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Battling gender stereotypes: A user study of a code-learning game, "Code Combat," with middle school children

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ABSTRACT.

Gender has been consistently controlled as a variable in usability and playability tests. However, there is no consensus on whether and how gender differences should influence the design of digital environments. According to some research, digital environments may be unintentionally designed especially for males as a result of the existing gender biases which risks reproducing gender-polarized culture in a computational field. This study attempts to highlight that females are still being negatively affected by existing gender stereotypes and prescribed gender identities despite relatively equal access and use of computer technology. This qualitative study aims to provide insights about the first-time user experience in a home environment of 16 middle school children in Turkey (8 males - 8 females), aged between 11 and 14 years, with a code learning game named "Code Combat". The analysis is supported with complementary quantitative findings. The present study investigates the participants' conceptualizations and opinions toward coding concept and this specific coding game. Further, it explores how existing gender stereotypes and gender biased expectations impact their behaviors and attitudes in the context of game experience. Our results indicated that perceived computer competence and perceived coding difficulty had important effects on the participants' performance relatedly with their gender identity. According to our findings, there are important gender differences to be found in our 9 constructs, namely; perceived computer competence, perceived coding difficulty, identification, perceived game difficulty, perceived success, level of enjoyment, level of anxiety, the likelihood of playing it another time and the likelihood of trying new features.

1. Introduction

Discrimination and societal stereotypes against specific groups are still affecting a large number of people today and have very complex social roots. Even the concerned groups sometimes may normalize and reproduce the stereotypes against themselves while evaluating it as common sense. Increased use of computers and technology may be defined today as a remedy of long-lived inequalities in society, but it is also true that technology has not affected all groups in a society in the same way. Technology is advancing while leaving some people behind and may perpetuate precisely same inequalities in a digitalized world. It is called *"digital divide"* which is *"a term that has been used to refer to the gap between those who have access to technology and those who do not, between those who have the expertise and training to utilize technology and those who do not"* (Cooper & Weaver, 2003, p. 3). The digital divide is not only caused by lack of ownership or use of technology. Furthermore, negative/positive stereotypes, narrowly prescribed social roles and norms which have been installed in people's minds throughout their lifespan could feed on this digital divide and maintain their presence in a virtual world maybe even more efficiently and sophistically than the real one.

A digital divide also exists between men and women in which women cannot access and take advantage of technology as much as men do. The computer is not inherently gendered however it has been constructed socially as a male domain which causes *"computer-phobia"* among women (Cooper & Kugler, 2009; Turkle, 1986). The use, liking and competence of computer technology are associated with being a male (Brosnan & Davidson, 1996) as a result of the existing gender stereotypes and societal expectations which also put females in a disadvantaged position in the process. Several studies in the past stated that attitudes toward technology differ significantly between males and females in terms of interest, knowledge and competence (Cooper, Wilder, & Mackie, 1985; Bame, Dugger, de Vries, & McBee, 1993; Durndell, Glissov, & Siann, 1997; Comber, Colley, Hargreaves, & Dorn, 1997; Nelson & Cooper, 1997; Young, 2000; Margolis & Fisher, 2001; Hale, 2002; Dickhauser & Stiensmeyer-Pelster, 2002). According to

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Margolis and Fisher (2001) and Cooper and Kugler (2009), these gender differences toward computer and technology are childhood patterns originated from boys' and girls' different socialization process and must be understood as a way to cope with prescribed gender roles and social norms.

There is a current tendency in many countries for adopting a new K-12 curriculum to start teaching computing and programming to children from earlier ages; aiming to create potential innovators with high order skills such as logical reasoning, algorithmic and computational thinking (Repenning, Webb, & Ioannidou, 2010; Bargury et al., 2012; Jones, 2013; Grout & Houlden, 2014; Grgurina, Barendsen, Zwaneveld, van Veen, & Stoker, 2014; Lee, Martin, & Apone, 2014). According to many researches, teaching programming to children with game playing affect their thinking skills positively and almost all of the children start to develop a positive attitude to learning computing and programming after the game play (Fessakis, Gouli, & Mavroudi, 2013; Bers, Flannery, Kazakoff, & Sullivan, 2014; Kalelioğlu, Gülbahar, Akçay, & Doğan, 2014). Thus, game playing seems to be a promising approach to get children interested in computer science but game design is what really matters for eliminating gender inequity in computer programming. It is crucial that both genders should be equally encouraged to improve their self-esteem and competence while learning coding since perceived competence is immensely associated with enjoyment and future intention to engage in a specific task (Gorriz and Medina, 2000; Ryan, Rigby, & Przybylski, 2006; Plass et al., 2007)

The difference between the two genders still exists in terms of computer literacy, interest, self-competence, self-efficacy,[1] probability to choose computer science as a career, and having positive attitudes towards programming (He & Freeman, 2009; Kiss, 2010; Burnett et al., 2010; Huffman, Wheten, & Huffman, 2013; Singh, Bhadauria, Jain, & Gurung, 2013; Papavlasopoulou, Jaccheri, & Giannakos, 2016). Currently, many efforts to broaden participation of female students (especially for middle school girls) in computing and programming are being conducted (Denner, Werner, Bean, & Campe, 2005; Denner, Werner, & Ortiz, 2012). Several studies developed new ways in order to make coding « an approachable and natural activity » for girls by developing construction-based gaming environments which enable visual storytelling such as Alice, Kodu and Scratch (Kelleher & Pausch, 2006; Maloney, Peppler, Kafai, Resnick, & Rusk, 2008; Hutchinson, Moskal, Cooper, & Dann, 2008; Baytak & Land, 2011; Fristoe, Denner, MacLaurin, Mateas, & Wardrip-Fruin, 2011) combined with designing artifacts such as wearable e-textile technologies (Buechley, Eisenberg, Catchen, & Crockett, 2008; Giannakos & Jaccheri, 2013; Kafai, et al., 2014; Kafai & Vasudevan, 2015) in summer camps and special programs (Graham & Latulipe, 2003; Craig & Horton, 2009; Burge, Gannod, Doyle, & Davis, 2013; Giannakos, Jaccheri, & Leftheriotis, 2014, pp. 398–409). These studies were conducted with the aim of providing girls the opportunity to be game constructors which would allow them to construct their own knowledge and to transcend preconceived gender images. It was revealed that these gender neutral game environments may help to motivate, build self-esteem and foster computational thinking of especially female students.

Morever, this suggests that it is important to reveal intrinsic and extrinsic barriers which keep young girls from being interested and/or choosing a career in computer science and explore new approaches to attract young females to the field of computer science before gender stereotypes and negative thoughts about computer science sit in (Armoni & Gal-Ezer, 2014; Prottsman, 2014). Because, if a female's early experience with software is discouraging and negative, it is not very likely that she will choose a career path in computer and technology (Beckwith, Burnett, & Grigoreanu, 2006, pp. 97–101; Rosson, Carroll, & Sinha, 2011) as a result of their low self efficacy beliefs (He & Freeman, 2009; Huffman et al., 2013; Zeldin & Pajares, 2000) and adopted stereotypes associated with women, femininity and computer science mismatch between them (Cheryan, Plaut, Davies, & Steele, 2009). This study aims to determine the boys' and the girls' opinions and conceptualizations about coding concept and computers. The second goal is to assess attitudinal and behavioral patterns of boys and girls due to gender stereotypes, which affect their game experience and performance while interacting with the code learning game "Code Combat."

