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Effects of gender and personality differences on students' perception of game design elements in educational gamification

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ABSTRACT

While many studies have reported the effectiveness of gamification in motivating students and making learning more fun, some others have reported contradictory findings regarding the potential of implementing game elements in an online gamified course. It is recognized that designing a successful gamification is a challenging process. Previous studies have shown that students' individual differences may impact their gamification experiences. This study complements the available body of research by examining the effect of gender and personality differences on students' perception of gamification in education. An experiment was conducted in a public university with 189 undergraduate students who took three online gamified courses, based on the self-determination theory, during two academic years. The results showed that gender and personality can affect students' perception of specific game elements. For instance, females are more likely to find feedback useful than males. Additionally, students low in extraversion are more likely to find a progress bar useful than students high in extraversion. The results also showed that gender moderates the effect of personality on students' perception of the implemented game elements. For instance, males low in extraversion are more likely to perceive badges' usefulness in gamified courses than males high in extraversion, whereas females low in conscientiousness are more likely to enjoy feedback than females high in conscientiousness. The findings of this study can help designers and educators personalize their gamified courses' design based on personality and gender.

1. Introduction

Digital games have been shown to be useful and effective tools for teaching adolescents, since they provide entertaining environments, which can make students more motivated and engaged while learning (Machado et al., 2018). The rapid increase in the use of digital games in education has motivated researchers and practitioners to look into different game elements that can stimulate learning engagement in non-gaming contexts. Consequently, a new approach has emerged named "gamification". Gamification is the use of game elements, such as points, badges and leaderboard, in non-gaming contexts to improve users' engagement, motivation and service profitability (Deterding et al., 2011; Hamari, 2017). Gamification has been successfully applied in different areas, such as marketing (Hamari, 2017), business (Kappen & Nacke, 2013), health (Jones et al., 2014) and education (Landers & Landers, 2014; Shi et al., 2014). It has also become a well-established technique in Human-Computer Interaction (HCI). Specifically, a more reflective stance on gamification design matters has spread across the majority of HCI domains in the last twelve years (Rapp et al., 2019). In this context, Rapp et al. (2019) highlighted that many research questions related to gamification have not yet been addressed by HCI researchers, related to the ways of designing more enjoyable and pleasurable gamified systems. The design of a successful gamification is a challenging process, and using many game elements at the same time does not always lead to an effective gamification (Fitz-Walter et al., 2017). Additionally, most gamified learning environments do not

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consider students' individual differences, as it is assumed that students have the same positive reactions toward using game elements (Böckle et al., 2017).

Recent studies have further shown that personality is considered as an important factor of individual differences (Essalmi et al., 2017). It can affect the way students learn in computer-based learning (Tlili et al., 2016), the design of gaming experiences (Ferro, 2018) and perception of gamification (Buckley & Doyle, 2017). Other studies have also shown that gender differences can affect preferences for game genres (Williams et al., 2009), game elements (Codish & Ravid, 2017) and academic achievement (Matthews et al., 2009). For instance, Carvalho (2016) found that female students have better academic achievements than male students. Furthermore, several researchers have investigated the relationship between gender and personality traits, finding that gender can moderate the effect of personality on users' acceptance of several technologies, such as social networks and avatars (Dunn & Guadagno, 2012; Mouakket, 2017).

Since educational gamification combines learning and gaming, it is essential to understand the impact of students' individual differences on the design of gamified courses. Therefore, this study investigates the effect of gender, personality and their interaction on students' perception of various game elements in three gamified courses. In particular, the implementation of the game elements was based on the self-determination theory to fulfil students' psychological needs. This study uses the Five Factor Model (FFM) of personality, which is the most accepted model in the literature to describe students' personality traits and it is derived from common language descriptors (Ackerman, 2020; DeYoung, Quilty, & Peterson, 2007). It is an accurate personality model and it is easier to be reused in different contexts (DeYoung et al., 2007).

The rest of the paper is structured as follows: Section 2 presents the theoretical background of the current study. Section 3 presents the proposed research method to investigate the effect of gender and personality differences on perception of game elements. Section 4 describes the obtained results, followed by the discussion of these results in section 5. Finally, Section 6 concludes the paper with a summary of the findings, limitations and potential research directions.

2. Theoretical background

2.1. Gamification and game elements

Several definitions have been proposed for gamification in the literature. For instance, according to Kapp (2012), gamification is "the use of game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems." Zichermann and Cunningham (2011) considered gamification as "the process of game-thinking and game mechanics to engage users and solve problems." However, the most-used definition is "the use of game design elements in non-game contexts" (Deterding et al., 2011). Werbach (2014) stated that each added game element should have a playful intention in order to be called gamification. For instance, the use of a progress bar game element in LinkedIn evokes enjoyment, like in game experiences (Werbach, 2014). Many researchers have discussed the effectiveness of gamification in educational contexts, where they have found that gamification can make learning activities more interesting and attractive for students (Andrade et al., 2016; Villagrasa et al., 2018).

In order to gamify a learning environment, several gamification design frameworks were proposed in the literature. For instance, Werbach and Hunter (2012) proposed a framework that relies on six gamification steps, called 6D and contains 30 game elements (Mora, Riera, Gonzalez, & Arnedo-Moreno, 2015). Klock, Gasparini and Pimenta (2016) proposed a framework based on seven aspects that may influence gamification. This framework contains 14 game design elements. Additionally, Marczewski (2015) proposed GAME framework based on user types that contains 52 game elements. Specifically, this framework is based on the self-determination motivational theory, which is the most important theory related to gamification research (Rapp et al., 2019). Toda et al. (2019) further pointed out that there are some similarities between the game elements proposed in the 6D and GAME frameworks. In summary, there are eight game elements which are commonly used in 6D and GAME frameworks. The benefits of these eight game elements are described in Table 1. These elements are later used for the design of our gamified learning environment.

2.2. Effects of gamification on education

Many studies in the literature highlighted the benefits of gamification on education. For instance, Giang (2013) stated that the use of game elements increases the ability to acquire new competences by 40%. Barata et al. (2013) showed that gamifying a Master's-level college course using points, levels, leaderboards, challenges and badges can enhance students' attendance and participation. Hew et al. (2016) showed, in an experimental study at an Asian university, that points, badges and leaderboards positively affected students' motivation and engagement to get involved in more difficult tasks. Çakıroğlu et al. (2017) showed that quests, leaderboard, points, reputation and real gifts increase students' attendance, engagement and interest in activities in an undergraduate course.

While the majority of studies generally report positive outcomes of gamifying a learning environment (Hamari, 2017), some of them exhibit negative outcomes. For instance, the use of competitive game elements, such as badges and leaderboard, can negatively affect students with low performance (Andrade et al., 2016). Researchers stated that game elements should be added carefully within a gamified course (Hanus & Fox, 2015). In this context, several studies investigated the effect of students' characteristics on their experience toward using gamified learning environments. For instance, Smiderle et al. (2020) investigated the effect of personality on students' perception of different game design elements. They showed that extraversion personality trait could affect students' motivation toward using game elements. Specifically, students high in extraversion are more likely to be motivated by using points, badges and leaderboard than students low in extraversion. Furthermore, Toda et al. (2019), and Codish and Ravid (2017) showed that gender could also affect students' perception of game elements. For example, it is found that males are more likely to have positive perceptions of competition than females (Toda et al., 2019).

