

Little Big Difference: Gender Aspects and Gender-based Adaptation in Educational Games

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Abstract. Computer games are tremendously successful and this is why the potential of using this medium for educational purposes is increasingly recognized and researched. As new learning technologies need to be appropriate and ensure equal learning opportunities for all students, however, it is important to take into account evidences on gender differences and in the context of computer games. This paper reviews relevant research results on gender aspects. Aiming for the realization of gender-based adaptation in educational games, a model incorporating research evidences on gender aspects is elaborated and implications for adaptation are derived. Adaptation principles and game design are illustrated by means of the 80Days project.

Keywords: game-based learning, educational game, adaptation, gender difference, game design.

1 Introduction

The young generation is familiar with information technology from earliest childhood on. Today's children grow up being surrounded by and using the whole range of toys and tools of the digital age – computer games, computers, internet, music players, cell phones, etc. and consequently, these children are – in the words of Marc Prensky – no longer digital immigrants but rather digital natives [1]. This development necessarily also has consequences for education. As Prensky points out, students of today are no longer the kind of students our educational system was designed for. Consequently, the use of computer technology for learning must not and has not stopped short of education.

The fact, that young learners of today spend a considerable portion of their lifetime watching TV and playing computer games – by far more than for reading, needs to be reflected by taking advantage and utilizing these very technologies for educational purposes. Computer games, with their dynamic and active nature, their rich and appealing possibilities are an incredibly successful technology, whose potential of being used for learning has been increasingly addressed since the 1990s. The central idea of game-based learning is to utilize at least part of the time people spend on playing computer games for educational intentions [2].

A critical aspect that needs to be considered in this context is whether there are differences in learners concerning their attitude and acceptance towards game-based learning, especially with respect to eventual gender differences. As computer games in general are dominated by males, the question arises whether this fact is immediately transferable to educational games. There are, at least, several evidences on gender differences in computer games that are important to be known and understood when aiming in advancing them as a novel approach to learning that is likewise suitable for both groups of learners [3].

This paper elaborates gender aspects in the context of computer games towards a gender-sensitive approach of designing games for educational purposes. This paper is organized as follows: We first give an overview on the state of the art on gender differences relevant and apparent in the scope of computer games. Based on this, the implications on computer game design in general are discussed. As an attempt for creating gender fair educational games, the issue of adaptation of a game to gender-based differences is taken up and an integrated framework for gender-based adaptation in computer games is elaborated. Finally, a case study of an educational game on geography is presented, translating the adaptation model and illustrating an example of an approach to educational games and to learning game design that successfully works for both sexes.

2 Computer Games and Gender Differences

General Attitude and Usage Patterns. Aside from differences that have been proven for computer usage in general, such as that males are more confident and skilled in handling computers [4], there is also particular evidence that males are specifically more engaged leisure game players than females [5]. Despite the popularity of computer games is rising in general, the majority of the medium's audience are still males [6]. As a consequence of that generally greater popularity of computer games amongst males, more males play and they play for longer periods [7, 8].

Personality Factors. Reasons that have been identified as accounting for a gender gap in playing computer games, which basically can be related to personality factors, include stereotypes and archaic role models for female characters, violence, lack of social interaction, and strong competitive elements in games [9].

Need for achievement refers to humans' desire for accomplishment and competence acquisition [10]. Males seem to have in general a higher need for achievement in playing computer games. Basically, need for achievement can be equated with challenge, which also has proven to be more important for males [3]. Research evidence led to the assumption of a stronger *competition orientation* in males than in females and of females (although able to perform similarly) being less effective in competitive situations [11]. Competitiveness as a trait can be explained by three components – the motivation to win/compete, the need to win, and self-efficacy. In a study on gender and computer games these factors turned out to be significantly higher for males than for females, confirming female's inferior competition orientation in computer games [9].

Sensation seeking refers to the tendency to search for varied, novel, complex, and intense sensations and experiences and to take risks for the sake of such sensations [12]. Findings in gambling and sports have shown that males feature a more distinctive need for sensation seeking than females do [13]. Sensation seeking is directly related to arousal – high sensation seekers have a high optimum level of arousal. Unsurprisingly, arousal, which has been identified as one of the most important reasons for playing games, has also proven to be more important for males than for females [14].

It has been shown that females in general have a low preference for observing or taking part in violent conflicts and resolutions, show in their media genre preferences in general less interest than males in violent entertainment and prefer non-violent entertainment [15]. As most computer games involve to a large extent and increasingly realistic *violence* and violent actions, it is not surprising that this is an important factor of females' dislike of games [9]. On the other hand, it has been argued that violent games provide male adolescents with the opportunity of intensive emotional arousal and thus explaining the appeal of those games to this audience [16].