2. Theoretical background

The current academic literature about computer technology in its gendered context has revealed that the technology does not treat both genders equally despite the fact that the digital gap between males and females in online presence has mostly weakened since 2000 (DiMaggio, Hargittai, Celeste, & Shafer, 2001; Losh, 2003, pp. 73–85; Cooper & Kugler, 2009, p. 5). Even though women's participation in online presence and in other areas of science and technology has risen, the percentage of women's numbers in computer science decreased gradually since the mid-1980s especially in the United States and United Kingdom. (Abbate, 2012, pp. 2–3). What are the roots of these differences between genders about their reactions to technology? The social construction of technology suggests that technology is shaped according to social context. Technological designs, meanings, narratives, identities are fit best into the way society is constructed (Mackenzie & Wajcman, 1985) and individuals react to technology according to their gender roles (Steele, 1997; Steele & Aronson, 1995).

Comber and Colley (2009) revealed that despite the increased use and interest vis-à-vis 1980s, females continued to experience higher computer anxiety[2] and lack of confidence compared to their male counterparts in the 2000s while interacting with technology because computer competence was still associated with being a male. Some studies also suggested that cultural differences were needed to take into consideration while evaluating the relationship between gender and computer anxiety. In a study based in Hong Kong, male participants reported a higher level of computer anxiety which was recorded as the first sample that found high computer anxiety in males (Brosnan & Lee, 1998). Some Eastern European samples from Romania and Bulgaria provided the smallest gender differences in terms of having positive attitudes towards technology through the pursuit of relatively greater involvement with fields of STEM in the Soviet Union era which emphasized both gender equality and importance of technology (Reinen & Plomp, 1997; Cameron, Durndell, Knox, Stocks, & Haag, 1997). As these countries left their past behind, they began to produce gender related effects of technology as their westerner counterparts (Durndell & Haag, 2002). These results are also consistent with the fact that gender roles and their limitations are entirely cultural constructs which are perceived differently in different cultures, contexts and historical periods (Cassell, 2003).

The idea of computers being male related objects profoundly affects people's mind as a powerful gender bias to the extent that by only defining a computer as a male, people think that it has a higher value just as a result of being associated with masculinity. In a recent study, participants were asked to complete a gender-neutral computer task with a computerized partner personified by the researcher as man

[1] Self-Efficacy: *"a person's judgement about his or her ability to carry out a specific course of action to achieve a goal" (*Beckwith et al., 2006*, pp. 97–101).*

[2] Computer Anxiety: *"a generalized emotion of uneasiness, anxiousness of coping or distress in anticipation of negative outcomes from computer-related operations."* (Chang, 2005).

(named James) or woman (named Julie) and to predict the estimated economic value of these computerized partners. Participants estimated that the male computer (James) would cost more than the female computer (Julie) despite having same performance evaluations (Posard, 2014). Relatedly, most prior work on gender differences in game type preference has emphasized that use of war and competition concept was responsible for female participants' high level of anxiety and underperformance since female participants tended to devalue stereotypically male areas of success. Males tended to demonstrate more desire for competition and beating their opponents preferably in violent games than their female counterparts. Females were found distinctive to violence-involved computer games (Cooper, Hall, & Huff, 1990; Hartmann & Klimmt, 2006; Law et al., 2009).

The digital gender divide is very crucial and damaging for females because they have to fight with gendered expectations, societal norms and negative stereotypes to succeed at information technology (Cooper & Weaver, 2003, p. 94, p. 94). A gender stereotype or an expectation toward a particular gender will affect the individuals either they believe in it or not when it is known. Males are expected to be more proficient regarding domains such as STEM, political science or history as pointed out in several studies (Tiedemann, 2000; McGlone, 2006; Appel, Kronberger, & Aronson, 2011). According to Cooper and Kugler (2009), the most critical consequence of this declared gender-biased expectation was that females tended to experience more anxiety toward the physical presence or the interface of a computer as a result of that expectation becoming a stereotype threat[3] for them. If a female knows about the existence of a negative stereotype regarding her competence with technology, she will experience more anxiety and lack of confidence because of treating it as an undeniable truth or because she will have to work harder to disprove the deficit that others believe in. Many studies have documented related results about negative effects of stereotype threat on achievement of stereotyped individuals in complex tests related to STEM. Females' performance in mathematics were impaired when they were made aware that women are considered as untalented at math (Steele & Aronson, 1995; Spencer, Steele, & Quinn, 1999; Aronson & McGlone, 2009). Existing gender stereotypes have contributed hugely to the software design process, breeding girls' lack of computer confidence[4] and computer anxiety, which with the absence of encouragement from educators and parents result in the decrease of girls' enrollment rate in computer science (Kelleher, Pausch, & Kiesler, 2007; Tiedemann, 2000). It is likely that these factors eventually affect their performance, rendering them skeptical about their computer ability and confirms the stereotype. If a female internalizes the negative stereotype about her gender in a particular subject, she can easily end up assuming that she is not competent enough on this specific subject (Cooper & Kugler, 2009) and self-limit the behaviors that develop certain abilities. (Appel et al., 2011).

In more recent researches which investigate the effects of stereotype threat on gaming performance of both females and males, it was similarly found that negative gender-related stereotypes harmed females' online gaming performance (Kaye & Pennington, 2016; Vermeulen, Castellar, Janssen, Calvi, & Looy, 2016). Furthermore, female gamers mostly engaged in gender-bending their game characters to avoid being seen as less competent and to be treated as equals by male gamers (Yee, 2006; Zaheer & Griffiths, 2008; Ivory, Fox, Waddell, & Ivory, 2014). Girls tend to position themselves as computer users or game players by either challenging or conforming to gender stereotypes and limitations (Kafai & Heeter, 2008). If a challenge occurs, girl, the 'challenger' also starts to question her female identity because she perceives the concept of being good at computers and being a girl as two oppositional things. According to Cassell (2003), *"many girls do not believe they are good at math or computer science, but those who are good at computers may not believe that they are good at being girls."* Stereotypically male-targeted computer games are more likely to broadcast stereotypical representations of masculinity which prevent female's interest and belonging into the gaming environment since they may not identify with these stereotypes as pointed out similarly by Cheryan et al. (2009, 2013).

Margolis and Fisher (2001) conducted over 230 interviews among computer science major students during 4 years to gather their experiences and perceptions of the field. They have found significant gender differences in attitudes and experiences among computer science major students. For example, female students were more likely to transfer out of their major, stating a loss of interest and confidence as a result of the existing male favoring image in computer science which has constantly been related to being successful in this area. Beckwith et al. (2006) also stated that even female computer science majors have low confidence about their computer ability, and this might also be related to the concept of self-efficacy. According to self-efficacy theory, low self-efficacy can affect people regarding their choice of engagement in a task, amount of effort during a task, their coping strategies, persistence when facing an obstacle, their perceived success in a task, and overall performance (Bandura, 1977; Bandura & Schunk, 1981; Beckwith et al., 2006, pp. 97–101; Bouffard-Bouchard, 1990; Busch, 1995). Empirical data have shown that males are tended to be more risk-prone, overconfident, more open to adopting new features and have more eagerness to explore the software than their female counterparts by courtesy of their high computer self-efficacy (Beckwith & Burnett, 2004; Burnett et al., 2010, 2011; Appel et al., 2011; Grigoreanu et al., 2012). In an earlier study in that field, male college students were found to have higher self-efficacy while handling complex computer tasks due to having more parental and social encouragement (Busch, 1995). Similarly, according to a survey conducted among college students on technology-related attitudes and beliefs, it was revealed that male students' perception of self-efficacy on technology was significantly higher than their female counterparts relatedly to the masculine gender roles (Huffman et al., 2013).

