

# 3 GAMES 4 CODING – DO GIRLS FEEL WELCOME?

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## Abstract

Learning games have become mainstream in many educational contexts, where one of them is programming education. Today there exists a wide variety of games where the players can learn about different programming concepts. However, earlier research reports that far from all these games appeal to a female audience. If game-based learning should reach the identified potential of a highly motivating learning environment, the game design must be an inclusive one where girls feel welcome. This study examines three games for learning fundamental programming in a test group with girls only in an after-school Maker community. The research question in the study was: "Which game design concepts do girls find appealing?"

Data were collected through interviews with girls in a makerspace after testing 3 games on computer programming. The tested games were: Minecraft Education Code Builder, CodeCombat, and imagiLabs. The interviews focused on the girl's perceptions of the games and of programming. Thematic analysis with a six-phase process of coding were used to analyse the collected data and cluster the codes in themes that supported in answering the aim and research question.

The study shows that all three games were perceived as engaging and that they supported development of programming skills. When asking which of the three games the girls would like to spend more time on to learn programming, opinions were divided. The girls also disagreed on which type of game graphics they found most appealing. However, findings indicate that there are clear patterns in what game design concepts the girls find important. These patterns can be grouped in the following categories: Creativity, customisation, flow, reward and feedback, exploration and programming skills. Firstly, the game should encourage exploration and creativity in both playing and programming. Secondly, for the programming tasks to be fun and challenging it is important to keep players in a flow state with help of rewards, instant feedback and a low threshold at start. Lastly, the possibility for customization and an engaging backstory were also appreciated by the girls in the study. These findings are recommended to take into consideration in future game development.

Keywords: Game-based learning, Learning games, Inclusive design, Girls and games, Programming education.

## 1 INTRODUCTION

To introduce programming for the younger target groups is an ongoing process in many parts of the world. Recent research studies on this subject reports that teachers and instructors are struggling to find suitable teaching strategies and engaging learning tools [1] [2]. For this new and younger learner audience, there is a new need for an alternative instructional design to support a more joyful learning process. A classic concept for motivating learners that has been digitalised and enhanced during the last decades is the concept of game-based learning [3] [4]. The use of educational games in science, technology, engineering, mathematics (STEM) and programming education, is today a frequently occurring phenomenon with promising results [5] [6]. As reported in several research studies, it is important that educational games, or serious games, have a design that are serious in the sense that they stimulate flow to create motivation [7] [8]. A fundamental part of the flow theory is that a person that participates in an activity should obtain increasingly complex information. The hyper focused flow state could be described as the flow channel. A channel of flow between the state of boredom by lack of challenges, and the state of anxiety by to challenging tasks [9] [10].

At the same time there has been a debate during the last decades on the differences between girls and boys gaming preferences [11] [12]. Regarding digital games there has been a fast and rapid development in the 21st century, with a rich assortment of new game types, reaching out to an increasing audience and to different age groups [13]. However, there are recent research reporting that girls still are not feeling that they are welcome in many of the game worlds that are seen as mainstream [14] [15]. If game-based learning should be able to fulfil its promising potential, games ought to have an inclusive

design where both girls and boys feel welcome. This study had the aim of investigating which game design details that make girls feel welcome and want to play for learning. To gather relevant information the selection of informants was to interview only young females. The overall research question that guided the research was: "Which game design concepts do girls find appealing?"

## 1.1 RELATED RESEARCH

Previous research has identified important design factors in educational games that potentially could affect the extent to which girls and women feel welcome. Previous research has highlighted that game content, mechanics and design are considered important for learning and engagement by both teachers and students in the development of educational games [16] [17]. In prior studies it has been noted that design factors that could be potentially important for an inclusive design were girls and women feel welcome include, for example, creativity, exploration without violence, collaborative interaction, customisation and character diversity [15] [18].