Given the importance of students' characteristics, it is very important

Table 1
Descriptions of the used game elements and their benefits.

Game element	Description	Benefits
Points	Numerical representation that shows players' contributions.	They can motivate students by making them learn more in order to gain more points.
Leaderboard	A board that shows students' rankings based on their scores.	It can positively affect their learning behaviours and outcomes, since it increases competition.
Badges	Virtual rewards for each achieved goal.	They can increase students' motivation and engagement within the course.
Feedback	Private and personalized information about students' performance.	It can positively affect their motivation to learn.
Progress bar	A bar which shows students' progress toward a goal.	It can give students a sense of progression.
Avatar	Students' virtual representation within gamification.	It can make students feel included and comfortable within their learning environment.
Levels	Moderate the level of difficulty based on students' expertise.	They can make students more engaged.
Chat	Messages for both collaborating and socializing.	It can make students feel related to each other.

to consider them while designing gamified learning environments. Hallifax et al. (2019), in this context, conducted a literature review to examine the impact of personalized gamification, based on students' player types, personality, etc, on students' motivation and performance. The results showed that personalized gamification is not always positive and there are some mitigated results. For instance, Monterrat et al. (2017) showed that students with counter-adapted game elements found their game elements to be more fun and useful than students with adapted or random elements. Therefore, more investigations are needed in order to understand students' perceptions of different game elements and further provide them an effective personalized gamification design. Additionally, according to the literature reviews conducted by Klock et al. (2020) and Hallifax et al. (2019) about personalized gamification, all the reported studies investigated students' characteristics independently, without taking into consideration the interaction between them, such as the interaction between personality and gender, which are the most important characteristics in educational gamification. Therefore, this paper complements the available body of research by examining the effect of gender, personality, and the interaction between them on students' perception of gamification in education. The next subsequent sections discuss gender and personality differences.

2.3. Gender

Gender differences are considered as an important factor in technology perception and usage (Park, Kim, Cho, & Han, 2019; Venkatesh et al., 2012). For instance, in a mobile learning context, females are less influenced by social factors than males (Wang et al., 2009). Park et al. (2019) found that males perceived usefulness of, and intention to use multimedia technology for learning is higher than females. In addition, males are more likely to be interested in using computers and technologies than females (Ahuja & Thatcher, 2005). Lima and Gouveia (2020) found that females in Portugal are less interested in the areas of Computer Science, Electronics and Automation, and digital/video games. Generally, female users focus more on the enjoyment and the ease of use of technology, while male users focus on the usefulness of technology (Malik et al., 2019; Park et al., 2019; Venkatesh et al., 2003). Malik et al. (2019), for example, found that female users play Pokémon Go to fulfil enjoyment gratifications, whereas male users focused more on social interactivity and achievement. Existing research shows that gender differences exist in social networking. For instance, females enjoyed using Myspace online social network more than males (Hargittai, 2007), while both genders equally enjoyed using Facebook. Additionally, gender differences were shown to affect individuals' perception for intrinsic and extrinsic motivation. For example, Conti et al. (2001) found that males reported higher levels of intrinsic and extrinsic motivation toward an art activity than females.

In digital games, research also shows that gender differences affect players' preferences for game genres, as well as their play style and emotions during the game (Hartmann & Klimmt, 2006; Yee, 2006). For instance, males like playing three-dimensional rotation and online games more than females (Hartmann & Klimmt, 2006; Lucas & Sherry, 2004). Male players also were found to be more aggressive than female players in games (Williams et al., 2009). With regards to gamification, there has been limited investigation of gender in gamification, but studies have shown that gender differences affect the perception of gamification (Codish & Ravid, 2017; Koivisto & Hamari, 2014). Furthermore, research has shown that gender differences can affect students' academic achievements. In this context, Matthews et al. (2009) found that female students outperformed male students on a given learning assignment. Similarly, Carvalho (2016) found that female students have better academic achievements than male students. Since both genders have similar levels of intellectual ability, this result was explained by the difference in students' personality characteristics.

2.4. Personality

Individuals behave differently in real life due to their different personalities (Gustavsson et al., 2003). Mount et al. (2005) described personality traits as stable psychological characteristics that define people's behaviour and cognitive style. Various personality models have been proposed in the literature, but the most commonly used and accepted model is the Five Factor Model (FFM) (Ackerman, 2020). FFM contains five dimensions that describe people's diversity (Chittaranjan et al., 2011), namely (1) Extraversion relates to socialization, energy and outgoing; (2) Agreeableness relates to cooperation, interpersonal communication and generosity; (3) Conscientiousness relates to self-discipline, responsibility, orderliness and competence; (4) Neuroticism relates to managing stress, emotional stability, warring and self-pitying; and, (5) Openness relates to intellectual curiosity, originality and imagination.

Shuto et al. (2017) showed that personality affects students' performance in lecture courses. For instance, students high in openness are more likely to have better performance in lecture courses, while students high in conscientiousness are more likely to have better scores on assignments. In addition, recent studies showed that students' personalities can be identified from their gaming behaviours within an educational game (Essalmi et al., 2017; Tlili et al., 2017). Schimmenti et al. (2017), on the other hand, showed that personality affects students' game genre preferences and Internet use. Furthermore, limited studies have discussed the importance of personality in affecting the design of gamified applications (Ferro, 2018) and perceiving gamified learning environments (Buckley & Doyle, 2017). For instance, students high in extraversion prefer gamification more than students low in extraversion (Buckley & Doyle, 2017), and students low in neuroticism are likelier to be less attracted to gamification (Jia et al., 2016).

2.5. Interaction between gender and personality

The investigation of gender differences in personality traits refers to examining which gender (male or female) has higher scores on each personality trait (e.g., extraversion). Psychological studies showed a significant gender differences in personality (Chopik & Kitayama, 2017; Weisberg et al., 2011). For instance, females have higher scores on extraversion, agreeableness and neuroticism than males (Weisberg et al., 2011). The influence of gender differences in personality can be explained by traditional gender role differences (Costa et al., 2001; Schmitt et al., 2008).

Moreover, other studies showed that gender can moderate the effect of personality on perceptions of social networks (Muscanell & Guadagno, 2012) and avatars (Dunn & Guadagno, 2012). For instance, males low in openness are less likely to play games on social networks, whereas females low in agreeableness are more likely to use instant messages. In addition, females high in neuroticism prefer to create personalized avatars to better represent themselves (Dunn & Guadagno, 2012).

2.6. Research gap and the purpose of this study

Despite the importance of considering gender and personality differences, little research is done regarding the effect of these factors on students' perceptions with respect to different game elements in educational contexts (Aldemir et al., 2018; Böckle et al., 2017). Specifically, to the best of our knowledge, there is no study that has investigated the impact of the interaction of gender and personality on perceiving different game elements in educational gamified contexts, i.e., the effect of men's and women's personalities on perceiving game elements in gamified courses. Furthermore, limited number of game elements, such as points, badges, levels and leaderboard, have been examined (Aldemir et al., 2018) with a limited number of personality dimensions. In this context, Nacke and Deterding (2017) claimed that

more investigations are needed in order to explore how to use game elements in gamified learning environments.