Digital games still has a special place because they were and still are the most outstanding softwares since most children's first experience with digital technologies is solely through them (Kelleher & Pausch, 2005). However, social construction of gender has already started reproducing itself immensely in a digitalized world since the birth of video games. In several content analysis research which examined representation of gender in computer games, it was observed that females are underrepresented, overly sexualized, and mostly featured in stereotypical passive roles (Cassell, 2003; Dietz, 1998; Provenzo, 1991). Many of the games for girls are designed to exclude boys and girls who do not fit into stereotypical notions of being a girl. Such empirical data set an example for designers or developers to step away from biological determinist decisions which reproduce and naturalize gender-polarized computer culture. Girls need to be taken into account while designing software but it does not mean that we need to create *"especially for girls"* which also may pave the way for another exclusion, even *"ghettoizing"* them as a subgroup whose special needs have to be taken care of. According to Justine Cassell (2003), software design must be *"undetermined"* which "*encourages to both boys and girls to express aspects of self-identity that transcend stereotyped gender categories"* and not perpetuate one-dimensional and preconceived visions of boyhood and girlhood. Without any diversity and acceptance of a range of different representations of gender, identity and style in the online experience,

[3] Stereotype Threat: *"knowledge of a negative stereotype being applied on a group may be associated with the poorer performance at a one task"* (Cooper & Kugler, 2009).

[4] Computer Competence: *"a person's belief about he or she has sufficient computer familiarity, knowledge and skills to handle a given task"* (Chang, 2005).

software for especially girls (i.e., girl games, girls-only programs for code learning) would be another apparatus to construct a gender divide (Cassell, 1998; Jenkins & Cassell, 2008).

Code learning games can provide a new arena for every child to learn new skills and play with computers and could have a potential to represent a gender inclusive trajectory for creating new and positive images for girls about computer and technology. Campe and Denner (2015) conducted a research on more than 350 papers about what students in K-12 can learn by programming their own games. They stated that constructionist gaming for code learning was found to be the most popular approach in middle school grades, followed by secondary and primary grades. These kinds of construction-based coding games create a potential to increase all children's skills, confidence, and motivation to coding and programming as revealed in many studies (Denner et al., 2005; Carbonaro, Szafron, Cutumisu, & Schaeffer, 2010; Denner et al., 2012) if they are properly designed with a gender-neutral approach which means not reinforcing male-dominated gender stereotypes about computing. Middle school years are found very critical to include females into computational area by various researches (Denner et al., 2005; Werner, Denner, Campe, & Kawamoto, 2012; Kafai & Vasudevan, 2015) since gender stereotypes about science being "for boys" are driven into girls and they start to lose their confidence and interest in branches of science such as physics, math, computing (Dreves, 1998; Kessels, 2005) and may choose their career path accordingly in these years.

With the recognized need of early exposure of children to broaden participation into computer science, there has been a concerted effort on the part of Turkish policy makers to implement a new K-12 curriculum. There is a continuing process to include coding and programming as a compulsory course into the 5th, 6th, 7th and 8th grades syllabus (11–14 age group) (The Ministry of National Education of the Republic of Turkey, 2018). However, it seems important to us firstly to a) determine the barriers which keep girls from getting included to coding and programming, b) develop gender-inclusive approaches to debunk gender stereotypes about computer science. This research investigates topics related to the first issue and aims to contribute to the second issue relatedly.

3. Methodology

This study aims to investigate the research questions with a qualitative and quantitative user research which is based on an analytical framework that consisted of 9 different constructs referring to several gender-related human-computer interaction (HCI) studies mentioned in the above literature. Constructs were mainly evaluated by easy-to-execute, child-friendly interview questions inspired from Kids Game Experience Questionnaire (Poels, IJsselsteijn, & Kort, 2008) and Post-Task Usability Questionnaire (Sauro & Dumas, 2009), which is suitable for studies with a small sample. Supportive construct assesment methods were task observation and performance evaluation. Following constructs were chosen due to their expected potential to reveal the gender stereotypes which affect participants' experience in a code learning game and their intention toward coding concept: Perceived coding difficulty, percived computer competence, identification, perceived game difficulty, perceived success of the game, level of enjoyment, level of anxiety, likelihood of playing it another time and likelihood of trying new features. This study is carried with a multi-method approach in which qualitative findings are supported with quantitative statistical data to enable an in-depth descriptive discussion of the results. In this context, 8 of our attributes (except identification)[5] were also tested statistically with non-parametrical Mann-Whitney *U* Test to see whether there was any gender relevance or not. The attributes which were found to be statistically gender-related will be detailed in the scope of this study. Statistical scores are presented with a rich set of qualitative discussion collected by in-depth interviews.

3.1. Research questions & hypotheses

In this study, we sought to determine different attitudinal and behavioral patterns for both genders while they experience a specific code learning game for the first time. This study also focuses on understanding these differences which are seen as impacted by gender stereotypes. The following three research questions are proposed to examine these goals through a set of 9 constructs mentioned in the following table:

RQ1. What are the girls' and boys' conceptualizations and opinions about computers and coding concept?

RQ2. What are the girls' and boys' behaviors and attitudes while playing a code learning game?

RQ3. What are the factors that affect their game experience and performance[6] due to the salience of gender stereotypes?

The above literature and research questions lead us to formulate the following seven hypotheses with relation to gender differences:

H1. There will be a difference in attitudes toward coding concept between boys and girls relatedly with their adopted gender stereotypes and perceived computer competence.

H2. Greater perceived computer competence before playing a code learning game will be associated with lower perceived game and coding difficulty.

H3. Girls exposed to a stereotypically male-targeted game environment will have a lower comfort level while playing the coding game and experience higher perceived game difficulty.

H4. Participants' anxiety and enjoyment during the activity is related to their intention to participate on future similar coding activities.

H5. There will be a difference in success expectation and failure perception in a code learning game between boys and girls due to game environment and perceived coding difficulty.

H6. There will be gender differences in males' and females' likelihood of trying new features in a code-learning game due to their different levels of computer self-efficacy and perceived coding difficulty.

H7. Girls exposed to a stereotypically male-targeted code learning game environment will have a lower intention to find coding concept relevant to their abilities, identities, and career choices.

We have measured our constructs by using a variety of data collection instruments such as in-depth interviews, task observation and performance evaluation. The following table explains the constructs, relating them to corresponding data collection instruments and refers to their adapted sources (see Table 1):

[5] Participants' level of identification with the game avatars attempted to be explored with in-depth interviews. Likert Scale was only used for more direct, concrete and objective questions considering participants' age.

[6] User testing of our study in the form of task observation and interviews was implemented to evaluate participants' attitudes, behaviours, emotions, perceptions during and before the test (gaming experience) which directly affect their accomplishment of the given task (gaming performance). Considering 1-h of maximum time play, participants who have reached a higher level, were judged to have performed better.

Table 1
Constructs used to measure participants' attitudes and behavior.