According to a study by Kinzie and Joseph [19] girls preferences tend to be more positive towards creativity in play, while boys tend to favor active play instead. Spieler and Slany [20] also highlight the importance of creativity in game design and notes that girls spend more time on the aesthetics of games, for example in creating artwork, than boys do. Customisation, or personalization, of games has also been highlighted in previous research as appreciated by girls [21] [22] [23]. A common approach for this in games is the opportunity to create or customise the appearance of a game avatar [21]. An example of such a game is The Sims, which also had approximately 50% female designers and a player base of estimated 40-50% females [24] [25].

Although exploration in games are important traits for both girls and boys, previous research suggests that it could be more important for female players [12]. Further, previous research has highlighted that for the exploration to support a game design that is female-oriented it should also stress less violence and threats for incorrect choices in the game [26]. Instead, the game design should highlight community, collaboration, and interactive challenges to appeal to girls and women [26] [27].

Previous research notes that the representations of girls and women in games are important, and that it should not be constructed according to a male gaze, for female players to feel welcome [26] [28]. Game characters should instead include both male, female characters that are diverse and characters that are non-gender-specific [26] [29]. Dickey [26] points out that a potential problem with games specifically targeted for women and girls is the portrayal of 'female' and whose ideas this is based on. Further, it should be noted that putting too much emphasis on players' genders regarding game preferences is at risk of forgetting, or downplaying, the cultural, social, and economic forces in the industry, for example through marketing and exposure, that also affect these preferences [30] [31].

## 2 METHODOLOGY

To identify inclusive game design for programming educational games, three different games were selected and tested by girls. The aim was not to compare the games, nor to measure the learning, but to find factors the girls find appealing and motivating. This was done by structured user tests followed by semi-structured interviews and a thematic analysis.

### 2.1 Participants and context

The game tests were carried out during meetups with a tech club for young girls, called Geek Girl, where all members and leaders are female or non-binary. Geek Girl is part of the local maker association, and they meet every other week in a makerspace at the university. A makerspace is a workshop-like environment with a culture of sharing knowledge, tools and ideas. Physical and digital materials and tools are often combined, e.g. for 3D printing and laser cutting. The activities in the tech club can include anything from electronics and programming to crochet and textile crafts. The members of Geek Girl have an interest in technology, design and problem solving. It is not unusual for members of a maker association to also share interests in gaming, role-playing and cosplay.

The tests were conducted with eight voluntary participants in the ages between 10 to 14, all female members of the geek girl afterschool maker class. Their parents were informed about this study and signed an informed consent form to approve their participation.

## 2.2 Games and test settings

Three different games were included in this study, all with the aim of teaching the basics of computer science by writing text-based Python code, see Fig. 1-3. Only free games were used and none of them required login. Recommended ages for the games, according to the game creators, are 9-16 [32], 8-13+ [33] and K-12 [34] respectively.

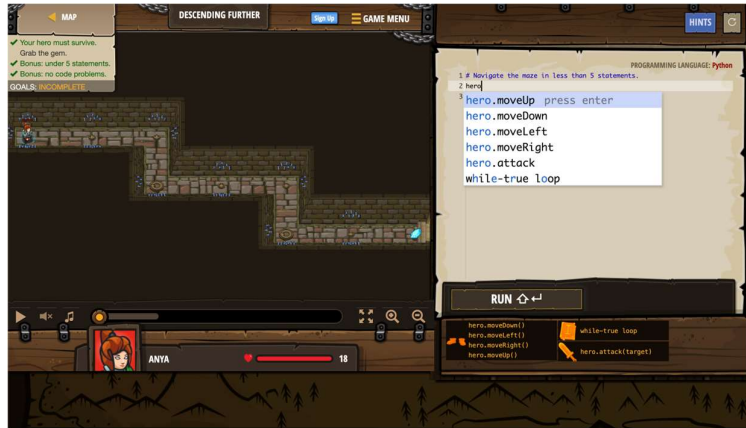


Figure 1. Screenshot of Python code editor in learning game 1, Code Combat [32]