This study contributes to the extant literature by going beyond implementing the most commonly used game element triad of points, badges and leaderboard (Rapp, 2017) to investigate in depth the effects of gender and personality (within the five-factor model) differences on students' perception of eight implemented game elements within gamified courses. These courses were taught at a public Tunisian university. Furthermore, since Rapp (2017) suggested thinking about systematic design strategies for gamified environments instead of individually adding game elements, this study also details how the courses were gamified. Specifically, this study aims to answer the following research questions:

RQ1. Does gender affect students' perception of different game elements in gamified courses?
RQ2. Does personality affect students' perception of different game elements in gamified courses?
RQ3. Does gender moderate the effect of personality on affecting students' perception of different game elements in gamified courses?

3. Method

3.1. Gamified courses and self-determination theory

The Modular Object-Oriented Dynamic Learning Environment (Moodle) was deployed to gamify the three courses taught in this study, namely, (1) Object Oriented Design Methodology (OODM), which aims to help students learn Unified Modeling Language (UML) diagrams, such as the class and use case diagrams; (2) Basic Software (BS), which aims to help students learn computer architecture and assembly language; and (3) Information Monitoring Methodology (IMM), which aims to help students learn monitoring techniques to collect the required information, which helps in the decision-making process. Moodle platform was chosen because it allows the integration of game elements, such as badges and leaderboard. In addition, the students were familiar with Moodle and had used it before for non-gamified courses at the university. All three courses were prepared by the same teacher. For each course, weekly materials in various forms, such as videos, texts, PowerPoint presentations, external links for online resources and mental break items (e.g., pictures) were added. To assess the knowledge of the students in each course, activities and quizzes were included to be completed individually or in teams.

To have successful gamified courses that can promote students' enjoyment and motivation, our implemented game elements should meet students' different psychological needs (Lombriser et al., 2016). Therefore, the self-determination theory, which has been successfully used in games (Przybylski et al., 2010; Przybylski et al., 2009; Rigby & Ryan, 2011), was applied in our gamified courses. This theory is based on three intrinsic psychological needs that stimulate enjoyment, namely competence, autonomy and social relatedness (Deci & Ryan, 1985; Ryan & Deci, 2002). Competence refers to self-efficiency, challenge and motivation while interacting with the environment (Vansteenkiste & Ryan, 2013). This can be achieved by using game elements that provide feedback about students' success to trigger feelings of competence and challenge. Autonomy refers to freedom in making decisions and doing tasks without any pressure (Vansteenkiste et al., 2012). This can be achieved by using game elements that allow students to be in charge and make their own decisions. Social relatedness refers to connectedness, belongingness and caring for others (Deci & Vansteenkiste, 2004). This can be achieved by using game elements that can trigger the feeling of relatedness within students. Based on the above presented game elements (see section 2.1), Table 2 presents the eight selected and implemented game elements in our gamified courses to match the three psychological needs. It should be noted that the efficiency of the proposed gamification design based on the Self Determination Theory (SDT), has already been validated in (Tlili et al., 2019). Specifically, the obtained results showed that there is a significant difference between students' level of intrinsic motivation before and after using the gamified courses. This proves the effectiveness of the designed gamified and self-determined environment in enhancing students' intrinsic motivation to learn.

Table 2
Implemented game elements in the gamified courses.

Psychological needs	Game elements	Matching psychological needs to game elements
Competence	Points	Feedback that shows students' contributions.
	Levels	Feedback that shows students' expertise.
	Leaderboard	Feedback that shows students' performance.
	Progress bar	Feedback that shows students' progression.
	Badges	Feedback that shows students' achievements.
	Feedback	Feedback that shows students' performance.
Autonomy	Avatar	Students can freely choose their visual representations within the gamified courses.
	Badges	Students have the possibility to display or hide their awarded badges on their profiles.
Social relatedness	Chat	Students can interact and collaborate to complete a given goal.

The functionalities of the eight integrated game elements in our gamified courses (presented in Table 2) are detailed below.

(1) *Points:* To increase the engagement within a course, Zichermann and Cunningham (2011) recommended using various types of points to be collected based on students' contributions. Therefore, in the gamified courses, students were automatically rewarded with 50 "experience" points for each finished learning activity. They also received nine "skill" points, as a bonus for doing additional learning tasks provided by the teacher.
(2) *Levels:* Each course contained ten levels. These levels were ordered from easiest to hardest, as recommended by Simões et al. (2013), to match the students' newly gained skills. Each week, students had a challenge of collecting a predefined number of points by completing several activities to reach the next level. These weekly activities were also added based on their complexity (from the easiest to the hardest). For example, students were required to progress from level 1 to level 2 in the first week. To do that, each student had to earn at least 120 points. Levels were presented using virtual badges indicating the reached level number.
(3) *Badges:* To integrate badges effectively, Enders and Kapp (2013) recommended not to overuse the badge reward but to use it only for meaningful achievements that require some effort to obtain. Therefore, in each level, students have an assignment/quiz to finish, which evaluates their knowledge about all the information gained in that level, in order to receive a badge. Various types of badges were implemented in each course depending on the activity completed, as shown in Fig. 1. For instance, when a student finishes all the required activities and quizzes at the end of the semester, he/she receives the final badge entitled "Graduate". This means that the student had now graduated from that course.

Fig. 1. Examples of the badges used in the gamified courses.

In addition, the illustration of this badge, as shown in Fig. 1, shows a picture of a victorious man on top of a mountain in order to give students a sense of achievement.

(4) *Avatar:* To make the course more fun, students had the freedom to upload their avatars, which represented them within the gamified courses. Students were also given the possibility to create their own personalized avatars in order to increase the feeling of emotional attachment, resulting in a better level of engagement (Dunn & Guadagno, 2012). For instance, as shown in Fig. 2, the avatars selected by students were displayed on the leaderboard to represent each one of them.

(5) *Leaderboard:* A board was displayed showing students' ranks based on their collected points in a course. It aimed to make students more competitive while learning. Furthermore, the leaderboard provided a real-time update system of students' ranks (i.e., whenever the students gained additional points, his/her position on the leaderboard was updated). Thus, students could see themselves go up on the board, resulting in a positive emotion that they had a chance of winning (Alaswad & Nadolny, 2015). At the end of the semester, the student who had the highest rank on the leaderboard was the winner. Fig. 2 presents the leaderboard of the BS course, which displays students' avatars, levels and collected points.

(6) *Feedback:* Each week, students received humorous feedback from the teacher in Moodle using images and texts to ensure their psychological safety and further encourage them while learning (Edmondson, 1999). The feedback was written by the teacher according to each student's performance within the course (e.g., based on the number of accumulated points or collected badges).