Constructs	Data Collection Instruments	Adapted Source
Perceived Coding Difficulty → *Which represents the degree of participants' general belief about coding and programming concept*	Do you know what a "code" is? (yes/no) Do you think code writing is difficult? (scale between 1 and 5) Why? Do you know what "loop", "function" or "variable" means? (open ended) How do you feel right now? Why? (open ended) In your opinion, how does a programmer look like? (open ended) In the future, would you be interested to work in coding, programming, or any other computer related business? (yes/no) Why?	Original
Percived Computer Competence → *Which represents the degree of participants' evaluation about their computer competence*	In your opinion, what is a computer for? What does it do? (open ended) For what purposes do you use your computer? For how many hours in a day? (open ended) Do you think you're talented when it comes to computers? (scale between 1 and 5) How do you feel about attempting science? (open-ended) Which computer games do you find to be entertaining? (open ended) Who do you approach when you need help with computers?	Ryan et al. (2006) Poels, De Kort, et al. (2008) and Poels, IJsselsteijn, et al. (2008) Burge et al. (2013)
Identification → *Which represents the degree of participants' intention to identify with the game*	Do you have any favorite computer game characters or avatars, if so which ones are they? (open ended) Do you think there are "boy" games and "girl" games? Why? (open ended) Did you like the character you picked for the game? Why? (open ended) If you could change one thing about the game according to your taste, what would it be? (open ended)	Original
Perceived Game Difficulty → *The degree to which the participants believed that the attending game experience was difficult for them*	Do you think Code Combat was an easy game? (scale between 1 and 5) Why? Which part challenged you the most during the game? (open ended)	Sauro and Dumas (2009)
Perceived Success of the Game → *Which represents the degree of participants' evaluation of their success and failure situation*	How would you rate your performance? Why? (scale between 1 and 5) Who would get the best score in this game? (open-ended)	Dickhauser and Stiensmeyer-Pelster (2002)
Level of Anxiety/Enjoyment → *The degree to which the participants felt nervous or joyful during the game experience*	How did you feel during the game play? (scaled between 1 and 5) Why? Which part did you enjoy or dislike the most about the game? (open ended) To make you feel more at ease, how should the game have been? (open ended)	Poels, De Kort, et al. (2008) and Poels, IJsselsteijn, et al. (2008)
Likelihood of Trying New Features → *Which represents the degree of participants' intention to try different features and code lines appeared in each level*	Task observance was scaled by the researcher upon their intention to use one or more new features. Why did you or did you not prefer using new features during the game? (upon the task observance) (open ended)	Beckwith et al. (2006)
Likelihood of Playing it Another Time → *Which represents the degree of participants' intention to participate a similar activity in the future*	Do you consider playing this game or another code learning game in the future? (scale between 1 and 5) Have your thoughts about coding concept changed after the game play? (open ended)	Buechley et al. (2008) Burge et al. (2013)

3.2. Code Combat

Code Combat[7] is a code learning game, launched in 2013, which intertwines programming concept with a medieval adventure where the player controls heroes and heroines (7 females-9 males), and along with his/her journey, the player goes on collecting gems and defeats various enemies, such as ogres, thugs, etc. by using proposed code lines. It is an open source game in which a player may learn different coding languages such as Phyton, JavaScript, CoffeeScript, Clojure, Lua, and IO and also offers paid phases. The player can choose from 59 languages on the home page of the game site. Code Combat has different medieval universes such as Kithgard Dungeons, Backwoods Forest, Sarven Desert etc. to introduce computer science concepts, game and web development to its players. Gradually, each universe becomes more difficult and provides an estimate of the time needed for its completion. Code Combat has a split screen interface which shows the code lines alongside (on the right) and lets the player control the game world which is displayed at the other part of the screen (on the left). Goals are explicated at the beginning of each level, and all the methods are listed in the middle of the interface. Players need to write the appropriate code line to make their character move and complete the mission. A level is completed when all gems have been collected and all the enemies have been defeated. In case of doubt, players are allowed to click on hints button to receive more explication (see Fig. 1).

[7] https://codecombat.com/play.

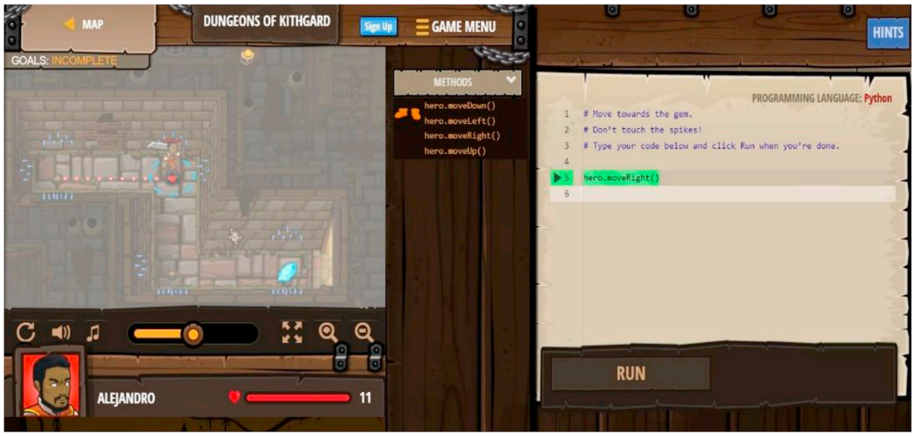

Fig. 1. Interface of code combat [8].

We have chosen Code Combat due to its language support in Turkish, its accessibility potential as it is a free open source game and most importantly its expanded use for computer classes and code learning programs in public schools in Turkey (Educational Informatics Network, 2017). The decision to limit each participant's game experience to at most an hour of play also motivated our choice of Code Combat since it has an easy-to-follow leveling system which allow us to compare and evaluate the participants' performance.

3.3. Participants

In this study, task observations and in-depth interviews with 16 middle school children from Turkey ranging in ages from 11 to 14 including 8 females and 8 males were conducted. We based our selection of sampling whereby our participants had to meet three criteria: (1) being a middle school student, (2) being a computer user, (3) having never experienced a code-learning game before. There were several reasons to focus on the middle school (11–14 years age group) children. First, our participants were considered old enough for playing a code learning game since middle school children in transition between Piaget's concrete and formal operations stages are more likely to approach problem solving by concentrating on available information and tend to base their decisions on empirical evidence (Hourcade, 2015, p. 128). Children during this period have more ability for complex thought and they have a strong sense of right and wrong (Centers for Disease Control and Prevention, 2017).

Secondly, middle school is a critical time for intervention, when girls actively explore their identities, abilities, interests, and make career decisions. In middle school, girls' favorite kinds of classes are consistent with their female identities, it is crucial to get to children in middle school age to affect their enrollment in computer science as indicated in previous studies (Denner et al., 2005; Kelleher et al., 2007; Werner et al., 2012; Kafai & Vasudevan, 2015).

3.4. Procedure

We aim to provoke children in verbalizing their own emotions and attitudes by in-depth interviews and observe their behavioral signs by video recording during and before game experience as a method which was suggested by several kids related HCI studies because of its potential in providing context and depth (Fails, Guha, & Druin, 2013; Iversen, 2002; MacFarlane, 2005; Poels, IJsselsteijn, et al., 2008; Poels, De Kort, & IJsselstein, 2008) rather than making them fill out exam-like scaled questionnaire after the game play. Compared to adults, children may need more support in communication to open up due to developmental differences.

To evaluate the participants' conceptualizations and opinions about computers and coding concept in general, a pre-test questionnaire were prepared. Two types of response scales were used in objective questions: (i) dichotomous scale (yes/no); (ii) 5 point Likert scale. In the pre-test stage of data collection, participants were also interviewed with open-ended questions to get more profound and new insights from them.

During task execution stage, the participants were asked to choose an avatar and play the first 10 levels (10 basic syntax levels) of the given game "Code Combat" in a given time of maximum 1 h. All participants were assured that they were always free to quit the game whenever they wanted. Parental informed consents were taken, and children also consented to participate. The research was conducted in their home environment to imitate a valid and representational game environment. The participants were observed, and audio, facial impressions, and mouse track were recorded with "ScreenCast-O-Matic" software during the task execution. These recordings were annotated to evaluate their performance by analyzing performance scores such as time on task, difficulty level, completed levels.

After the task execution, the participants were interviewed to evaluate their introspective judgments about their game experience, and their replies were recorded. The responses referring to our set of the construct were modulated on a 5 point Likert scale to be able to provide statistical data. The scaled questions were referred to their level of enjoyment and anxiety, perceived game difficulty and perceived success. In the after-test stage of data collection, open-ended questions were used mainly to get more thorough and new perceptions from the participants (see Table 2).