In their *interaction styles*, females characteristically show pro social patterns. Media research yielded that they value programs with a great extent of meaningful dialogues and interaction. Most often, single-player games provide few possibilities for social interaction and are rather action-oriented. This lack of social interaction is an important reason for females disliking games [9]. Females clearly express a preference for games that involve communication and human relationships [17].

Game Types. Males and females also characteristically differ in the type of games they prefer to play. This is due to differing interests and preferences, which are argued to be grounded already in infancy and socialization, but probably also because computer games are mostly designed by males, therefore, including essentially masculine characteristics, a high level of violence, and strong gender stereotypes [3]. While males have been found to prefer strategy, action, adventure, sports, and simulation games, particularly with violent content [16, 18] females prefer puzzles, board games, quizzes, role-playing and adventure as well as educational games [5, 7, 14]. The main theme of computer games preferred by boys is contest between good and evil, competition, and winning, whereas girls favor storylines, exploring game characters' personalities [17]. [18] underline, though, that in sum the types of games that appear especially usable for learning – like strategy, adventure, and role-playing games – are appealing for both, males and females.

Also game speed and time pressure must be considered. Action games (preferred by male players) require dexterity and fast reaction, and usually a faster game play than role-playing games (preferred by female players). In contrast, there is some evidence that young girls prefer colorful, slowly changing screens in a multimedia learning interface [19]. To sum up, females seem to prefer rather an unhurried game play, whereas males opt for action and speed to get encouraged.

Reasons to Play. The reason or motivation to play computer games has also identified to differ between genders [9]. Existing games are referred to by females as lacking meaningful social interaction and discouraging because of violence and stereotyped gender roles of female game characters. Female players rather prefer the

(para)-social appeal of games, collaboration and community aspects than competitive elements [20]. In the context of massively multiplayer online role playing games it has been found that there are gender differences on the relevant motivational factors for playing – whereas male players feature higher scores on the factors ‘achievement’ and ‘manipulation’, females indicated higher scores on ‘relationship’, ‘immersion’, and ‘escapism’ [21].

Skills. It could be shown that males have in general better computer skills and literacy [4]. Research results on online skills have shown that although there are no great gender differences in online abilities, females self-assess their skills significantly lower than males – which in turn may affect their online and usage behavior [22].

Computer games commonly require cognitive and perceptual skills on which males tend to perform better than females, such as spatial awareness and visualization [23]. It has also been pointed out that the gender-specific differences in cognitive abilities fit well with the general gender-dependent preferences for different game-genres [24]. Interestingly, recent research results, however, have shown that the gender differences on certain aspects of spatial cognition can be reduced through playing an action computer game for a few hours [25]. Moreover, current learning games often involve and require an integration of different skills to accomplish combinations of activities, and are thus in general less likely to privilege one gender [3].

Game Characters and Avatar Preferences. It has been shown that female characters are “underrepresented and proportionally more often sexualized to their male counterparts” ([6], p. 103). Analyses of best-selling computer games have shown that only a small percentage of game characters are female, and a large part of them holding roles of rather bystanders than active participants [17]. Traditionally, stereotypes and archaic role models are applied to portray female game characters – they are weak victims that need to be protected or rescued by powerful males and their visual design exaggerates female sexuality [26]. This under- and misrepresentation of game characters is one reason for the inferior attraction of computer games to females – although at least a portion of women feel also ready to accept such role stereotyping [9]. In general, females express strong preferences for female game characters over male ones [27].

Gender differences have been researched on avatars, that is, the representations of gamers in virtual or gaming environments. It could be shown, that gender significantly influences the selection or creation of avatars. Most male gamers prefer male avatars, while female prefer female avatars. Furthermore, it could be shown that males want to have avatars that are powerful fighters, whereas females want to see good fashioned and beautiful characters [28]. The preference for avatars that match the own gender was also shown with static avatars outside of a gaming context [29].

As the player interacts with the game through the avatar, it is pointed out by researchers that it is important that a player feels comfortable with the avatar. The player should be able to identify with the avatar. In general, it is advisable to provide gamers with the chance to select (or create) their favorite avatar from a multiplicity of options [28, 29]. Female players should have the possibility to choose a female avatar; if this option does not exist, she might feel discontent and, as a result, might as feel as like the game was not made for her and refuse to play the game [26].