(7) *Progress bar:* To make a course meaningful for students, they should clearly see their progress towards the course goal (O'Donovan, 2012). Therefore, a coloured progress bar was implemented to which weekly activities were added. An unfinished activity was coloured blue in the progress bar, while a finished activity was yellow. Upon receiving feedback on an activity, it was coloured green. This could give students a sense of progression in the course.

(8) *Chat:* Students could use synchronous discussion (instantaneous messages) to collaborate with their friends or to help them if they had any inquiries. In addition, to motivate students to complete the required goals in teams, they would receive several points once they had achieved them, as recommended by Hou and Wu (2011).

Fig. 2. Leaderboard of the BS course.

3.2. Participants

The experiment was conducted at a public Tunisian university during two academic years, namely 2017/2018 and 2018/2019. Participants were 189 undergraduate students majoring in computer science and aged between 18 and 23. Specifically, 66 participants were males and 123 were females. Gender was measured by asking participants to report the gender they are identified as (male, female, or other gender). The obtained results revealed a binary gender result (i.e., male or female), and no other gender was identified. One hundred and nineteen students were enrolled in the BS course, which was delivered to them in their first year (out of three); 56 students were enrolled in the OODM course, which was delivered to them in their second year (out of three); and 19 students were enrolled in the IMM course, which was delivered to them in their last year.

3.3. Experimental design and instruments

As shown in Fig. 3, at the beginning of the semester (of both academic years), students' personalities were collected. The students then took the provided gamified courses (OODM, BS, IMM) using Moodle for the whole semester (three months). Specifically, the three courses were chosen because they are parts of the Computer Science curriculum at the university, and they are taught online. Therefore, students did not receive any compensation or incentive for their participation in the experiment. At the end of the semester, all the students answered a questionnaire to collect their demographic data and to assess their perceptions toward the different game elements. The questionnaire was in English, as all students have a good level of English because they learn it since primary school. In addition, to eliminate any potential ambiguity or misunderstanding, the instructor explained all the questions before starting. The instruments used in this study are as follows:

- Big Five Inventory (BFI): It is validated and widely used in the literature to identify individuals' personality (John & Srivastava, 1999). BFI is a 5-point Likert-type questionnaire, with answers ranging from 1 (strongly disagree) to 5 (strongly agree). It consists of 44 items which cover the five personality dimensions in the FFM, such as "I am someone who is helpful and unselfish with others" for

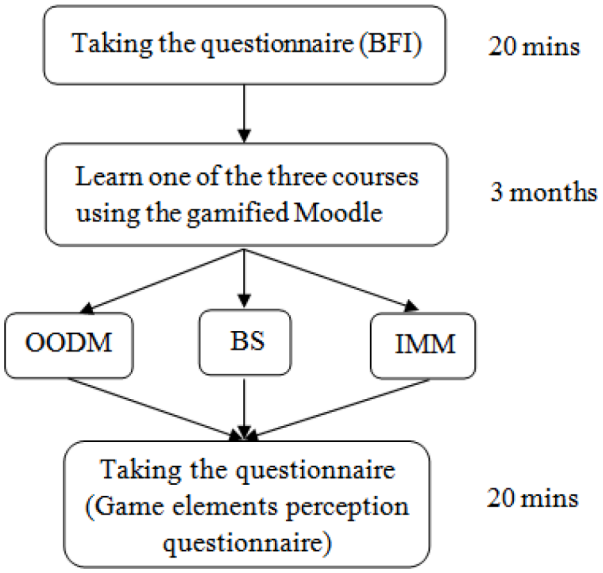

Fig. 3. Experimental procedure

the agreeableness dimension and "I am someone who is talkative" for the extraversion dimension. For each personality trait, the reliability, mean and standard deviation were calculated. As shown in Table 3, the results yielded an alpha of 0.7 or higher, which means that all the personality traits produced acceptance reliabilities. In addition, both males and females tended to fall near the middle of the scale.

- Game elements perception questionnaire: It contains two parts (see Appendix): (1) Demographic questionnaire: It comprised multiple-choice questions which aimed to collect demographic information about students, such as their gender, age, the course they were enrolled in, and their gaming frequency (some information was collected, but not used in this study); and, (2) Perception questionnaire: Students' perception of each game element was measured in terms of enjoyment and usefulness using 5-point Likert-scale questions from 1 (strongly agree) to 5 (strongly disagree). These questions were adopted and modified from several questionnaires in Bajko et al. (2016); Halko and Kientz (2010); and Koivisto and Hamari (2014). Enjoyment is defined as students' degree of enjoyment and contentment when using each game element. This construct includes statements such as "I enjoy using the leaderboard while learing" and "I find it enjoyable to receive badges while learning." Usefulness is defined as students' degree of belief that each game element will enhance learning within the gamified courses. This construct includes statements such as "Using the leaderboard motivates me to learn more" and "I find the progress bar useful." The questionnaire was validated in a previous work (Denden et al., 2017a; 2018). Furthermore, to ensure the reliability of the questionnaire, the internal consistency of the two constructs (enjoyment and usefulness) was calculated using Cronbach's alpha. The obtained alpha value for each construct was above 0.7, which means that this questionnaire is reliable (Yu, 2001).

3.4. Data analysis

A series of linear regressions were performed in order to examine whether gender and personality affect the perception of game elements (the eight implemented game elements in Table 2). We also conducted a series of multiple regression analyses to determine the interaction between gender and personality for each game element (among the 8 game elements) in the gamified courses. Specifically, we have analyzed each dependent variable with the interaction of each personality trait and gender in a separated regression (e.g., leaderboard-enjoyment with gender and extraversion). In all cases, and as has been mentioned by Aiken and West (1991), gender was entered as a dummy coded variable (Female-1, Male-0), the big five traits as a centred continuous predictor to reduce the potential for multicollinearity and enhance the interpretability of the results (Barron & Kenny, 1986), and a gender by trait interaction term.

Table 3
BFI personality traits means and standard deviations ($N = 189$).

Personality	Male ($n = 66$)		Female ($n = 123$)		Overall	
	Mean	SD	Mean	SD	Mean	SD
Extraversion, α = 0.88	3.23	0.53	3.27	0.55	3.26	0.55
Agreeableness, α = 0.82	3.71	0.53	4.06	0.42	3.94	0.49
Conscientiousness, α = 0.84	3.62	0.69	3.63	0.58	3.62	0.62
Neuroticism, α = 0.78	2.50	0.71	2.78	0.69	2.68	0.71
Openness, α = 0.86	3.73	0.40	3.61	0.41	3.65	0.41

4. Results

4.1. Correlation analyses

Pearson's correlation was used to test the correlation between gender and personality traits, and among the eight game elements. As shown in Table 4, a strong correlation was found between extraversion and openness ($r = 0.34$, $p < 0.01$), which means that students high in extraversion are more likely to be open to new experiences. In addition, a negative correlation was found between neuroticism and conscientiousness (r = -0.37, $p < 0.01$), which means that students high in neuroticism are more likely to be less conscientious. Furthermore, the results showed that there was a strong correlation between gender and neuroticism ($r = 0.18$, $p < 0.01$), which means that male students are more emotionally stable than female students.