[8] Although the interface in Turkish language is exactly identical as the English version, a screenshot in English is presented for the better understanding of an English reader.

Table 2
Research stages & methodological approaches.

RESEARCH STAGES & METHODOLOGICAL APPROACHES		
Pre-Test Stage	Task Execution Stage	Post-Test Stage
Collecting data with in-depth interviews based on close-ended and open-ended questions using: • Likert Scale • Dichotomous Scale • Open-ended questions **Output**: Statistical Data and Interview script **Relevant Constructs in the Analysis Framework**: • Perception of coding difficulty • Perception of computer competence • Level of anxiety • Identification	Task Recordings with Screen Cast-o-Matic • Task observation and performance evaluation **Output**: Observation notes and performance scores **Relevant Constructs in the Analysis Framework**: • Identification • Likelihood of trying new features • Level of anxiety • Perceived Success • Perceived Difficulty	Collecting data with in-depth interviews based on close-ended and open-ended questions using: • Likert Scale • Dichotomous Scale • Open-ended questions **Output:** Statistical Data and Interview script **Relevant Constructs in the Analysis Framework**: • All 9 constructs of our study
MIXED METHOD DATA ANALYSIS: Combined qualitative and quantitative data interpretation		

4. Results & discussion

4.1. Results related to pre-test stage

In this part, the findings derived from pre-test stage are detailed in two parts: The results of the statistical data and qualitative data derived from pre-test in-depth interviews are presented. Pre-test stage aims to summarize key gender differences in computer conceptualization, attitudes towards computers and coding concept as well as the level of encouragement in learning coding and programming.

All of the participants expressed a certain level of interest and ability toward computer concept. This study shows no differences between gender and computer conceptualization since both genders tended to define computer as a fun tool for learning things, playing games, socializing and doing homework. However, we found major differences in their computer attitudes by gender. Boys are more likely to express greater interest and spend longer hours (m = 6 h in a day) with computers than females (m = 2 h in a day). Boys were more curious than girls in learning different aspects of computers and more willing to participate in related activities through a club or group at school. Girls on the other side, had limited permission for computer use and computer club participation. Most repeated statement was *"when I play too much with computers, my mother asks me to clean my room, prepare the table or she is just mad at me for not having done anything"*. Most of girls' parents (n = 6) did not let them spend a lot of time with computers and their judgment toward their kids playing with computers has a potential to affect their computer attitudes negatively. Girls tended to limit their use of computers because of the discouragement coming from their parents*: "I promised my mom and dad to study hard and help more to my mother this year. I gave up my favorite game because it affected me poorly and made me spend my time for nothing"* or *"I would love to go computer clubs to at least take a look at what was happening, but my parents would not allow me. I am not that good with computers anyway."* None of the boys reported a lack of parental encouragement about their computer use during our in-depth interviews.

Participants' game preferences had been affected from certain gender stereotypes. The most preferable game types for girls were "*dressing up* (n = 4), *"platform"* (n = 5), *"racing"* (n = 3) *and "role-playing"* (n = 4) games. On the contrary, the most preferable game types for boys were "*first-person shooter"* (n = 7) *"war"* (n = 5) *"fighting"* (n = 4) *and "strategic"* (n = 3) games. Gender and game type preferences are related. None of the female participants expressed any interest for some of the specific genres such as FPS or strategic games. Similarly, none of the male participants seemed attracted by role-playing or dressing up games because of their *"girliness"* and *"silliness."* Both genders excluded themselves voluntarily from specific game types since they perceived these games as identified with a particular gender.

Participants were also asked about their perception in coding concept. Most of the female participants (n = 6) indicated that coding remained a mystery to them, outside of their everyday interactions with computers, irrelevant with their identities and career plans; this reminds findings from previous studies indicating that females are less computer-oriented than males. Currently, in our study, they are embracing some "fun" aspects of computer technologies but see coding and programming as irrelevant to their own lives: *"I think that I like using computers, playing games is fun but it's not like I'll be doing coding or anything. Not for me. I cannot."* or *"I've heard of Scratch while some boys talking about it in school but I did not try. I wasn't that into technology, I mean, I was afraid to fail. It is cool learning how to code and also cool to learn it by playing but it is difficult for me. I am also not good at math."* Here we see female participants expressing their initial lack of comfort and perceived competence in coding but also seeing them being curious towards computers to some extent.

We also asked the participants who they contact if they need help with computers. Females' most repeated responses were *"my dad"*, *"some boys in my class."* For a reverse situation, we asked about occasions in which they are asked to help someone else. All the girls answered that they help their mom, little sister, some older relatives. All the girls had their 'male computer experts' in their life. Most of the girls (n = 5) also indicated confidently: *"there are very few women in the world who would understand computer related things and in specific, this coding game."* All the male participants, on the other side, stated that they would help the others and sometimes asked their father's help.

The results of the quantitative data analysis also confirmed the statistical significance which draws a sharp distinction between gender/perceived computer competence and gender/perceived difficulty of coding are summarized as follows (see Table 3):

Table 3
Statistical Results before task execution with italic values demonstrating statistical significance at $p < 0.05$

Result Type Before Task Execution	*Outcomes with Mann Whitney U Test*
Perceived Computer Competence (PCC)	*P = 0,001* ($p < 0.05$); Males' PCC is higher
Perceived Difficulty of Coding (PDC)	*P = 0,001* ($p < 0.05$); Females' PDC is higher

The female participants rated themselves significantly lower in computer competence than their male counterparts. Interestingly, a girl never rated herself higher than 'average' (mean: 2.5) and a boy never rated himself lower than 'competent' (mean: 4.375). Most of the participants (n = 12) could not define the code itself, but all of them were familiar with the concept and knew that it was computer related. When participants were asked about their perceived difficulty of code writing, the results showed that female participants were more likely to find the coding concept more complex and difficult than male participants despite of the fact that neither of the participants could define the code properly. A girl never rated the difficulty of coding lower than 'difficult' (mean = 4.6), and a boy never rated the difficulty of coding higher than 'average' (mean = 2.5). Participants (mostly boys) who declared higher level of computer competence before playing also showed higher enjoyment, more positive mood from pre to post play and greater interest for code learning in the future as similarly revealed in a user study which investigated motivations in different playing environments (Ryan et al., 2006).

All male participants declared their desires and sympathies to be employed in the computational ecosystem in the future. Most of the female participants (n = 7) declared that *"it would be difficult, "too risky"* for them because they cannot *"handle it correctly."* They also added that they *"are not good at math," "do not have any interest" or "enough competence"* to succeed in programming, coding or technology. However, most of the girls (n = 7) specifically gave reference to certain gender stereotypes when we asked about their perception of programmers. They indicated that they had never seen a female programmer in their lives and added: *"women cannot succeed in computer sciences as men do."* The most repeated statement, *"It is a man's job. We aren't men!"* was striking because girls used the all-embracing 'we' referring to her "female nature." Some of the other responses were: *"I did not see any female computer scientists or programmers. Are there any? The image of a programmer which pops up in my head has glasses and a beard"* or *"a fat guy with dark t-shirts."* Male participants also embraced similar gender stereotypes in their perception of computer scientists and programmers by stating that *"my teacher is one of the few women I know that can understand the computers"* or *"a programmer can only be a regular smart guy like me who works on fun and exciting projects."*

