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Gender-based Engagement Model for Serious Games

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***Abstract*— Information and Communications Technology (ICT) improve learning quality and increases outcomes while allowing for more natural control of learning systems. It has a significant impact on the economy in many regions. However, there is a lack of female engagement in ICT fields in many countries. Serious Games are effective tools for learning, and it can be used to motivate women to study Computer Science. Gender preference factors affect engagement and motivation to play certain types of digital games, but few studies have designed digital games for females. Furthermore, most games with Computer Science content do not interest young adult females and fail to describe how the social and cultural content of the game explains the game experience of female players. As a solution, an extensive study of related literature on effective Serious Game elements, including motivational elements that influence a player to engage with digital games, effective educational game elements, female preference elements regarding digital games, and elements that impact the motivation of players to engage with the game was conducted. The result is a conceptual model for gender-based engagement in Serious Games. The proposed model will be implemented to increase the engagement of undergraduate females in Computer Science.**

***Keywords*— gender; serious game; computer science; ICT; engagement; motivation; female's preferences.**

I. INTRODUCTION

Information and communication are related to the fields of Computer Science (CS), Information Technology, and Computer Technology (CT). STEM (Science, Technology, Engineering, Math) education makes heavy use of computer technologies [1]. STEM studies conducted in the last decade have shown a general lack of female involvement [2]. Surveys such as the Taulbee Survey (2014) showed that female students' participation rate in Computer Sciences is at 14.1% only, in the U.S.A. [3]. Similar underrepresentation of women in ICT is also seen in Europe [2]. Overall, the lack of women enrolment in STEM courses has affected the presence of a woman in technical and executive positions in tech companies [2]. For example, the Netherlands has achieved a female enrolment rate in CS of only 4% to 5% [4]. This is similar to Australia, where the majority of female high school students disliked studying Information Technology (IT) [5].

The developed world is not alone in this problem, with developing countries such as Kuwait also seeing very low female enrolment in computer technology—37.7% in 2014 [6]. In 2013, Kuwait recorded a female enrolment percentage of 26.4% over the average regional rate [6]. A lack of female enrolment in CT is also seen in Saudi Arabia, which had a female enrolment rate of 11.2% in 2013-2014 [6]. Low female enrolment rate in CS has also been observed in Jordan, with only 8.3% female undergraduate computer networking students in 2014-2015 [7]. Yemen has also observed a low female enrolment rate in CT, at 6.7% in 2014 [6]. At the Sana'a Community College, female enrolment in computer networking was only 34% in 2013-2014 [8],[6]. The issue of low female enrolment rates is not universal, with many countries such as Malaysia not seeing an underrepresentation of women in CT fields. Malaysia has even reported female enrolment rates for CT that are greater than 50% [9]. One possible solution to the lack of female representation in ICT is to encourage young women to choose ICT as a possible career [5].

The fact that developed countries have seen such low participation rates for women in CT may be attributed to social and psychological factors [5], which affect enrolment in computing fields [10]. In the past decades, multiple initiatives have been carried out to increase female enrolment in ICT [4], [11]. However, these initiatives have shown little effect on female enrolment in math, physical sciences, engineering, and Computer Science (CS) [11].

Hence, in this study, we analyzed the literature on efforts to increase female participation in STEM fields and identified the factors that help increase female engagement with the STEM-based courses. One potential technological application for learner engagement is Serious Games, which can be used to educate and teach players [12]. Many studies

encourage the use of digital video games for learning experiences, as they support instructional design with motivations, challenges, and learning principles [13].

A. Digital Games

A game is a system in which players engage in artificial conflict, defined by rules, that results in a quantifiable outcome [14]. Computer games are approaches that provide direct interaction with the player interface to produce visible reactions towards the game device or computer and encourage diversion, play, and competition [15]. Recently, digital games have been considered as one of the most common, fast-growing entertainment methods, raking in a universal market size of $93 billion [16]. Video games have many benefits; it improves the imagination and logical thinking of the players. It also helps to teach collaboration between players. Recent researches on video games have been based on the video game's technical, appeal and ethical and socio-cultural aspects [17]. However, digital games involve many genres and types, which are discussed in the following section.

