)

5 Findings

5.1 Quantitative findings

The findings seen in [Table 1](#) reveal that the experimental group (Exp) scored a higher mean on all items in the User Engagement Scale than the control group (Con) did, with 3.54 (SD: 0.99) and 2.76 (SD: 1.17), respectively.

Table 1: Findings from the user engagement. Experimental group (Exp), n=27. Control group (Con), n=15.

Items	Mean (Con)	SD (Con)	Mean (Exp)	SD (EXP)
Focused attention				
The time I spent reading just slipped away	3.00	1.31	3.44	0.93
I was absorbed in reading the text	2.73	1.33	3.48	0.94
Perceived usability				
I felt stimulated while I was reading	2.73	1.10	3.59	1.19
I found the text easy to read	2.13	0.92	3.44	1.15
Aesthetic appeal				
The game was graphically pleasing			3.33	1.00
Reward				
Reading the text was worthwhile (rewarding)	3.13	1.30	3.85	0.77
I felt interested in reading the text	3.20	1.15	3.67	0.92
I would recommend the text to others	2.40	1.06		
Total	2.76	1.17	3.54	0.99

The level of focused attention was higher in the experimental group than in the control group, especially regarding how absorbed the students were (Con: 2.73/Exp: 3.48). The perceived usability was also higher for the students playing the game. Students playing the game felt more stimulated while reading (Con: 2.73/ Exp: 3.59) and found the text easier to read compared to the students with the only analog read (Con: 2.13/Exp: 3.44). However, the voice over supplementing the text read in the game-based version makes a comparison of the reading difficult. The aesthetic appeal was only asked in the experimental group, with general positive

perceptions of the game graphics (Mean 3.33). The reward was also reportedly higher in the experimental gaming group than in the control group, though we expected the positive effects to be even higher for these items. A very interesting finding (not shown in the table) is the groups' disparity in response to the item "I have reached a clear understanding of the text"; whereas 85% of the experimental group perceived (indicated by the response "strongly agree" or "agree") that they had reached a clear understanding of the text, only 33% of the control group did. Further, the results of the knowledge test are very positive and strongly favor game-based learning (Table 2).

Table 2: Findings from knowledge test. Experimental group n=27. Control group n=15.

Learning outcomes Objectives % Students	Experimental group (game) % Correct answers	Control Group (analog) % Correct answers
80 % know who Kroisos was	44	50
80 % know Gyges view on the king's plan	70	57
80 % know in which room Gyges hide	74	64
80 % know the posed ultimatum	81	64
80% know where/ how Candaules was killed	85	46
80 % know why Gyges was accepted as king	78	62
40 % are engaged in the story	78	27
80 % have read the text/ are doing their homework	90	72

Except for the first question ("who was Kroisos?"), the group with game-based learning performed much better than the non-gaming group. The reason for the experimental group's low score for the first question could be explained by not being in focus, and was only mentioned as part of a larger text frame before the game's start. The findings revealed that 78% of the students in the experimental group were engaged in the story, in contrast to 27% of those in the control group. Further, 90% of the experimental group read the mandatory homework, in contrast to 72% of the control group.

5.2 Qualitative findings

All nine interviewed participants liked the alternative gaming way of learning, as it added variation to the otherwise monotonous way of learning by reading through analog texts. The students could comprehend the subject displayed in the game; overall, it was an appropriate and adequate way to tell the story. Several students commented that they usually did not do their homework, neither for their classes in classical civilization nor for other subjects. The students explained how the game approach changed their attitudes towards homework:

"This is the first time I have ever done my homework in classical civilization." (ID3, George, Group 1). "If I was presented with a game in the last three years, I would probably have done twice the amount of homework throughout upper secondary school." (ID9, Noah, Group 3). "This [game] made me remember the text, in spite that is more than a week ago I did this homework. Normally, I can't remember any other texts I read." (ID8, Jacob, Group 3).

A few students mentioned elements to be improved (e.g., colors and graphics). Other students mentioned that it could be advantageous to have some breaks in the game, maybe due to the text-heavy reading in the game. We did heavily emphasize the text's relation in the game, which the teacher liked: "I liked the interaction in that you had to go do a little exploring to get the key to unlock the next piece of text...also, I liked how the text bits came into the screen, making it like we do in the class teaching, with the text bits being present." (Teacher).

An interesting point that the teacher mentioned concerned students he considers poor readers, who, according to the teacher, were mainly male students. However, these students seemed to be much better prepared than

usual. The teacher emphasized that game-based learning could be beneficial for students with reading difficulties or lack of reading engagement.

6 Discussion and conclusion

Reading engagement is a multidimensional construct including behavioral, affective, and cognitive dimensions. Reading a difficult mandatory text from classical civilization involves many variables, including motivation, emotional engagement, and preferences. It is very difficult to account for all these variables, so, to address this, we used an engagement score as an indirect measure of learning. Our study revealed a higher level of reading engagement in game-based learning. All items used to assess user engagement (including focused attention, perceived usability, aesthetic appeal, and anticipated reward) revealed higher levels of engagement in the gaming experimental group than in the non-gaming control group. In the knowledge test, the gaming group performed much better than the control group did. In conclusion, this game-based learning, designed specifically to teach the mandatory reading of Herodotus *The Histories*, improved students' reading engagement, leading to much higher recalls within important story elements. Further, especially students with reading difficulties or lack of reading motivation could benefit from game-based learning. The story was well told in the game, and the improved homework preparation and learning outcome was achieved through increased engagement. While these results show that the gamified approach is more effective than traditional reading, this is not a novel result, and as such, this study in classical civilization does not approach the general problem of reading engagement. However, based on the results, we suggest that gamified reading should be adopted more widely, being included in the already wide range of other materials for learning. Future work is needed to create significant evidence and insights regarding students' reading engagement via game-based learning. First, researchers need to include a much higher number of students from classes across various gymnasiums (high schools) for data collection. Second, further details are required on the identification of readers, including their confidence in reading. Future longitudinal studies are needed to provide insights as to whether gamified experiences have positive effects on intrinsic reading engagement outside a mandatory school setting.

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