Gender Differences in the Impact of Gamification Elements on Performance and Anxiety

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Abstract

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Keywords: Gamification, Gender

Gender Differences in the Impact of Gamification Elements on Performance and Anxiety

Theoretical Background

Gamified digital learning environments

Digital learning environments Intelligent Tutoring Systems (ITS) can be referred to as "any computer program that can be used in learning and that contains intelligence" (Freedman et al., 2000). Therefore, ITS accompany a student on his or her learning experience of a specific domain of knowledge by creating tasks that appeal to the students needs (González et al., 2014). ITS can range from simple instructive texts to simulations and virtual realities, as a model imitating and abstracting certain aspects of the real world to reduce complexity for machine and user (Psotka et al., 1988). Modern ITS are split into three intertwined models: student, domain and tutor model. The student model holds the information about the user. The user is characterized from different angles the information is updated as the user advances within the ITS. The domain model contains the knowledge and structure of the learning material. It supplies the tutor model with tasks based on the input from the student model. At last the tutor model controls the interaction with the student and contains the information which tasks are shown to the user in accord with the learning objectives from the domain model (González et al., 2014; Freedman et al., 2000).

With the rising interest in Gamification ITS also grow in importance as they can be used together. The use of gamified elements enhances the ITS and Gamification require some sort of progress tracking model for the gamified elements (e.g. Content unlocking to work). González et al. (2014) suggest adding more models as Gamification requires additional systems for visualization and feedback. Additionally, new studies created a connection between emotions and learning, other studies connected relationships between teachers and students and an increase in student motivation (Woolf et al., 2010). Both results were linked in a study by Woolf et al. (2010) showing how digital learning

companions improved the overall learning ability and self-concept of all students, especially low achieving students. For the context of this thesis it is also important that the ITS version with a male learning companion was muted twice as much as the female version, resulting in a lower effect. The study showed differences between gender, in discussion Woolf et al. (2010) suggested considering gender within the student domain could further advance its predictive power.

Gamification

Gamification can be defined as "the idea of using game design elements in non-game contexts" (Deterding et al., 2011) to further increase motivation and user activity within interaction design (Deterding et al., 2011). These game-design elements "gamified elements" are elements often found in classical games. Often used elements are points, badges, leaderboards and avatars, other mechanisms include content unlocking, storytelling and memes (Zainuddin et al., 2020). Often those elements are used specific constellations like the PBL triad described by Werbach and Hunter, 2012, which contains points, badges and leaderboards, a system that is not only known from games, but also everyday enterprise features like loyalty programs and employee competitions (Werbach & Hunter, 2012). Points because they add an absolute scale, badges because they represent a status symbol and work like a temporary goal to strive toward and leaderboards to compare yourself to peers (Werbach & Hunter, 2012). One of the positive effects of gamification is brought by the feedback in different forms (task, process, self-regulation, self) either immediate or delayed. Feedback is one of the most important factors in the relation between education and learning Sailer and Homner, 2020. The use of gamified elements showed positive outcomes in multiple studies, in general (Hamari et al., 2014) as well as in education specific contexts (Sailer & Homner, 2020). But gamification, especially some elements like leaderboards, can also lead to negative outcomes. Leaderboards, while motivating through comparison, have been reported to demotivate participants (Almeida

et al., 2021). "Pavlovication" as Klabbers, 2018 calls it, Gamification, as it is often a short question-answer-reward-cycle, conditions the user to learn conditional and narrows the possible ways to solve a problem down (Klabbers, 2018). Some studies also suggested that gamified learning platforms also lack individualism regarding choice and display of gamification elements, resulting in discomfort and negative emotions (Santos et al., 2023).