For the dependent variables, the correlation was first tested between the enjoyment and perceived usefulness of each game element. As shown in Table 5, a strong correlation was found between enjoyment and perceived usefulness of the eight implemented game elements as follows: leaderboard ($r = 0.41$, $p < 0.01$), progress bar ($r = 0.56$, $p < 0.01$), avatar ($r = 0.47$, $p < 0.01$), feedback ($r = 0.65$, $p < 0.01$), badges ($r = 0.59$, $p < 0.01$), points ($r = 0.47$, $p < 0.01$), chat ($r = 0.66$, $p < 0.01$) and levels ($r = 0.58$, $p < 0.01$. This implies that students who enjoy a particular game element are more likely to find it useful.

The correlation was also tested between the enjoyment and perceived usefulness of all game elements. As shown in Table 5, a strong correlation was found between perceived enjoyment of the majority of game elements. For instance, a strong correlation was found between perceived enjoyment of levels and points ($r = 0.46$, $p < 0.01$) and between levels and progress bar ($r = 0.40$, $p < 0.01$). These results demonstrate that students who enjoy using levels are more likely to enjoy using points and the progress bar. In addition, a strong correlation was found between perceived enjoyment of the leaderboard and points ($r = 0.44$, $p < 0.01$), which means that students who enjoy using the leaderboard are more likely to enjoy using points. Furthermore, a strong correlation was found between perceived enjoyment and the perceived usefulness of some game elements. For instance, a strong correlation was found between perceived enjoyment of the leaderboard and perceived usefulness of the avatar ($r = 0.27$, $p < 0.01$), which means that students who enjoy using the leaderboard are more likely to find the avatar useful.

4.2. Gender differences

As shown in Table 6, the regression results showed that gender can significantly affect only students' perceived usefulness of feedback in gamified courses ($\beta = 0.26$, $t = 2.07$, $p = 0.03$). Specifically, female students are likelier to find feedback useful than male students.

4.3. Personality differences

As shown in Table 6, the regression results showed that extraversion

Table 4
Correlation matrix for gender and personality.

	1	2	3	4	5	6
1. Extraversion	-					
2. Agreeableness	0.11	-				
3. Conscientiousness	0.22*	0.22**	-			
4. Neuroticism	−0.16	−0.28**	−0.37**	-		
5. Openness	0.34**	−0.10	0.16*	−0.15*	-	
6. Gender	0.01	0.34**	0.01	0.18*	−0.13	-

* $p < 0.05$

** $p < 0.01$.

Table 5
The correlation matrix among the game elements and students' perceptions.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Leaderbord-Enj	-															
2. Learderboard- Use	**0.41****	-														
3. ProgressBar-Enj	**0.30****	**0.29****	-													
4. ProgressBar-Use	**0.29****	**0.30****	**0.56****	-												
5. Avatar-Enj	**0.19****	**0.15***	0.13	0.10	-											
6. Avatar-Use	**0.27****	**0.27****	0.10	**0.18***	**0.47****	-										
7. Feedback-Enj	**0.35****	**0.26****	**0.45****	**0.29****	0.11	**0.18****	-									
8. Feedback-Use	**0.21****	**0.28****	**0.29****	**0.34****	**0.15***	**0.14***	**0.65****	-								
9. Badge-Enj	**0.34****	**0.14***	**0.22****	**0.26****	0.06	0.13	**0.43****	**0.23****	-							
10. Badge-Use	**0.28****	**0.24****	**0.21****	**0.26****	0.05	0.14	**0.33****	**0.26****	**0.59****	-						
11. Point-Enj	**0.44****	**0.20****	**0.35****	**0.17***	**0.20****	**0.21****	**0.38****	**0.15***	**0.40****	**0.34****	-					
12. Point-Use	**0.35****	**0.40****	**0.16***	**0.30****	**0.15***	**0.17***	**0.16***	**0.19****	**0.30****	**0.32****	**0.50****	-				
13. Chat-Enj	**0.25****	**0.23****	0.11	0.09	**0.22****	**0.17***	**0.25****	**0.15***	**0.26****	**0.24****	**0.32****	**0.35****	-			
14. Chat-Use	**0.25****	**0.30****	0.13	0.10	**0.21****	0.14	0.14	**0.14***	**0.17***	**0.20****	**0.25****	**0.17***	**0.66****	-		
15. Level-Enj	**0.29****	**0.14***	**0.40****	**0.15***	0.07	0.13	**0.40****	**0.19****	**0.26****	0.12	**0.46****	**0.28****	**0.18***	0.12	-	
16. Level-Use	**0.30****	**0.29****	**0.22****	**0.27****	0.10	**0.17***	**0.26****	**0.17***	**0.15***	**0.18***	**0.41****	**0.48****	**0.22****	**0.21****	**0.58****	-

Statistical significances are boldfaced and reported as $^{*}p < 0.05$ and $^{**}p < 0.01$.

can significantly affect students' perceived usefulness of the progress bar in gamified courses (β = -0.40, t = -0.23, p = 0.00). Specifically, students low in extraversion are likelier to find the progress bar useful than students high in extraversion.

Conscientiousness was also shown to significantly affect students' perceived enjoyment of points (β = 0.21, t = 2.28, p = *0*.02). Specifically, students high in conscientiousness are more likely to enjoy points than students low in conscientiousness.

Moreover, the results showed that agreeableness can significantly affect students' perceived enjoyment of feedback (β = -0.32, t = -2.34, p = *0*.02), and both enjoyment (β = -0.29, t = -2.26, p = *0*.02) and usefulness (β = -0.40, t = -2.92, p = *0*.00) of the progress bar. In particular, students low in agreeableness are more likely to enjoy feedback than students high in agreeableness. Additionally, they are also more likely to enjoy the progress bar and find it useful than students high in agreeableness.

Finally, the regression results showed that openness can significantly affect students' perceived enjoyment of feedback (β = -0.41, t = -2.53, p = 0.01), the avatar (β = -0.39, t = -2.57, p = *0*.01) and the progress bar (β = -0.31, t = -2.03, p = *0*.04). Specifically, students low in openness are more likely to enjoy these three game elements than students high in openness.

4.4. Interaction between gender and personality

As shown in Table 6, the regression results showed that there was a significant gender by extraversion interaction in perceiving badge' usefulness (β = -0.49, t = -2.10, p = *0*.03). As shown in Fig. 4, the simple effects demonstrate that extraversion did not affect the perceived badge' usefulness for female students (p = *0*.83 and greater than 0.05), but did for male students. Specifically, males low in extraversion are more likely to find badges useful than males high in extraversion (β = -0.46, t = -2.43, p = *0*.01).

The results also showed that there was a significant gender by agreeableness interaction in perceived enjoyment of the avatar in the gamified courses (β = -0.51, t = -1.99, p = *0*.04). As shown in Fig. 5, the simple effects demonstrate that agreeableness did not affect the perceived enjoyment of avatar for female students (p = 0.86 and greater than 0.05), but did for male students. Specifically, males low in agreeableness are more likely to enjoy avatar than males high in agreeableness (β = -0.48, t = -2.54, p = *0*.01).