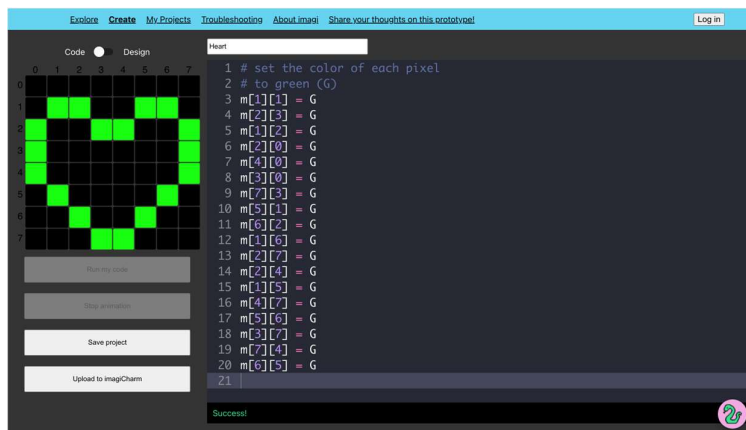


Figure 2. Screenshot of Python code editor in learning game 2, imagiLabs [33]

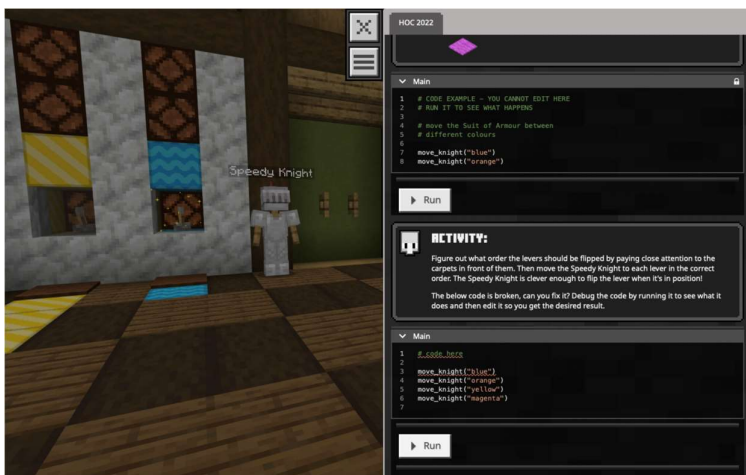


Figure 3. Screenshot of Python code editor in learning game 3, Minecraft Education Edition Code Builder [34]

## 2.3 Procedure of tests and interviews

To ensure that the tests and interview questions were reasonable and clear, these were first pre-tested on one pilot tester. The purpose of a pre-test was to try out, for example, how many levels to play of each game to be able to compare them and answer the interview questions.

The game testers were asked to complete a couple of coding challenges within each game. The testers worked in pairs on one laptop to encourage collaboration and joint problem solving, see Fig. 4.

When the tests were finished, the testers individually answered interview questions. The interview was semi-structured and voice recorded.

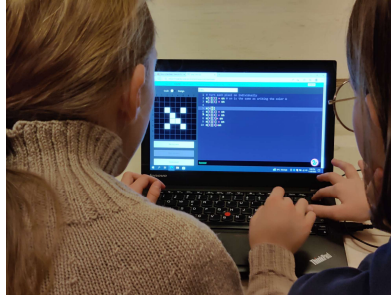


Figure 4. Test setting

## 2.4 Analysis

The verbal data from the interviews were transcribed and analysed using a thematic analysis following the six-phase process by Braun & Clarke [35]. First, the recordings were transcribed to text. Then the transcriptions were coded by all three authors individually, sorted and combined into categories. The categories were grouped to identify themes. All themes were revised and the validity in relation to the data set was considered to make sure the representation was accurate. Finally, the themes were named.

All quotes were translated from Swedish to English by the authors, and to some extent altered for readability. However, the underlying meaning has kept unchanged as strictly as possible.

## 3 RESULTS

The codes found during the text analysis by each author were written on digital sticky notes in the tool Miro (Miro, 2022), an online collaborative whiteboard platform that enables distributed teams to work together. The notes were sorted, coloured and grouped into categories. This resulted in six themes, see Fig. 5.: Creativity, Customisation, Flow, Reward/Feedback, Exploration and Programming skills.