B. Game genre and types

The terms game types and game genres can be used interchangeably to represent the gameplay, content, and game narrative [18]. There are many genres of games such as strategy games, role-playing games, simulation games, puzzles, drills, practice games, massively multiplayer online role-playing games (MMORPGs), and adventure games [19]. The most popular game types are role-playing games (RPGs) followed by puzzles and action-adventure games [18]. Meanwhile, the most popular game genres for Game-based Learning (GBL) are fantasy games [18]. Other researchers have a different view of the best GBL genre, in which Melero et al. (2012) indicated that puzzle games are a right game genre in GBL, as they have educational values, and guides the player to achieve the game goals step-by-step as well as gives the player a feeling of control throughout the game [20].

C. Serious Games

Serious Games are not used for entertainment only; they can also be used to educate players [21]. Serious Games can be used when it is difficult to use traditional educational methods to fulfill learning goals [22], [23]. The objective of Serious Games is to overcome learning barriers and to motivate students to learn and help them to achieve their learning outcomes [24]. Multiple studies have used Serious Games to engage players with ICT and STEM topics [25]–[27].

There are multiple ways of CS education to utilize gaming [41]. Computer Science is composed of sub-fields such as Computer Graphics, Computer Programming, Computer Networking, and Information Systems. Most Serious Games for CS education have focused on programming and binary numbers [25], [26], [30]–[35].

D. Serious Games for Higher Education

Serious Games have been used to teach complicated proficiency learning in higher education [36]. There are very few studies (0.5%) in Systematic Mapping that have investigated the use of Serious Games in higher education [37]. Educational Games that can be used to engage with, educate, and motivate students are considered effective games [18]. While the effect of engagement in gaming is well-understood, few studies have investigated how engagements effect learning in Game-based Learning (GBL) environments [18].

Multiple studies have revealed that the motivation to play a specific type of digital game depends on gender [38], [39]. The gaming industry has only made a few attempts to investigate female-targeted or female-preferred games [40]. This includes the vast majority of current educational games focused on CS [41]. So far, computer games have not made efforts to clarify how the social and cultural content of the game explains the game experience for female players [39].

Serious Games are an effective and engaging educational tool; the investigation of their ability to engage female players with CS is needed in higher education. Female engagement and motivation with Serious Games are affected by such factors as personal preferences and social and cultural factors. In the next section, we discuss stereotyping and gender in digital games.

E. Stereotyping and Gender in Digital Games

In the 1970s, the word "gender" was used by feminists, focusing on the essential cultural or social quality of distinctions based on sex, whereas the biological word "sexual difference" was rejected [42]. In feminist research, the word "gender" is often used instead of the word "girl" or "woman" [42]. Stereotyping reduces people to specific essential characteristics and abilities [39]. It is part of a sorting process for people to make sense of the world despite creating undesirable connotations [39]. Many types of research report that the gaming society and industry usually deal with women as enemies, labeling them with gender stereotypes, sexism, and harassment [16]. In addition, prior studies on digital games state that men play more and are better gamers than females [16]. There is still a negative stereotyping of the female gender, while at the same time, people hope to increase the representation of the female gender in games so they could rival the male representation [17]. Moreover, Kondrat (2015) indicates that most video games tend to over-represent stereotypes and in general use extensive violence and cruelty. Dill et al. (2007) noticed that most digital games are aggressive, so females become disinterested in playing these types of video games [43].

Video games are currently no longer a male-dominant entertainment medium, as shown by the increase in female player rate to almost 42% of total players [29]. Females are now more interested in playing digital games than before. The Entertainment Software Association (ESA, 2013) report revealed that there are 47% female and 53% male players among the American gamer population [39]. Additionally, the Interactive Software Federation Europe (2012) reported that 43% of all women aged 16 to 64 play digital games [39], [16].

In 2000, Will Wrights developed a game called "The Sims," which is considered the most popular game among female gamers [17]. Recently, other digital games such as "Final Fantasy," "Mass Effect," "BioShock Infinite" and "Tomb Raider" have ceased gender stereotyping [17].

Amongst these new offerings, other popular female games thrive such as "Second Life" [45], and "The Sims" [25]. These games are popular among female gamers, which means that females have their preferences, which are different from that of male gamers.