Finally, the results showed that there was a significant gender by conscientiousness interaction in perceived enjoyment of feedback in the gamified courses (β = 0.49, t = 2.42, p = *0*.01). As shown in Fig. 6, the simple effects demonstrate that conscientiousness did not affect the perceived enjoyment of feedback for male students (p = *0*.15 > 0.05). However, gender can affect the perceived enjoyment of feedback for female students (β = -0.27, t = -2.05, p = *0*.04). Specifically, females low in conscientiousness are more likely to enjoy feedback in the gamified courses than females high in conscientiousness.

5. Discussion

The results showed that gender did not affect students' perceptions of most of the game elements. Specifically, it can only affect students' perception of feedback's usefulness in gamified courses. In particular, female students may find feedback more useful than male students. This gender difference may be explained by gender role expectations, which suggest that females are more concerned with others' evaluations of them than males (Deci, 1975). Therefore, they may find feedback more useful to enhance their performance than male students. This finding is inconsistent with previous study, which showed that gender did not affect students' perception of feedback but did only for badges (Denden et al., 2017b). However, the interaction between gender and personality using game elements had an effect on perceiving badge-usefulness, avatar-enjoyment and feedback-enjoyment. In terms of personality

Table 6
Results of the multiple regression analysis on students' perceptions of game elements with respect to gender and personality.

			Leaderboard		Points		Chat		Feedback		Avatar		Levels		Progress bar		Badges	
			Enj	Use	Enj	Use	Enj	Use	Enj	Use	Enj	Use	Enj	Use	Enj	Use	Enj	Use
Gender		β	0.03	0.05	0.02	0.02	0.02	0.11	0.09	**0.26**	-0.14	-0.03	0.00	0.02	0.02	0.03	0.05	0.14
		t	0.53	0.76	0.37	0.31	0.35	1.52	1.27	**2.07**	-1.92	-0.44	0.08	0.34	0.38	0.44	0.75	1.97
		p	0.59	0.44	0.71	0.75	0.72	0.12	0.20	**0.03***	0.05	0.65	0.93	0.73	0.70	0.66	0.45	0.05
Personality	Extra	β	-0.18	-0.07	-0.18	-0.07	-0.13	-0.14	-0.09	-0.05	0.02	-0.03	0.00	-0.10	-0.13	**-0.40**	-0.10	-0.17
		t	-1.96	-0.80	-1.95	-0.77	-1.46	-1.51	-1.05	-0.59	0.22	-0.35	0.04	-1.09	-1.42	**-0.23**	-1.10	-1.89
		p	0.05	0.42	0.05	0.44	0.14	0.13	0.29	0.55	0.82	0.72	0.96	0.27	0.15	**0.00****	0.27	0.06
	Agre	β	-0.10	-0.04	-0.08	-0.07	-0.09	-0.06	**-0.32**	-0.15	-0.05	0.00	-0.04	-0.06	**-0.29**	**-0.40**	-0.03	-0.07
		t	-1.41	-0.63	-1.12	-1.04	-1.23	-0.92	**-2.34**	-1.95	-0.81	0.07	-0.65	-0.92	**-2.26**	**-2.92**	-0.52	-0.97
		p	0.15	0.52	0.26	0.29	0.21	0.35	**0.02***	0.05	-0.41	0.94	-0.51	0.35	**0.02***	**0.00****	0.60	0.32
	Cons	β	0.02	0.00	**0.21**	-0.03	-0.04	-0.02	-0.04	-0.02	-0.14	-0.00	-0.04	0.00	0.04	-0.03	-0.02	-0.03
		t	0.39	0.02	**2.28**	-0.49	-0.61	-0.31	-0.61	-0.34	-1.97	-0.03	-0.57	0.11	0.56	-0.50	-0.29	-0.51
		p	0.69	0.98	**0.02***	0.61	0.54	0.75	0.53	0.73	0.05	0.97	0.56	0.90	0.57	0.61	-0.76	0.60
	Neur	β	0.05	0.02	0.00	0.02	0.09	0.02	0.07	0.00	0.10	-0.04	0.02	-0.05	0.07	0.02	0.11	-0.00
		t	0.77	0.34	0.11	0.35	1.26	0.28	1.03	0.09	1.41	-0.54	0.30	-0.76	0.97	0.27	1.60	-0.02
		p	0.43	0.73	0.90	0.72	0.20	0.77	0.30	0.92	0.15	0.58	0.75	0.44	0.28	0.76	0.11	0.98
	Open	β	-0.14	-0.06	-0.13	-0.14	-0.13	-0.11	**-0.41**	-0.14	**-0.39**	-0.08	-0.17	-0.11	**-0.31**	-0.14	-0.11	-0.10
		t	-1.92	-0.84	-1.80	-1.95	-1.88	-1.64	**-2.53**	-1.95	**-2.57**	-1.13	-1.47	-1.52	**-2.03**	-1.97	-1.61	-1.45
		p	0.05	0.39	0.07	0.05	0.06	0.10	**0.01***	0.05	**0.01***	0.26	0.28	0.13	**0.04***	0.05	0.10	0.14
Gender × Perso	Gen × Extra	β	0.15	-0.01	-0.07	-0.12	-0.06	0.00	-0.01	0.00	-0.01	-0.09	0.02	0.01	0.02	0.08	-0.04	**-0.49**
		t	1.68	-0.20	-0.75	-1.29	-0.65	0.08	-0.13	0.03	-0.12	-0.99	0.29	0.14	0.21	0.88	-0.51	**-2.10**
		p	0.09	0.83	0.45	0.19	0.51	0.93	0.89	0.96	0.90	0.32	0.76	0.88	0.82	0.38	0.60	**0.03***
	Gen × Agre	β	-0.10	-0.03	-0.09	0.00	-0.04	0.01	0.00	0.00	**-0.51**	-0.10	-0.12	-0.12	0.00	0.01	0.00	-0.05
		t	-1.39	-0.41	-1.20	0.01	-0.58	0.17	0.01	0.02	**-1.99**	-1.41	-1.68	-1.60	0.03	0.19	0.09	-0.65
		p	0.16	0.68	0.22	0.98	0.55	0.85	0.98	0.98	**0.04***	0.15	0.09	0.11	0.97	0.84	0.92	0.51
	Gen × Cons	β	0.10	0.02	-0.00	0.01	0.15	0.12	**0.49**	0.09	0.07	0.13	0.06	-0.02	0.07	0.03	0.13	0.10
		t	1.39	0.31	-0.06	0.24	0.35	1.68	**2.42**	1.23	1.02	1.79	0.90	-0.38	1.00	0.40	1.88	1.45
		p	0.16	0.75	0.95	0.80	0.79	0.09	**0.01***	0.21	0.30	0.07	0.36	0.70	0.31	0.68	0.06	0.14
	Gen × Neur	β	0.02	0.77	0.08	0.00	-0.05	-0.07	0.00	-0.00	0.04	0.12	0.02	0.06	0.01	0.05	-0.07	0.03
		t	0.38	1.04	1.20	-0.00	-0.67	-0.96	0.06	-0.12	0.60	1.72	0.27	0.86	0.14	0.73	-1.00	0.46
		p	0.69	0.29	0.23	0.99	0.49	0.33	0.94	0.90	0.54	0.08	0.78	0.38	0.88	0.46	0.31	0.64
	Gen × Open	β	0.47	-0.02	-0.03	-0.13	-0.08	0.00	0.01	0.01	-0.00	-0.12	-0.12	-0.13	-0.06	0.06	0.07	-0.01
		t	0.64	-0.32	-0.44	-1.86	-1.17	0.01	0.19	0.26	-0.08	-0.16	-1.68	-1.78	-0.84	0.92	0.96	-0.21
		p	0.52	0.74	0.65	0.06	0.24	0.98	0.84	0.79	-0.93	0.87	0.09	0.07	0.40	0.35	0.33	0.83