3 Implications on Game Design

In conclusion, the large body of research on gender differences in the context of computer games calls for an according consideration and reflection the game design and development, and for gender-neutral games. There is an emerging discussion and awareness on implications for (also educational) practice [17] and female-targeted game design [26, 30]. This led to the design and development of games especially for the female target audience. In the beginning of this development, games were launched that had been designed relying on stereotypical interests of girls, such as fashion, horoscopes, romance – resulting in so-called ‘pink software’ like the ‘Barbie Fashion Designer’. Simultaneously, however, there have been voices against marketing according to and reinforcing old stereotypes but rather to the opportunity of using game technology to go a step further [30]. ‘Tomb Raider’ managed to overcome the traditional ‘princess to be saved’ portrayal of a female character, with a capable and independent woman as main character. A real success story was born with ‘The Sims’, a game that focuses on social interaction between players and game characters and succeeded in attracting many female players.

Especially in the context of designing educational games a gender-sensitive approach is strongly needed, as the new learning technologies need to be appropriate and accepted for all students and ensure equal (learning) opportunities. Thus, in addition to a gender inclusive game design, the approach of adapting the game to gender-based differences appears highly suitable.

4 Gender-based Adaptation

Instead of designing games that address predominantly one specific group of gamers separately, to date hardly any effort has been made to create games that are equally suited for different preferences and characteristics through the provision of personalized game experiences. By arranging for a variety of differing game features, components, and characteristics that are chosen in accordance to the individual player, one single game could fit different learners.

Although the adaptation to current knowledge and competence is thoroughly being researched and implemented through macro and micro level adaptive approaches in e-learning and also in educational games [31, 32], current computer games – similar to the majority of existing e-learning systems – do not account for gender differences through an according adaptation of the game, game feature, story etc. Such an adaptation to gender-based differences appears especially important and relevant for educational games because of several reasons. When designing and developing an educational game it should be appealing to all students. Even more important, as an educational game aims in realizing stealth learning without explicit awareness of the learning process, it is necessary to create optimal conditions for this implicit learning process. This should involve, aside from an adaptation to the learner’s knowledge and competence, also a gender-based adaptation, which should in consequence lead to beneficial effects on motivation and learning performance.

4.1 An Integrated Model of Gender Aspects in Educational Computer Games

In an approach to elaborate a framework for the adaptation of an e-learning system to individual abilities, preferences, and gender differences, the utilization of principles and structures based on *Knowledge Space Theory* has been proposed [33]. Using the framework of *Competence-based Knowledge Space Theory* [31, 34, 35], these individual characteristics and gender specificities can be modeled and structured. It is assumed that – following the notion of prerequisites – a surmise relation between those factors can be established that captures the know-how derived from a large body of research and empirical studies on the involved individual factors. This means, that from the degree of one characteristic the degree of another one can be assumed. [33] identified a model incorporating individual factors influencing learner's choice of using a computer for educational purposes [36] and related it to proven gender differences in order to establish a learner structure modeling gender differences in relation to those individual factors as a possible basis for adaptation of an e-learning system. Through this approach the number of possible learner states (combinations of individual factors) can be reduced to a meaningful range by establishing structural assumptions based on the existing empirical research evidence in the domain.

Building upon this work and upon the thorough analysis on empirical evidence of gender differences as presented in section 2, the different factors and aspects of individuals and computer games have been analyzed and related to each other. The resulting model is depicted in Figure 1. Based on the overview on gender aspects presented before, it captures the central aspects of computer games on which gender differences have been ascertained, as well as underlying latent constructs of cognition and personality. These underlying constructs, in turn, feature characteristic gender differences and at least partly explain and account for the gender gap in the different game aspects. The model can be understood as a *Bayesian Net* model with the nodes representing probability variables¹ and the arrows representing conditional dependencies representing relationships and influences among the variables [33, 36]. The diverging preferences of males and females for certain game types, for example, can be explained by considering gender differences in competition orientation, sensation seeking, and interaction preferences. The same factors can be assumed to influence also the reason or motivation to play, which in turn will be influencing the preferences on game types and, supposingly, also usage patterns. The frequency and duration of playing computer games furthermore might be influenced and might influence computer and spatial skills.