Before task execution, nearly all female participants (n = 7) reported their high level of anxiety stating that they *"could not be able to sleep last night"* (n = 4) (the night before the test) because of the *"fear of failure"* and *"anxiousness"* since they had no prior experience in coding and code learning game. Female participants' lack of confidence and high level of anxiety toward coding concept cause low-performance expectancy, limited computer use, and most importantly a voluntary self-exclusion from coding and programming field as similarly revealed in previous technology related studies (Colley & Comber, 2009; Cooper & Kugler, 2009; Cooper & Weaver, 2003; He & Freeman, 2009; Huffman et al., 2013). All these findings lead us to summarize our pre-test findings as follows: As our H1 and H2 state that there is a correlation between the participants' perceived competence in the computational field and perceived difficulty of coding concept and their gender identity. Females tended to exclude themselves from code learning concept due to their lack of computer competence, lack of parental encouragement, and the existing stereotypical gender beliefs about coding such as not seeing coding concept as a component of their female gender role. Males displayed more confidence about their computer competence which fostered their self-esteem toward coding concept and relatedly our code-learning game. Females were more inclined to develop a specific coding anxiety, describing that coding concept was complicated and not related to the entertaining aspects of computers. Stereotypes of programmers' physical appearances in participants' minds may distance girls from coding more than boys due to the fact that girls are more likely to conform and maintain less technology-oriented female gender roles.

4.2. Results related to task-observation and post-test stage

The findings from the in-depth interviews after the task execution are in line intertwined with the findings obtained from the task-observation stage. The results derived from task-observation stage regarding the participant's gender, time on task, task completion state and the most difficult level according to participants are summarized as follows (see Table 4):

Table 4
Summary of our participants' performance evaluation.

Participants	Age	Time on Task	Task Completion	Most Difficult Level for Participants
M1	12	1 h.	Maximum Time Limit Reached at 6th Level	6th Level
M2	13	35 Min.	Task Completed	6th and 10th Level
M3	13	23 Min.	Task Completed	10th Level
M4	11	50 Min.	Task Completed	6th Level
M5	12	34 Min.	Wanted to quit at 6th Level	6th Level
M6	11	32 Min.	Task Completed	8th Level
M7	13	1 h.	Maximum Time Limit Reached at 9th Level	9th Level
M8	13	34 Min.	Task Completed	6th Level
F1	13	27 Min.	Wanted to quit at 6th Level	6th Level
F2	14	35 Min.	Task Completed	6th Level
F3	11	34 Min.	Wanted to quit at 6th Level	6th Level
F4	13	1 h.	Maximum Time Limit Reached at 8th Level	6th Level and 8th Level
F5	12	44 Min.	Wanted to quit at 8th Level	8th Level
F6	13	32 Min.	Wanted to quit at 6th Level	6th Level
F7	12	32 Min.	Wanted to quit at 6th Level	6th Level
F8	14	36 Min	Task Completed	10th Level

Identification: Identification with the game characters affects players' comfort, willingness to play the game, and relatedly their game experience especially in the learning tools for school aged children (Yee, 2007). This study revealed some gender differences in perceiving game characters. At the beginning of the task execution, all participants in our study preferred characters to be of their same gender. All female participants declared that they had chosen the game character by evaluating its appearance and male ones by evaluating its strike force. Female participants indicated that the storyline of Code Combat did not include characters that they could relate to, and they could not find any characters as a sort of *"like them."* According to them, female characters are portrayed as *"ugly", "out of fashion"* and *"powerless."* It was bothering for them (n = 5) to discover that two of the female avatars had the same voice, but the male ones' were all unique. Some of the female participants (n = 5) changed their avatars and preferred a male one because they believed that female avatars *"do not have enough power to beat the enemies"* and *"always squeak annoyingly when they fail."* However, *"male avatars always sound powerful even if they fail."* It could be argued that female participants tended to mark the game as an area of male dominance and as a consequence, they needed to engage in gender-bending. However, they declared that they did not feel comfortable with it (n = 5) and they had difficulties of identification with game characters (n = 6). Accordingly, they felt excluded; either challenging or conforming to the existing gender stereotypes and limitations. Correspondingly, female participants' identification with their gender led them to a disidentification with the characters of the game, and they distanced themselves from it. This result is also parallel with other studies in the field (Cassell, 2003; Kafai & Heeter, 2008). However, all male participants demonstrated more desire and comfort for fighting with the enemy in game levels as revealed in previous studies (Law et al., 2009). They displayed high eagerness to use the "attack" code to complete the related level to the extent that they tried to use it even when it was not related to the game progress (n = 5). Underpinned by stereotype threat theory (Steele & Aronson, 1995) and our H3, it can be argued that Code Combat as a reproduced safe zone of traditional male dominance, made male participants feel familiar, comfortable and motivated while rendering opposite emotions in female participants during the game experience (see Fig. 2).

Fig. 2. Example of a male avatar in Code Combat.

Some impressive results were also exposed when the participants were asked if there were any *"girl games"* or "boy games" in the gaming ecosystem. They tended to respond mostly that there were not (n = 10). However, all the boys especially noted that they did not play "Barbie" or "Dressing Up" games since they were boys and these types of games were boring to them. According to all participants regardless of their gender, girls can play the games which are mostly preferred by boys if they *"are able to"* but boys do not play the games which are mostly preferred by girls simply because they are boys. For them, it is a highly marked behavior to play "dressing up games." It was one of the most interesting findings of this study that female participants who like playing football games and racing games (n = 4) also declared that they enjoy playing these kinds of games simply because they *"had not been raised like girls"*, they are not *"as the other kinds of girls that only like giggling and gossiping around", "there are not so many choices for girls but boys have more diverse video games", "girls' games are childish and not very interesting."* These facts lead us to the conclusion that female participants feel obliged to transcend their female identity to *"be able to play"* boys' games as a way to transcend the traditional female stereotype. Stereotypical female computer games are belittled and found childish or easy by most of the participants (n = 12) regardless of their gender. Traditional female stereotypes created a *"stereotype threat"* which have enormous effects on limitations of both genders as stated similarly in other studies (Cassell, 2003; Kafai & Heeter, 2008; Cooper & Kugler, 2009) and affect their game experience and performance negatively as predicted by our hypothesis 3 (see Fig. 3).

Fig. 3. Example of a female avatar in Code Combat.

The results of the statistical data analysis regarding the relatedness between gender and our study's set of the construct (except identification) are summarized as follows (see Table 5):

Table 5
Statistical Results after task execution with italic values demonstrating statistical significance at $p < 0.05$

Result Type After Task Execution	*Outcomes with Mann Whitney U Test*
Perceived Game Difficulty	*P = 0* (< .05); Females' PD of the game is higher
Level of Enjoyment	*P = 0.007* (< .05); Males enjoyed the game more
Level of Anxiety	*P = 0.001* (< .05); Females were more anxious
Perceived Success	*P = 0.001* (< .05); Males' PS is higher
Likelihood of trying new features	P = 0.003 (< .05); Males are more likely
Likelihood of playing it another time	P = 0.008 (< .05); Males are more likely