Extraversion (Extra), Agreeableness (Agre), Conscientiousness (Cons), Neuroticism (Neur), Openness (Open), Personality (Perso), Gender (Gen), Enjoyment (Enj), Usefulness (Use).
Statistical significances are boldfaced and reported as $*p < 0.05$ and $**p < 0.01$.

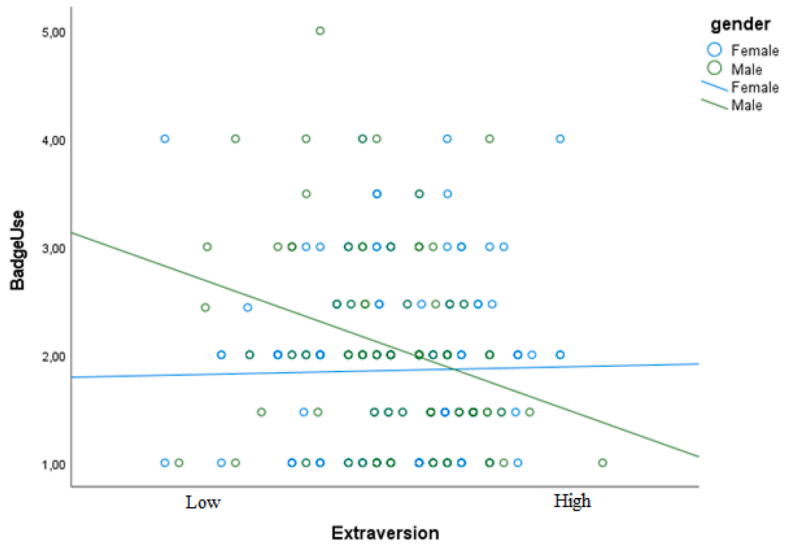

Fig. 4. Gender by extraversion interaction for the perception of badge' usefulness.

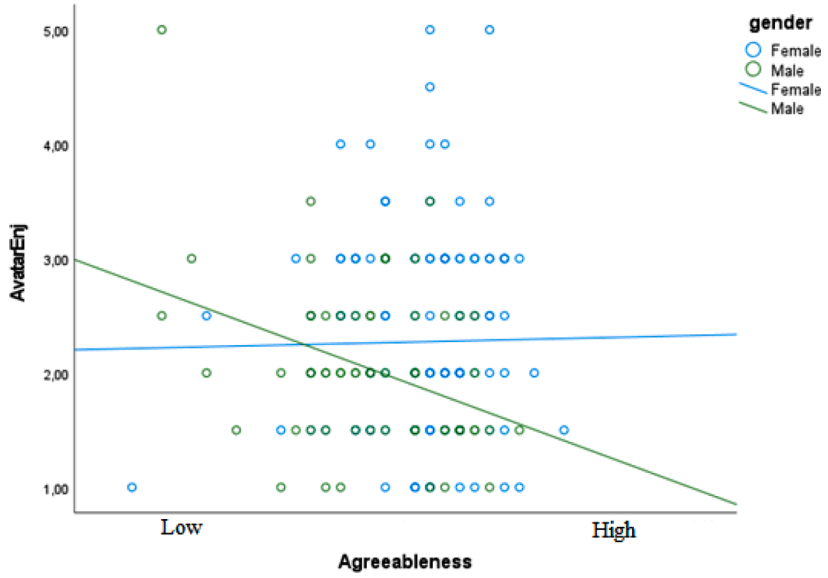

Fig. 5. Gender by agreeableness interaction for the perception of avatar enjoyment.

findings, several different effects were found:

Neuroticism did not have any effect on students' perception of game elements. This result is similar to the finding of a recent study (Smiderle et al., 2020), where no effect of neuroticism was found on students' perception of different game elements.

Additionally, when combining neuroticism with gender using the different game elements, no effect of interaction was also found on students' perception of different game elements.

Extraversion can affect only students' perceived usefulness of the progress bar, where students low in extraversion are more likely to find it useful than students high in extraversion. This can be explained by students low in extraversion are thoughtful and contemplative (Terrell, 2005), and since the progress bar provides summary feedback about students' progress in relation to their goal (Locke & Latham, 2002), students low in extraversion may find it more useful than students high in extraversion.

However, the interaction between extraversion and gender using game elements showed an effect on perceiving badge-usefulness. This relationship was moderated by gender. Specifically, males low in extraversion are more likely to perceive badges as more useful than males high in extraversion. This can be explained by males, rather than females, perceive badges as more useful, since they are more achievement-oriented (Malik et al., 2019; Williams et al., 2009). In particular, males low in extraversion, compared to those high in extraversion, have lower reflectiveness and intellectual interests; thus, they may prefer badges (as a form of reward) to increase their learning motivation. This is consistent with previous research, in which students low in extraversion were found to be more likely to enjoy badges than students high in extraversion (Codish & Ravid, 2014).

Conscientiousness can affect only students' perceived enjoyment of points, where students high in conscientiousness are more likely to enjoy them than students low in conscientiousness. This can be explained with the fact that students high in conscientiousness, who are more capable and effective, tend to be more competent (Costa & McCrae, 1998), and since points present a numerical value that show students' competence in the course, students high in conscientiousness may enjoy them more than students low in conscientiousness.

However, the interaction between conscientiousness and gender

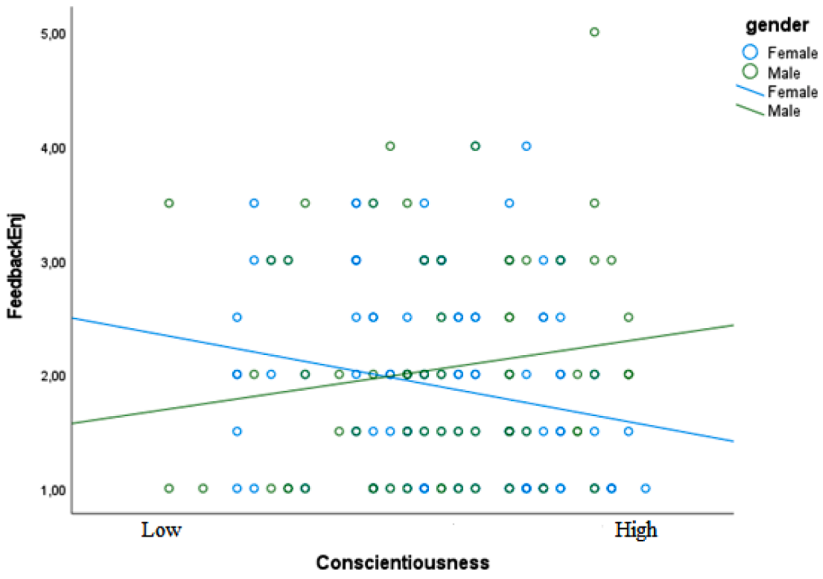

Fig. 6. Gender by conscientiousness interaction for the perception of feedback enjoyment.