This framework can be further enriched based on the model established and capturing gender-based differences and individual factors for user modeling and adaptation in educational hypermedia [33, 36]. To this end, factors captured by those models that appear relevant in the context of educational games are taken up (see Figure 1), thus bringing in an additional factor 'visual design' in the model. Research evidence in the field of visual design of web-based learning and web pages has shown that females seem to prefer clearer, undistracting background design and are more attracted by colors, while males tend to prefer a more complex design and are attracted by graphics, animations and interactive aspects [37, 38]. As one possible

¹ Variables representing the 'inner state' of an individual regarding different characteristics.

explanation for such findings the gender differences in processing visual displays has been raised [23, 37]. The component ‘causal attributions’ relates to the causal explanations for success or failure, and for which systematic gender differences have been identified. While males tend significantly more likely to explain success as do to their ability, females tend to attribute the cause of failure more likely to themselves than males [39, 40]. These attribution biases are directly related to the self-efficacy beliefs of individuals, which have been proven to be higher for males in the context of computer games and working with computers [9, 40]. Such dysfunctional attributional styles appear also in other domains [41] and are associated with maladaptive behavior which may eventually lead to giving up earlier and to avoidance [41, 42]. Furthermore, the variables ‘expectation’ and ‘value’ adapted from [36] may serve for explaining usage patterns on computer games. While in accordance with the model ‘computer literacy’, and in the present context, also ‘reasons to play’ can be assumed to influence the perceived value of playing computer games, the expectations of successfully playing a computer game will be influenced by self-efficacy beliefs. Both, expectations and value of playing computer games will consequently be determining factors of actually choosing to play an educational computer game [40].

The model presented in the previous section provides useful information about a player for the purpose of adaptation by making (preliminary) assumptions on user characteristics (i.e., the user model) based on well-established research findings without explicit assessment. This is especially valuable as in the context of a game there is only limited possibility for explicitly querying lots of things.

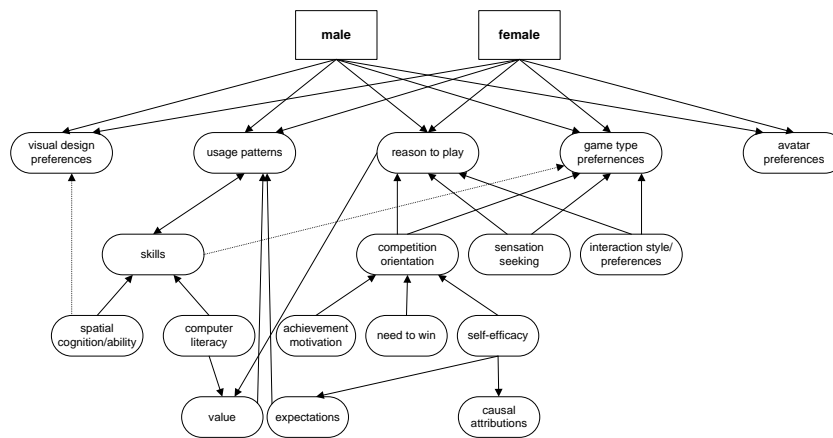


Fig. 1. Model on gender aspects relevant for educational computer games.

4.2 Educational Game Design for Gender-based Adaptation: A Case Study

In the sequel the derivation of implications for gender-based adaptation from the model and an according design shall be illustrated. This will be done by means of a case study game design incorporating and relying on the presented model - the demonstrator game of *80Days* (www.eightydays.eu). *80Days* is a European research project aiming in advancing psycho-pedagogical and technological foundations for

successful digital educational games. The project's endeavors include the development of a higher-level theoretical framework by melding adaptive educational technology with interactive adaptive storytelling. This shall allow an adaptation of a game's story and features to individual learners' abilities and preferences. An educational game teaching geography is being developed, aiming in a new learning technology that is equally suitable for both, male and female learners. This is ensured firstly through the choice of a game genre that has been proven to be suitable and accepted by both groups of learners. Secondly, and even more important, adaptation principles relying on the presented model on gender aspects have nurtured game design.

Inspired by Jule Verne's novel 'Around the world in eighty days' the game is a modern version of a journey around the world – in a UFO with an alien travel companion. From an educational perspective, the game's main objective is to teach geography skills (use of maps and globes, basic knowledge of the Earth, physical geography processes and implications). From a storytelling perspective, the main task for the player is to assist the alien in exploring the planet and collecting useful information for an intergalactic travel guide. From the game play perspective, the main component of playing is to navigate the UFO to different destinations around the world and to do accomplish a variety of adventurous missions on earth.