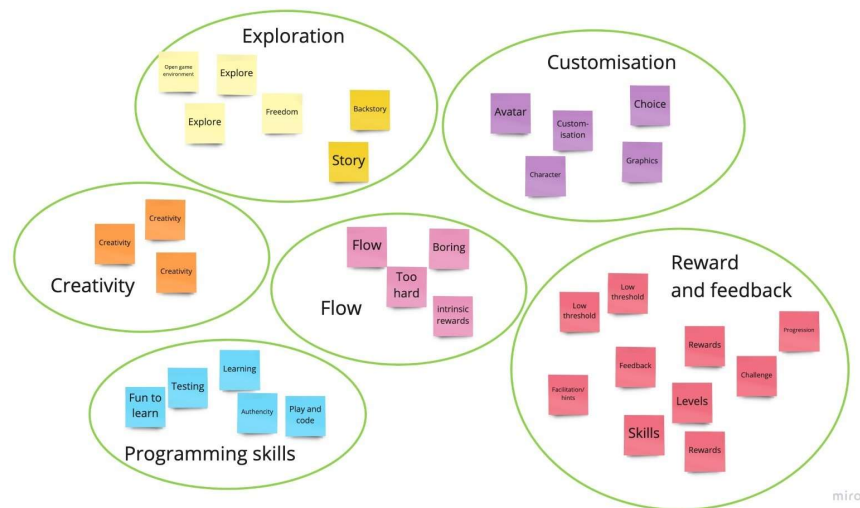


Figure 5. Screenshot of the Miro board where the codes were grouped into themes during analysis.

### 3.1 Creativity

The interviews showed that a level of creativity within the games was appreciated, such as being able to create something with code.

- “I think it's fun to create stuff so I would make a game where one can draw things”, and
- “I would like to build different things, like in Minecraft but with instructions to build stuff”,

were two testers' responses when they were asked what kind of programming game they would create if they were game developers.

### 3.2 Customisation

In one of the games in this study the testers were asked to choose their avatar and customise it. The more levels they complete, the more (programming) skills the avatar gets (Fig. 6.). Several of the testers commented that it's fun to choose your avatar, and to collect things for it.



Figure 6. Example from the game Code Combat.  
The avatar has different skills which will be unlocked when completing more levels.

### 3.3 Flow

One observation during the tests was how important it is not to lose concentration because the programming became too difficult, or the instructions were hard to understand. On the other hand, the testers tend to lose motivation if it was perceived as too easy. Some quotes from the game testers were:

- “I liked that there were challenges, like if the goblin sees you or if you go towards the thorns, you fail.”
- “It was a bit too easy.”
- “I thought it was a bit boring. I didn't understand at first and if you don't understand, it won't be so fun.”

Also, the testers appreciated challenges, stories, and the possibility to level up in the games.

- “I liked that there were challenges, like if the goblin sees you or if you go towards the thorns, you fail.”
- “I would make a game with different challenges and if you pass them you can level up.”

Their comments about this were grouped in a category named Flow during the analysis.

### 3.4 Reward and feedback

Comments about rewards, feedback, hints, and progression were categorised as Reward and feedback.

- “It's more fun to work if you work for something. For example, dress up your avatar.”
- “I like that you were told right away whether you did right or wrong.”

### 3.5 Exploration

One of the games in the test is built on an open gaming environment, a so-called sandbox game. This was something several of the testers enjoyed. Some quotes about it from the interviews were:

- "It was fun to walk around and get assignments."
- "You can go wherever you want in the gaming environment."

These comments were coded and categorised as a theme named Exploration.

### 3.6 Programming skills

The game testers were asked which of the games they believe is good for improving their programming skills. All three games received good reviews when it comes to learning Python, and they pointed out some features they liked in the different games:

- "Creating your own shapes and figures is a fun way of programming."
- "It was good that you could try your code and then redo and test again."
- "It was good to get examples of how you can solve it."