Gender and Stereotype threat

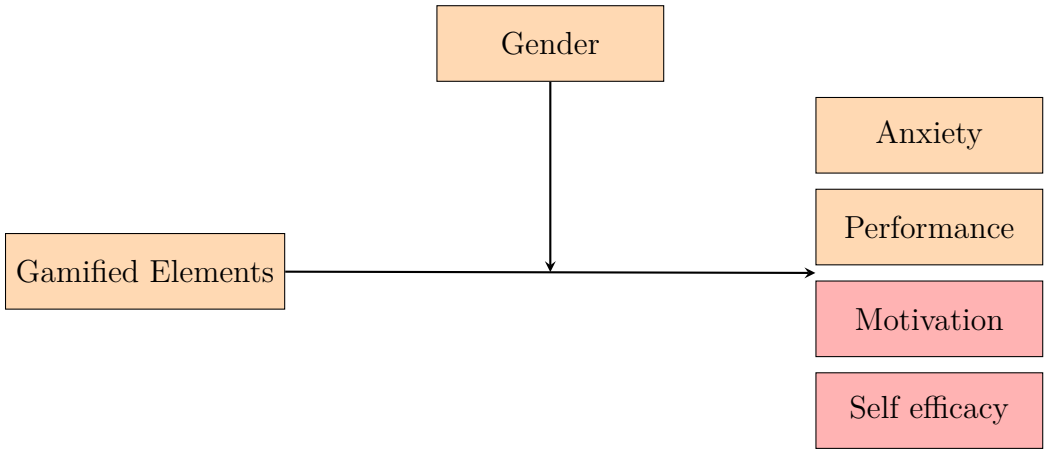
Gender, as a concept within social sciences, refers to more than the binary categorization of male and female. It encompasses a range of identities and experiences that are shaped by a complex interplay of biological, psychological, and social factors. Gender is not solely determined by biological characteristics; instead, it is increasingly recognized as a spectrum, acknowledging the presence of diverse gender identities beyond the traditional binary understanding (Lindqvist et al., 2021). Socialization plays a critical role in shaping gender identity. It influences how individuals perceive themselves and interact with their surroundings based on the gender norms prevalent within their society. These norms dictate behaviors, roles, and expectations, which are often internalized from an early age through various socialization agents like family, media, educational institutions, and peer groups (Kampshoff & Wiepcke, 2012). While acknowledging the spectrum of gender identities, this thesis will focus primarily on the binary categorization of gender—male and female. This approach does not negate the validity of non-binary or genderqueer identities but rather limits the scope of investigation to traditional gender roles within the binary framework.

Stereotype threat occurs when "one can be judged by, treated in terms of, or self-fulfill negative stereotypes about one's group". Although this study does not aim to eliminate stereotype threat it is an important factor as it can explain at least some of the differences different genders experience while studying computer science (Cheryan et al., 2011), especially regarding math (Spencer et al., 1999). Stereotype threat even leads to

lower identification with academics and specific subjects (Christy & Fox, 2014).

Hypotheses

As noted in the first chapter, there are open questions regarding the efficiency of various gamified elements and how different genders relate to these gamified elements. The question of the efficiency of certain elements and combinations of elements remains unresolved (Dehghanzadeh et al., 2024). To explore the connection between gender and gamification elements, we have created the following model:



This model additionally incorporates concepts of motivation and self-efficacy, which, although not featured in my thesis, are included in the doctoral thesis of **Nadine Koch**. Since males perform better than females in solving progressive matrices from age 15 onward, Hypothesis **H1a** one-sidedly formulated (**ravenStandardProgressiveMatrices2003**). The hypotheses we want to investigate in this work are:

H1 Males and females differ in their cognitive and affective states.

a) Male performance is better compared to female.

b) Male and female students differ regarding their anxiety levels.

c) Male and female students differ regarding their motivation.

d) Males have a higher self-efficacy compared to females.

H2 Different gamified elements have a varying impact on the cognitive and affective states.

a) Gamified elements impact performance differently.

b) Different gamified elements impact anxiety levels differently.

c) Different gamified elements impact motivation differently.

d) Different gamified elements impact self-efficacy differently.

H3 Different gamified elements differently impact the cognitive and affective states of males and females.

a) The influence of different gamified elements on performance differs between males and females.

b) The influence of different gamified elements on anxiety levels differs between males and females.

c) The influence of different gamified elements on motivation differs between males and females.

d) The influence of different gamification elements on self-efficacy differs between males and females.

All hypothesized effects result from interacting with the gamified digital learning environment.