Perceived Game Difficulty: Although some of the male participants could not complete the game (n = 2), needed help and hints (n = 6), and faced obstacles (n = 8), their perception of task difficulty toward the game was significantly lower (mean = 2) than their female counterparts. The male participants ignored that they faced obstacles when they evaluated the level of game difficulty regardless of whether they had succeeded or had failed. They did not mention at all that they had difficulties on the task in post-test interviews. On the contrary, female participants' perception of game difficulty was significantly high (mean = 4) even for the ones that have completed the task successfully. Female participants who could complete the task did not mention at all their computer self-efficacy or coding ability and admitted that they had difficulties during the game in post-test interviews. Most of the girls (n = 5) tended to quit the game directly after facing an obstacle by blaming their intrintsic lack: *"it was too difficult for me, I do not even know properly what code is", "I failed because of my lack of coding ability", "I can not handle these kind of coding related games", "I felt so anxious, it was like a really difficult math problem"* or *"it was clearly a boy game, even the girl characters were like boys. I did not like that."* Contrarily, some of the boys (n = 2) kept trying until they reached the maximum time limit even though they were struggling in the game as a result of their high level of perceived computer competence:*"everbody would have difficulties in this level, there is obviously something wrong with this game. Normally I play very difficult computer games"* or *"the game concept is very fun but they* (Code Combat developers) *did not manage to code some of the levels properly. I would construct a better code learning game and I will do so in 10 years."* Boys also expressed non-verbal reactions such as turning their back against the screen to question the researcher if there was a possible error when they encountered an obstacle during the game. The results of our data regarding this construct indicated that participants' self-efficacy, the game type and the perceived difficulty of coding concept has largely affected the perceived game difficulty, level of anxiety and relatedly their overall performance and confirmed our H2 and H3. Girls tended to quit the game upon facing an obstacle due to their lack of familiarity with the game environment and higher perceived difficulty of coding concept. Boys were more likely to persist during the task and attribute difficulties they face to external factors such as system characteristics or possible game errors. It could also be argued that female participants' higher perception of game complexity had largely been affected from stereotypically male targeted game environment and their lower level of self-efficacy as similarly stated by several studies (Beckwith & Burnett, 2004; Durndell & Haag, 2002; He & Freeman, 2009; Rosson et al., 2011) and stated by our hypothesis 3.

Level of Anxiety and Enjoyment: According to the data obtained, it is observed that as the level of anxiety of participants increased, the level of enjoyment decreased. This issue was mainly the case for female participants. Female participants agreed significantly more than their male counterparts with the statement: *"I was terrified that I was not going to be able to understand the game and I was very nervous while playing it."* Most of the female participants (n = 6) indicated that their anxiety level was extremely high (mean = 4.125) before the game. They were also observed to frown and grunt during the task execution which demonstrated their low level of enjoyment and high level of anxiety/tension. They thought that they were not going to be able to perform good enough since it was related to coding (n = 6) and some of them reported that they found the game frustrating (n = 6), irritating (n = 4) and boring (n = 2). Some of the female participants (n = 4) indicated that they would have performed better if there had been no violence involved in the game. This idea may be summarized better with the following statements: *"when I found out that it was a battling game, I got frustrated because I feared that I would possibly not be able to complete the game as good as the others that you (the researcher) have been working with", "normally, I can manage limited kinds of computer tasks but when it comes to coding I know that I will perform poorly and feel anxious automatically. I am not the right person for you. I will be the worst player of the entire game history."* All the male participants were observed to be comfortable during the task execution. They expressed non-verbal reactions such as laughing and yelling with excitement which can be associated with their high level ol enjoyment. Also, they reported that they had experienced low anxiety levels (mean = 1.5) during and before the game and enjoyed the game accordingly. According to the data derived from in-depth interviews, it can be suggested that females' performance and persistence were affected negatively both because of the game type and because of their high level of anxiety that they had experienced before and during the game. It can be argued that computer anxiety concept, which was underlined many times within studies from all over the world for the past 20 years (Comber & Colley, 2009; Law et al., 2009), started to transform into coding anxiety among females. As predicted by our H4, coding anxiety in girls fosters their negative attitudes toward serious educational games, leads to disidentification with the coding and programming area and affects their performance negatively where computer skills are needed, which in our research happens to be a code-learning game.

In post-test interviews after the game play was completed, females (n = 6) displayed more fear and anxiety toward coding concept specifically, by stating *"from now on, coding will be my worst nightmare", "coding was a really strange subject for me, I felt horrible. It felt like it was never going to end", "I thought what I was doing there, I wasn't that kind of a girl. I thought of quitting".* All male participants indicated that coding was easier than they thought in the first place and displayed their joy and confidence by stating that *"if coding is like this, I can do it in my sleep"* or *"I felt really confident, as if my teacher was asking me regarding a subject that I had just studied yesterday."*

Perceived Success in the Game: The female participants rated themselves lower in success than their male counterparts. Even the ones (n = 2) that could complete the task did not claim themselves as successful. It was one of the valuable results of this study that a girl never rated herself above average (mean = 2). On the contrary, a boy never rated himself lower than successful (mean = 4.5) despite the fact that some of them had difficulties (n = 8), needed help (n = 6) or couldn't complete the game (n = 3). Interestingly, the boys who could not finish the game asserted that their game characters were not *"powerful"* enough and that *"there was something wrong with the game."* The male participants' computer confidence was overwhelmingly high to the extent that whenever they felt challenged during the game, they tended to question the researcher and the game. Most of the male participants (n = 6) asked whether there was *"any problem"* or *"error"* with the game or not. Male participants agreed significantly more than their female counterparts with the following statement: *"I have done what it needs to be done, but my character cannot attack the enemies and beat them all. Has somebody ever passed this level?"* All the male participants were more likely to attribute their failures and obstacles that they faced during the game with the external factors (possible problem or error in the game) and their success to their computer ability (internal factor). Boys were more inclined to avoid difficulties that could have defamed their success. Whenever female participants felt challenged, they mostly tended to quit the game after a few minutes of trying and blamed their *"lack of competence in such coding-related games"* or *"boy games"* on not having to be able to complete all of the 10 levels. Some of the female participants (n = 2) tended to attribute their success to *"not being an ordinary female"* and belittled their performance even if they completed the task. On the other side, most of the female participants (n = 5) were largely affected by their biases of prejudices toward violent and beating games. They tended to mark this *"violent game"* as an arena of male identification and success, excluding themselves voluntarily as *"a female who dislikes violence."* Furthermore, interestingly, when participants were asked who would get the best score in this game, all male participants indicated: *"nobody would perform better than me" or "I probably have performed better than all the girls you worked with"* and females declared *"a certain guy in my class"* or *"my older brother/sister would perform better than me."*

These statements have provided us insights in understanding how differently the boys and the girls attributed their success or failure conditions in a code-learning game: Being successful in a *"violent"* coding game is associated with being a boy and is perceived as a male area of success. For a male participant, not being successful or having difficulties in Code Combat could only depend on external factors while females stated internal factors and questioned themselves when they failed as revealed similarly in Nelson and Cooper (1997), Dickhauser and Stiensmeyer-Pelster (2002), and Cooper and Weaver (2003). Male participants in this study were most likely to maintain their gender biased views of technology as indicated in previous studies (Durndell et al., 1997; Comber et al., 1997; Nelson & Cooper, 1997; Young, 2000) and extend it to the coding area. All the male participants expressed greater self-confidence and perceived success about playing code-learning games despite of the fact that they had no prior experience in coding as stated by our hypothesis 5.

In this study, conventional gender discourses about success expectations were also revealed with regard to coding concept. Some of the male participants (n = 4) asked about the other players' scores after the play. They had very clear opinions about the other participants' achieved success in the game. The conversation that we had with one of our male participants showed how gender stereotypes are internalized among children:

Researcher: Is it possible to guess who had played before you by looking at scores that he or she achieved? A boy or a girl?

M4: Yes. Very likely a boy.

Researcher: Why do you think that?

M4: Because he had a better score than me, probably he has more experience about coding than I did or has played the game before.

Researcher: Do you think it is possible to tell whether it is a girl who has played the game only by looking at the score?

M4: Yes. Because they probably could not have done it the way it must be done. For example, they could not have passed the 6th level (the level in which M4 encountered difficulties). They do not know anything about coding. You have to keep calm and think strategically to be able to program. Girls would be freaked out.