Not only did they appreciate the fun and creative parts of the games, but there were also comments on how and when they felt smart and how much they like the problem-solving part of programming. One girl expressed:

- "It feels as if you are programming for real."

## 4 DISCUSSION

An interesting finding is that several of the girls mentioned their appreciation for the possibility to choose their own avatar in the beginning of a game. The lack of female, or gender neutral, protagonists in video games, and that girls find this irritating has been reported earlier [36]. However, this study confirms that it is an appreciated feature when it is implemented in games, and something that the authors see as a standard recommendation for game design.

Findings also confirms the categories for girl inclusive design in the literature review by Mozelius, et al, [37]. Besides the Category of Character diversity, and the already mentioned importance of both male and female characters in video games, findings also confirm the category of Creativity and customisation. It seems obvious that girls have a passion for customisation of not only avatars, but also for color schemes and game worlds. Moreover, girls tend to like more open game worlds that enables exploration, than just games with 'race against the machine' gameplay. An example of a game with an open game world that attracts girls is The Sims, a game where there also are a lot of customisation and design features [38]. A reason for the relatively small number of games with open game worlds is probably that they are more time consuming to develop. On the other hand, to add features for customised avatars and colour schemes are not complex and could be rapidly implemented.

The category of Reward and Feedback have comments that indicate both extrinsic motivation (virtual coins and money), and intrinsic motivation (to do something meaningful). Intrinsic motivation leads to the category of Flow where the some of the game testers also brings up the opposites in the theory: boredom by too simple tasks, and anxiety by too difficult challenges. As in many games, to keep players in a flow state could be addressed by dividing the game into levels. Some easy initial levels can introduce the context and the gameplay, that players with pre-knowledge or good gaming skills can finish off quickly. A positive finding is that several game testers see programming tasks as fun and challenging. An explanation might be that girls from a Makerspace community, are more prone to engage in problem solving than the average girls. A phenomenon that would be interesting to investigate further in future studies.

Programming skills finally, is the most specific category with educational games for programming as quite a narrow specialisation of digital games. Results from the previous categories could be applied to most video games, but learning to program is a both specific and challenging field. Like mentioned in the previous section regarding problem solving, the game testers have a surprisingly positive attitude towards code and programming tasks in the games. This should also be investigated further in a future comparative study with testers from other contexts. Anyhow, we see it as a positive finding that the programming tasks did not seem to disturb the gameflow. Moreover, the tester opinion that "Creating your own shapes and figures is a fun way of programming", could be a key to girl inclusive design for educational games in programming education and STEM. As concluded in [39], to involve graphic design in computer science and programming could be a success factor for girl inclusion also at university level.

## 5 CONCLUSION

The answer to the research question "Which game design concepts do girls find appealing?" Is that creativity, customisation, flow, reward and feedback, and exploration in open game worlds are concepts that appeals to girls. Design concepts that probably are even more important for educational games on programming, where learning to program has an identified high initial threshold. These categories could be summarised to engagement and development of skills and that educational games must stimulate both. If a game is not engaging the learning process is not supported, and if the development of skills is not thoroughly implemented, there will be gaming for gaming's sake. Finally, if the game design does not appeal to girls the game would not be engaging for girls, and the girl inclusive design is not achieved.

## 6 FUTURE WORK

The results from the game testing are surprisingly positive considering that the tested games are designed for learning to program. Programming education has been classified as problematic learning, and many programming courses at university level still have a clear male majority of participants. An interesting future study would be to test an educational game on programming in different test groups, where one of the groups consists of geek girls. A study that would fit in very well in the Gaming4Coding project that is described in the next section.

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This study was facilitated by funding from the Gaming4Coding project. Gaming4Coding is a two-year Erasmus+ project, with the aim of developing a game where secondary school students should learn text-based programming. At the same time as the game must be joyful experience for players, it should be a game where girls also should feel welcome to play and learn. The highly motivating features of game-based learning are used to promote interest in coding in the young audience, and especially in girls.

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