F. Male and Female Preferences for Digital Games

There are differences in gender preferences for digital games and game modes, whereby females prefer explorative, the creative gameplay more than males [13]. It is proven that women play more frequently but for less time than men, and their preferences for game genres are also different than men [46]. Males have been found to spend more time playing computer games than females [29], [47]. Females prefer puzzle games [44], while both males and females like racing, simulation, and virtual games [46]. Male gamers like to play action, strategy, role-playing and fighting game genres, while females prefer social games [29] with rewards offered in the games [13], educational/edutainment [44], and simulation game genres [44], as well as collaborative, and exploration gaming [39], virtual life, virtual world [48], and party games [48]. Moreover, females like to play adventure games, but they prefer to observe others first before playing themselves [13]. Females do not like to play video game genres that require commitment [46]. The motivation preference elements in gaming for females are challenge, escapism, fun, social interaction [16], motivation, fantasy, competition, and arousal [49].

In digital games, males are more aggressive [45] and prefer competition [29], [51] violence [39], and challenges more than females [29]. The competition element seems to be one of the significant themes in male-oriented activities [51]. Violent games are one of the most apparent masculine attributes in most digital games [51]. Using educational games limits the use of violence in the game content. However, the game design of violent games is still core to male-oriented activities and social roles [51]. Games with violent content tend to be competitive. However, it is not necessary for games to be competitive, so competition and violence should be assessed as two different concepts [51].

The female preferences towards elements in digital games should be considered in Serious Game design for CS education, to ensure engagement with the game, and eventual mastery of the learning content. The next section discusses engagement and its effects and relationship with Serious Games.

G. Engagement in Serious Games

Game engagement means that the students are engaged in the game after they have experienced the game, felt emotionally and cognitively connected to the game elements, and achieved the games' goals [18]. Educational games engage players in learning [18]. The enjoyment and motivation gained from playing digital games impact player engagement [18].

Using Game-based Learning (GBL) in education has many benefits such as engaging students in activities, which inspire, simulate new characters, provide rewards that reality cannot offer, discover new worlds, and learn [37]. Another benefit of GBL is that the time the students spend studying and reading is double that of playing games. As a result, educational games are the best way of teaching today [15]. In general, many studies on Serious Games have been based on different curricula and focused on motivating and engaging players.

H. Motivation and Engagement in Serious Games

Digital games have a set of inherent characteristics and features, which relate to engagement in the game such as the game design and player characteristics. These features and characteristics involve the motivation to play, player attributes, player characteristics, gender, age, game genre, and game features [18]. Several types of research in entertainment games have studied game elements and the reasons for enjoyment, motivation, and engagement in games [18]. On the other hand, digital Game-based Learning provides a combination of motivation, simulation, engagement, adaptivity, collaboration, and data collection, which make this learning innovation a distinctive method [52].

II. Material and Method

To construct the gender-based engagement model, we follow the following method.

A. Material

In order to construct the model, an analysis of related literature was conducted. The following keywords are used: gender preferences in digital games, female preferences in digital games, engagement and motivation elements in (digital games, Serious Games, educational games, Game-based Learning, and edutainment games), effective learning elements in Serious Games, and social and cultural elements that affect female engagement in ICT studies. Searches were conducted in IEEE, Google Scholar, ACM Digital Library, Science Direct, Springer, and Taylor & Francis. 162 elements were retrieved. This was followed by the elimination of repeated elements that used different names for the same thing. As a result, we obtained 52 final elements.

Finally, we abstracted 21 elements that were matched with gender preferences in digital games that affected motivation and engagement with learning elements, as well as social culture elements that influence gender engagement in ICT studies as in Figure 1 below.