Methods

Participants

Design

This study explored the impact of various gamified elements and participant gender on performance and anxiety. The independent variables were gamified elements, with

participants randomly assigned to one of eight conditions: Avatars (A), Badges (B), Points (P), Leaderboards (L), Narrated Content (N), combinations of Points, Badges, Leaderboards, and Avatars (PBLA), Points, Badges, Leaderboards, Avatars, and Narrated Content (PBLAN), and a control group with no gamified elements. Each participant experienced three of these conditions, ensuring that all conditions were evenly distributed across participants. Participants underwent a series of tests in a fixed order during each round, beginning with a gamified performance test in an digital learning environment followed by not gamified assessments for anxiety, self-efficacy, and motivation. The performance tests utilized standard progressive matrices, adapted with gamification techniques to engage and challenge participants uniquely in each round. The dependent variables included:

- **Performance**, assessed through accuracy and response times in the gamified progressive matrices.
- **Anxiety**, evaluated using a standardized questionnaire immediately after the performance test.

Although self-efficacy and motivation were also assessed through subsequent questionnaires, these variables were not analyzed within the scope of this bachelor thesis. The collected data for self-efficacy and motivation are intended for use in the doctoral dissertation of **Nadine Koch**. This research employed a repeated-measures design, where each participant was exposed to three different gamification conditions chosen randomly. This within-subjects approach facilitated the analysis of individual responses to each condition across the different rounds, providing insights into how variations in gamification can affect psychological states and performance. The sequence and consistency of the testing procedure, including the series of questions asked in the gamified digital learning environment were always maintained to ensure the reliability of measurements and comparability of results across the various stages of the experiment.

Procedure and Materials

The study was conducted in two seperate rooms, one equipped with 5 and one with 7 iMac's. The study was displayed in full-screen mode to ensure no further distractions. At the start participants were shown a consent form as at least some personal data was collected, gender, age and study program. Participants also had to enter a deletion code in order to request their data's deletion after the collection.

Question items

Afterwards the study proceeded to three iterations of 20 questions each, that are based on Progressive Matrices used by Albuquerque et al. (2017). Every iteration was followed by three questionnaires for anxiety, motivation and self-efficacy. Then a data submission dialog guided the participants to the next iteration. To generate 60 questions out of the 20 fromAlbuquerque et al. (2017), the questions were slightly altered by this author. These questions are embedded into the digital gamified learning environment.

Gamified Digital Learning Environment

The Environment used a combination of different Gamified Elements for each iteration.