In this study, there were gender differences in participants' level of success, success expectations and failure perception which were also found related to the game type and perceived coding difficulty as predicted by H5.

Likelihood of trying new features: This study revealed that there was a significant difference in the way of playing the game between girls and boys. Female participants tended to ask the researcher mostly *"is it OK if I pushed this button?"*, *"what if I wrote the wrong code line"*, *"is it OK for you if I fail in this level? I am afraid I will for sure"* which typified their phobia and their low self-efficacy toward coding concept. They did not even try new features proposed by the game as it evolved. While all female participants were hesitant in trying a new line of code or new accessories or features since they were *"unnecessary risks"* or *"not worthy"* in their perception. On the other hand, most male participants (n = 7) tended to try all the new features and code lines proposed comfortably. The gender differences in expectation of their ability to play a new code learning game may lead the female participants to prevent their ability to cope with new features which can be related to their low self-efficacy revealed in previous studies (Beckwith et al., 2006, pp. 97–101). A female participant with lack of confidence in her ability to succeed at a code learning game may be hesitated to use new code lines because of the fear that the risk she takes may not contribute to her overall performance. Also, she may consider that the cost of learning them will be high, as a result of a lack of confidence in her own capabilities (Beckwith et al., 2006, pp. 97–101). Our data confirmed H6 in terms of gender differences in males' and females' likelihood of trying new features in a code-learning game which is associated their different levels of computer self-efficacy and perceived coding difficulty.

Likelihood of playing it another time: Relatedly with other results in this study, gamification of code learning within a battling arena prompted male participants' curiosity and confidence (n = 8) toward coding concept and the game while decreasing females' confidence and the likelihood of playing it another time (n = 4) according to their statements.

When asked if they would play this game again or try another code learning game to understand how their perception of coding had changed after the game experience, female participants found coding concept way more irrelevant to their abilities, identities and interests: *"it is a way more difficult than I thought. It seems easy at the beginning but gradually I felt like an idiot while playing", "I knew that I could not succeed in a coding game, are there any other games which involve unicorns to learn coding", "I find coding and programming really cool but I do not understand why we have to beat ugly creatures to learn coding. I hated this game, it made me feel uncomfortable. I would never play it again."* All the male participants displayed a greater interest toward viewing coding as more relevant to their identities, their daily lives, and their career choices after the game experience and displayed eagerness to learn coding and playing more code-learning games in future and confirmed our H7.

Regardless of their gender, some of the participants reported that repetition of code lines (n = 7) and lack of social interaction (n = 4) in the game ended up making the process monotonous. Difficulties with codes in English (n = 7) have also been experienced regardless of gender. These four factors ended up having an impact on the level of enjoyment and likelihood of playing it another time.

4.3. Discussion

The results of the study revealed that there were important gender differences to be found in our 9 attributes, namely; perceived computer competence, perceived coding difficulty, identification, perceived game difficulty, perceived success, level of enjoyment, level of anxiety, likelihood of playing it another time, likelihood of trying new features. Qualitative and quantitative findings in our study consistently illustrated common attitudes in female participants such as lower perception of computer competence, lower self-efficacy, higher perception of code difficulty, higher level of anxiety which were rather the opposite in their male counterparts. Female participants reported negative feelings toward coding concept after playing the game and vice versa for the male participants.

Overall, the obtained qualitative and quantitative empirical findings of this study pointed out that perceived computer confidence and code difficulty had important effects on the participants' attitudes and performance in a coding game relatedly with their gender identity as predicted by H1 and H2. The circulation of negative gender stereotypes in society about coding and computer prevent females from developing an interest in these fields. We found out that the detrimental “coding experts need to be male” or “coding is for boys” stereotypes discourage females from seeing coding relevant to their identities, harm their success expectations and increase their levels of anxiety during their game experience as stated by H4, H5 and H7. It was also valuable to derive from our in-depth interviews that female participants associated their interest or success in a computational area with not being an ordinary female. They needed to create a different social identity for themselves as a safe zone which may be evaluated as a way to cope with their prescribed gender roles. It also seemed relevant to underline that if children's first interaction with coding concept took place in a game field which involved scenes of violence and fighting, existing traditionally male-positive stereotypes were empowered and the female participants' level of perception of success and comfort plummeted accordingly. Females were more likely to indicate coding ability as one of their weak points since the game environment was perceived as a male area of identification or success. As a result, they quickly became frustrated and excluded themselves voluntarily. Our data in this regard highlighted that participants' strong gender identification, their perceived success and competence in a code learning game were intertwined as declared in H3 and H7. Specifically, in this study, three hypotheses (H2-H4-H6) were supported by the findings which showed that perceived computer competence and lower perception of coding and game difficulty predict the intention to play the game, try different features as well as directly affecting the enjoyment derived from game experience. Females could not develop their computational thinking abilities and lacked in showing their true potentials due to the existence of intrinsic and extrinsic barriers in their minds.

5. Conclusion

The present study was conducted using a multi-method approach to provide insights about 16 children's first-time user experience in their home environment with a code learning game named “Code Combat.” Although the case study was mainly exploratory research, obtained results were encouraging. However, more empirical studies with concrete results are needed to emphasize the crucial role of gender neutral game environment as a vehicle to involve more girls in coding and programming, especially in Turkey. Parents, educators, and policy makers should take into consideration the existence of gender-biased computational environment, which extends into the code learning area, and realize the impact this has on children's motivation to learn coding and adopt to computational skills.

Our study supports current literature that existing gender stereotypes affect children's attitudes and behaviors toward computers differently and suggests that a similar relation exists in terms of coding concept, gender and a violence involving code-learning game (experienced for the first time in a home environment) with a wide range of constructs. Gender differences are so consistently found in player experience tests and no less found in our own study. However, the main goal of our research was to show how and under what conditions these gender differences are reproduced in a code-learning game area without naturalizing them as biological truth. To our knowledge, there is no previous player experience study which uses a qualitative approach to illuminate the effects of stereotypical gender presumptions on children's part in coding area and how they cope with these presumptions in depth and in context. Our findings in this regard highlight the importance of developing genderless code-learning environments and new approaches to increase the interest, engagement and participation in coding and programming in general, and especially for females. Code Combat as a code learning game did not facilitate all the children's engagement in programming although it has a potential to do so by being an open source, free of charge, and language supported code learning game. The design of Code Combat does not offer any constructionist gaming experience at the beginning and its stereotypical-male-centered design intimidated girls in their first encounter with coding concept. Our study demonstrated that Code Combat's game environment broadcast a masculinity that made girls feel excluded from the coding area as we hypothesized in H3 and H7.

However, there are some limitations to be acknowledged in this research. Primarily, its sample size limits the quantitative results of the study. Although mixed method data analysis described in this study were designed to be broadly applicable, a larger sample would have enhanced the quantitative results and produce more data necessary for evaluating the effectiveness of this method. Secondly, in this research, participants were only analyzed in terms of their gender. Their individual preferences, cognitive traits and learning styles could also be evaluated for a deeper understanding of the code learning process for children. Moreover, our constructs are new or adapted mostly from quantitative research models, and may need further refinement and more extensive construct validation with longitudinal research efforts. Besides, this study did not take into consideration the code-learning process to limit the scope of the study. Code-learning process within a game environment can be investigated as further research. It is also possible to deepen this research by comparing different code-learning games to better understand and analyze how game type affects the both genders' level of anxiety, comfort and relatedly game performance. We are currently considering a seminar designed to identify ways of attracting female middle school students to coding and programming area with a participatory and genderless design concept as a future work which is something that has never been realized in Turkey according to our knowledge.

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