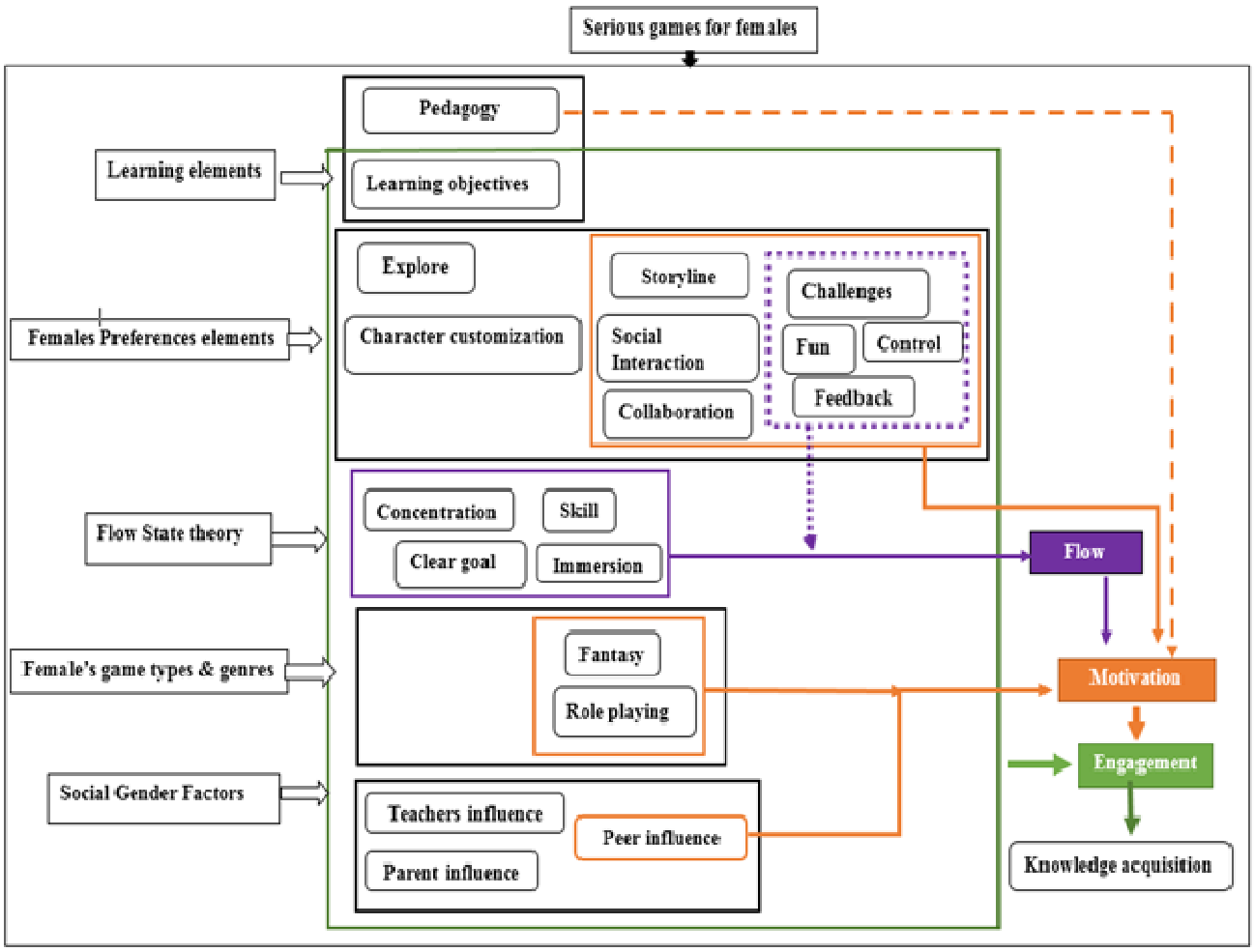

Fig.1 The conceptual Model for Gender-based Serious Games

B. Method

We used these elements to construct a conceptual model for Gender-based Engagement in Serious Games. We differentiated arrows for each component. The orange arrows represent motivation elements, green arrows for engagement elements, and purple arrows represent flow state theory elements.

III. Results and Discussion

The proposed conceptual model consists of five elements as shown in Figure 1. Game elements were categorized into learning elements and elements for female digital gaming preferences. Orange-colored arrows were used to display motivational elements, while green-colored arrows were used to display engaging elements. The five elements and their sub-elements are described as follows:

A. Learning elements:

Pedagogy: Digital games and Serious Games are differentiated by pedagogical elements designed to instruct and inform, in addition to differences in story, art, and programming [53]. Learning outcome: When players are emotionally engaged with a game due to its motivational or learning outcomes [18].

B. Female preference elements in digital games:

An analysis of studies on digital games, gender-based digital games, and Serious Games yielded the following elements for female gaming preferences.