In the beginning of the game only a small set of user characteristics is queried, namely sex, age, computer game experience and preferences, and sensation seeking (Brief Sensation Seeking Scale; [43]), which coincides to a large extent with variables covered by the previously presented model. The preliminary assumptions on user characteristics (as based on the model) can be verified and adjusted based on the information gathered in the game's intro screen and are later on continuously updated and refined based on the gamer's behavior and interactions during and with the game. The evolving user model is used as a basis for adapting the game to the individual player. The game as such foresees a comprehensive adaptation of story elements and learning content to a learner's current skills and needs, as well as to preferences and motivational states. In the following, we want to confine our descriptions on adaptation to only the implications for gender-based adaptation, as can be drawn from the model presented in this paper. These adaptation mechanisms build upon the supposed dependencies and influences among the variables as derived from the literature and mirrored by the model.

The **visual design** of the educational game can be adapted in order to meet individual *preferences* and needs. Females should be provided with a clearer, somewhat simpler visual design, while males should be provided with more complex, animated visual design elements. This would also accommodate an adaptation to *spatial ability*, as well as the level of experience with games (*computer literacy*). In the 80Days game design this aspect of adaptation is implemented in the visual design of the UFO cockpit and head-up-display (HUD), with information displays that can be activated and deactivated (see Figure 2). A further possibility of adaptation to computer literacy and gaming experience would be to adapt the information provided in a game's tutorial for conveying game literacy (e.g. control commands and navigation of the UFO).



Fig. 2. Sketches of different HUD versions in the 80Days game.

Adaptation to *competition orientation* should occur through realizing differing **levels of competition** in the game in terms of combatants represented by other players or non-player characters. In case of the 80Days game this aspect can be realized through adapting the number of competing UFOs (flying with or without competition with other UFOs).

Adaptation to *attribution bias* and *self-efficacy* should be realized by a motivational/attributional training through **feedback** mechanisms that guide learner's perception on causal attribution of success and failure with the aim of increasing motivation and self-worth [41]. In case of high self-efficacy, an individual can be guided towards (more) realistic attributions. And in case of low self-efficacy a training of more realistic and self-confident feedback should be realized, such that successful experiences become more explicit and engaging and help fostering expectation of success. In 80Days this aspect of adaptation is captured by adaptive motivational interventions during the game given by the alien.

Adaptation to *sensation seeking* can be realized through differing levels of **game speed** (time pressure/time limits) in a game and differing levels of **risk or adventure**. This most probably needs to be accompanied by an according adaptation of the game story, aligning the level of time pressure and risk and adventure to be taken to each other. The 80Days game realizes a three-mode story pacing with different speed levels – one relaxed version without time pressure, one more driven version with time pressure, and one fast and hectic version with explicit time limits.

Adaptation to *interaction preferences* can be done through realizing differing degrees and options for **interaction** in the game. This can be taken up in 80Days by realizing different extents of dialogues and interaction possibilities between the player and non-player characters, or respectively, other players.

Adaptation to *avatar preferences* can be done through provision of avatars corresponding to known preferences of genders in this regard. Alternatively, a set of different avatars can be provided to the player to choose from it (as an aspect of adaptability through the player). In the 80Days game this aspect is planned to be taken into account by the provision of two avatars, a boy and a girl.

5 Conclusion

Gender differences relevant in the context of (educational) computer games have been observed with respect to several aspects. Many of them add up or contribute to the fact that the game sector is dominated by males and girls and women are less involved in games than boys. Recently, however, there seems to be at least a trend of increased involvement of females. Aside from the emergence of female subcultures feeling prepared and willing to adopt contemporary computer games designed for males [9] this development reflects the increasing consciousness on gender specificities and gender sensitivity in the game sector thus leading to the advent of games appealing and engaging female players. With the adaptation of computer games to gender-specific characteristics and preferences on a within-game level, this development can be further enhanced. This aspect of adaptation seems especially suited and necessary in the context of educational games, where one learning technology should be supply all students with equal opportunities and chances for learning. Through gender-specific adaptation of computer games the implicit classification in typically male or female oriented computer games could be overcome and progress towards the development of games that appeal both, male and female players, could be made. In this paper, we presented a framework that can be used for such adaptation purposes, integrating research on gender aspects that are relevant for (educational) computer games. The realization of gender-based adaptation is not only assumed to have enhancing effects on students' motivation and learning performance, but also opens ways to (cost) effective game development. This means, gender-based adaptation could also a step further in aiming in methodologies for more cost-effective development and games – through the realization of one game appropriate for both genders instead of different games for males and females, and thus reusing or using resources more effectively.

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