Procedure

Scoring

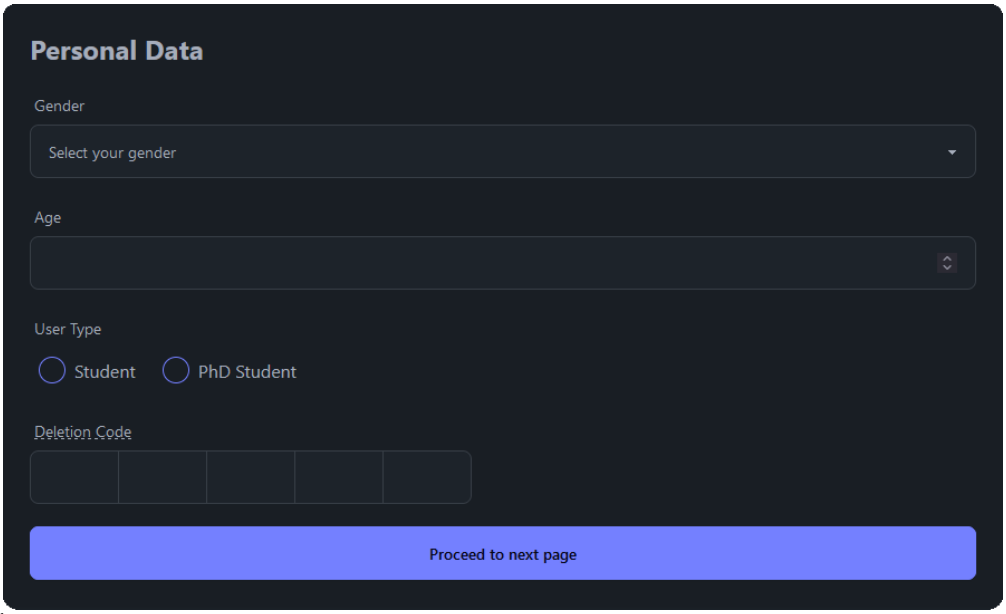


Figure 1

The personal detail collection form

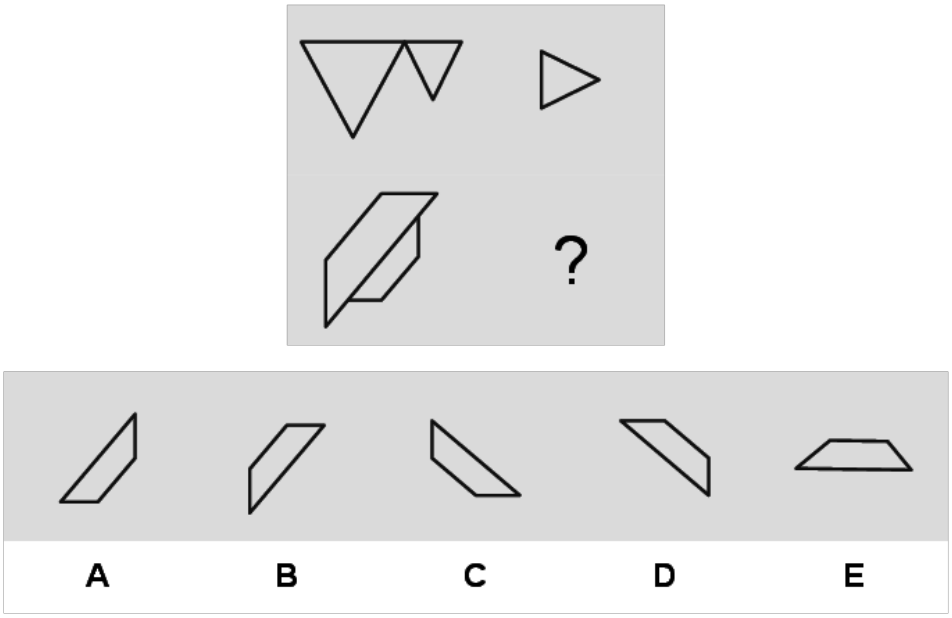


Figure 2

A standard progressive matrix, One of the tasks given to the participants

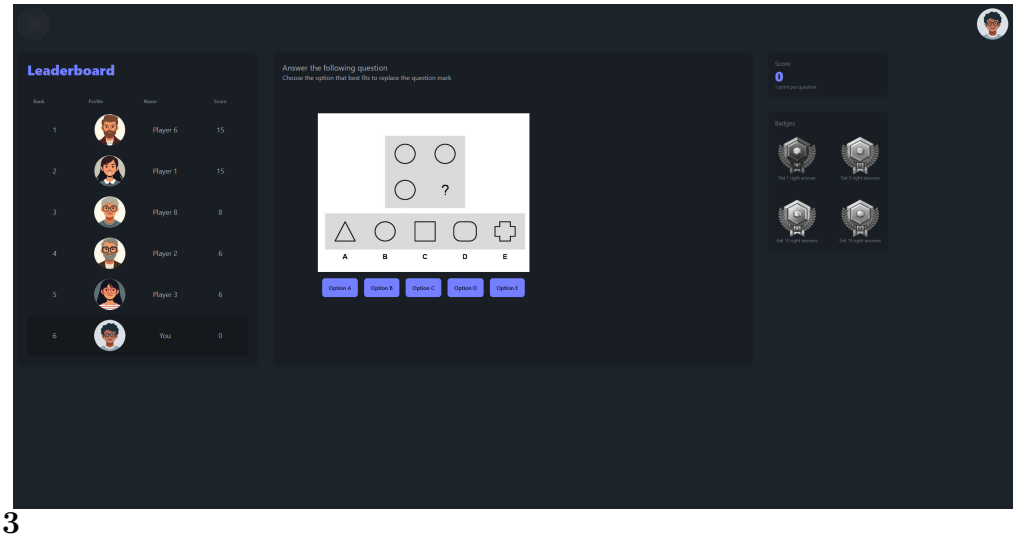


Figure 3

The Digital Learning Environment with Points, Badges, Leaderboards and Avatars enabled.