using game elements showed an effect on perceiving feedback-enjoyment. Specifically, females low in conscientiousness are more likely to enjoy feedback in the gamified courses than females high in conscientiousness. Particularly, feedback is considered to be an important game element for female students, as we have found in our gender analysis results. However, unexpectedly, students low in conscientiousness enjoyed feedback game element more than students high in conscientiousness who are expected to show more interest to know others' feedback in order to motivate them while learning. This may be explained by students high in conscientiousness can become more stressed when they receive negative feedback (Dennis, Masthoff, & Mellish, 2012), they therefore expressed their negative perception toward feedback game element. Consequently, females low in conscientiousness rather than females high in conscientiousness enjoyed using feedback.

Agreeableness can affect students' perceived enjoyment of feedback, where students low in agreeableness are more likely to enjoy it than students high in agreeableness. This finding is different than the findings of Swift and Peterson (2018), where they found that students high in agreeableness, rather than low in agreeableness, enjoyed perceiving positive feedback. Therefore, it is possible that in our study negative feedback affected students high in agreeableness perception of feedback. Additionally, this finding may be explained by students low in agreeableness have problems of interpersonal communication, which can show their disagreeable characteristics (Okdie et al., 2011); therefore, they prefer online feedback instead of face-to-face feedback in order to avoid this problem.

Additionally, agreeableness can affect students' perceived enjoyment and usefulness of progress bar, where students low in agreeableness are more likely to perceive enjoyment and usefulness than students high in agreeableness. This result is consisting with existing research showing that students low in agreeableness would prefer a progress mechanic feedback than students high in agreeableness (Codish & Ravid, 2014). Additionally, since progress bar shows students' progress in relation to their goal, this finding shares similarities with a previous study showing a negative correlation between agreeableness and goal-setting motivation (Judge & Ilies, 2002). Enjoyment and perceived usefulness from progress bar by students low in agreeableness may be explained by self-interest dynamics that values the individual progress as opposed to team work dynamics of the students high in agreeableness (Costa & McCrae, 1998).

However, the interaction between agreeableness and gender using game elements showed an effect on perceiving another game element, which is avatar-enjoyment. Specifically, males low in agreeableness are more likely to enjoy the avatar game element than males high in agreeableness because it allows them to hide their disagreeable nature and appear in a way that corresponds to societal norms, and hence feel more comfortable when interacting with others. This is consistent with previous research (Guadagno, Okdie, & Kruse, 2012), in which males low in agreeableness exaggerate their self-presentation when interacting with others.

Openness can affect students' perceived enjoyment of feedback, where students low in openness are more likely to enjoy feedback than students high in openness. This can be explained by students low in openness are more likely to report lower self-efficacy and task performance (McEnrue et al., 2009), and since feedback is a form of performance, students low in openness may perceive it positively, as a sort of support to enhance their course performance. This finding shares some similarities with a previous study showing that openness can affect students' perception of feedback and it did not affect their perception of points, badges, leaderboard, levels and chat (Denden et al., 2017a). However, this study found that students' high in openness are more likely to have positive perception of feedback.

Additionally, openness can affect students' perceived enjoyment of progress bar, where students low in openness are more likely to enjoy progress bar than students high in openness. This may be explained by progress bar is also a form of performance feedback, therefore students low in openness may enjoy it. In this context, Star (2015) also found that students low in openness are more likely to perceive performance under competitive conditions, and since the progress bar shows students' progress and performance and fulfil the need of competence, students low in openness may be more likely to enjoy the progress bar than students high in openness.

Moreover, openness can affect students' perceived enjoyment of the avatar game element, where students low in openness are more likely to enjoy it than students high in openness. This can be explained by students high in openness showing high imagination, novelty-seeking and curiosity (Ross et al., 2009); therefore, they may find the implementation of the avatar boring, since it simply consists of uploading a picture to represent themselves in a course. This finding is consistent with previous research by Jia et al. (2016).

However, the interaction between openness and gender using game elements did not had any effect on students' perception of any game element. This may be explained by the absence of correlation found

between gender and openness.

6. Conclusion, limitations, and future directions

This study investigates the impact of gender, personality and the interaction between them on students' perceptions of different game elements within three gamified courses at a public Tunisian university. The obtained results, collected from 189 students, demonstrated that individual differences, specifically gender and personality, could affect students' perception toward different game elements in gamified courses. The findings of this study can contribute to the HCI field by adding the effects of individual differences on the effectiveness of gamification design, which has not been fully investigated by HCI researchers (Rapp et al., 2019). In particular, these findings can help designers of gamified environments and applications, by providing design recommendations for targeting specific student groups based on gender and personality in order to increase the motivation and learning performance. For instance, it is recommended to implement a personalized gamified environment to help students overcome low motivation and engagement problems by suggesting the game elements that they are more likely to enjoy based on their personality and gender. Another suggestion is to implement feedback for female students low in conscientiousness.

On the other hand, this study has several limitations which should be acknowledged for further studies. For instance, it did not cover all the factors which may affect the perceptions of game elements in gamified courses, such as player types (e.g., the Player types Hexad, which is based on six types, namely Achiever, Socialiser, Philanthropist, Player, Free Spirit, and Disruptor) (Tondello et al., 2016). In addition, there are different designs and ways of implementing game elements. For example, the design of the integrated badges in Moodle can be different in other learning platforms like AR or VR-based learning environments. Additionally, there are different presentations of feedback mechanics such as points, written feedback (case of our study), or feedback using badges. Therefore, more design investigation is required to further generalize the results. The students in this study were also major in computer science, and they have the same demographical details, such as ethnicity. Thus, to generalize our results, further investigation should be done with students from other majors (e.g., economics) and from different countries. Furthermore, this study did not have non-binary gender participants and therefore the findings cannot be applied to them.

Future work could focus on: (1) evaluating the effectiveness of the proposed personalized gamification design by taking students' personality and gender into consideration, for enhancing their learning performance. Specifically, students will be grouped into a control group using a non-personalized gamified learning and an experimental group using a personalized gamified learning (according to the findings of this study). The learning performance between the two groups will then be compared to draw conclusions regarding the impact of the personalization process on learning performance; (2) investigating the effect of players types on students' perceptions toward different game elements, and their interactions with respect to personalities and gender; and, (3) developing a smart gamified learning environment which implicitly identifies students' personalities based on their learning behaviours in order to automatically personalize their gamified courses.

Credit Author Statement

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The authors have no conflict of interest to declare.

Supplementary materials

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