1) Explore: Game-based Learning is a collaborative tool that interfaces with intrinsic motivations [15]. Most learning studies in gaming have supported collaborative methods of play [18]. Cooperative and collaborative gaming methods are some of the most popular ways of playing games [18]. The engagement of students with significant gaming activities allows for role-playing through the assumption of new identities, the exploration of new worlds, and the discovery of new knowledge [37]. Females show preference towards exploratory gaming involving gameplay tools and actions [13]. Previous studies have shown the preference of female gamers for exploratory gameplay [13].

2) Character Customization: Young adult women appreciate relationships between in-game characters and player avatars. Female players commonly use player avatars as a means of self-expression, and enjoy games that involve customization options; this is in contrast with male gamers, who tend to treat their player avatars as puppets [40]. Females like to choose the Customization options for their avatars, which include the customization of clothing,

weaponry, and accessories [40]. Both offline and online RPGs are known for their customization options [40].

3) Storyline: In-game storylines allow players to engage with in-game characters and situations, creating a motivational element for further in-game exploration and content completion [18]. The storyline is a prime gaming motivational element [18]. Females like to play games with good storylines [40].

4) Social Interaction: Social interaction is an element in cooperative or collaborative gaming that increases motivation [49]. It is a prime factor for female engagement with gaming [22], [23]. Moreover, social interaction is an element that increases the engagement in digital games [54]. Females are attracted to games with social interaction opportunities [16].

5) Collaboration: Collaboration encourages intrinsic motivations in gaming [15]. Most studies on Game-based Learning [18] agree that collaboration is important for intrinsic motivation. It is also one of the most popular playing modes [18]. Females prefer cooperation in games [16].

6) Challenges: Both male and female players are motivated to play challenging games, although men usually score higher [37]. Gameplay is enjoyable when players feel that a game is challenging, but not so challenging that it is too difficult to engage. It must also encourage players to explore the game world [18]. Challenge is a key component in the framework on motivation by Malone and Leaper [12]. Challenges increase the intrinsic motivations in games [15]. When a player is engaged in a video game in such a way that the player's abilities and the game's difficulty are in sync, a state is known as "flow" will occur and control the player [13], [55]. For females, the challenge is one of the many motivational elements that improve engagement with traditional games [49], [54].

7) Fun: Engagement in digital games is best realized *when a* game both entertains a player and holds their concentration [12]. Fun is a core motivational preference for female players [49].

8) Control: Control is an attribute that effects *motivation in* the framework of Malone and Leaper [12]. Control in digital spaces improves student enjoyment and interest on an emotional level [18]. Control provides students with the ability to complete gameplay tasks on their terms [18]. Control in gaming is a player ability to change or choose between different options [12]. Control improves intrinsic motivation [15]. The sense of control is an aspect of player flow that interacts with player engagement and achievement [52]. Females prefer to control the game, instead of the game controlling them [40].

9) Feedback: When players interact with GBL, *immediate* feedback is received, supported by animation and graphics [18]. Clear in-game feedback improvers intrinsic motivation [15]. To maintain player flow, learning environments must match player skills with environments that display clear goals and immediate feedback [14]. In video games, activities that have clear and immediate feedback supports player flow [13], [55]. Digital environments that support player flow through feedback improve student engagement and achievement [52]. In gaming, feedback is a factor that enhances player engagement [54].

C. Flow State Theory:

1) Concentration: In digital environments, high amounts of player concentration and enjoyment increases flow [12]. In video games, flow occurs when players concentrate on accomplishing enjoyable activities [55].

2) Clear goal: In games, it is necessary to design environments that support clear goals and matches player skills to create flow [14]. In video games, flow occurs when players are engaged in activities with clear goals [13], [55]. There are multiple flow elements in digital games, which support player engagement and achievement [52]. Goal clarity increases player engagement [54].

3) Skills: Skill is an element that influences player flow [14]. GBL improves a player's ability to learn, which improves his or her knowledge and skills [18].

4) Immersion: Immersion is linked to mental flow, and occurs when a player is fully engaged in an activity that is both enjoyable and requires his or her full concentration [56]. Immersion is an engagement element that represents the need for players to submerge themselves in the game's story and gameplay.

D. Females Game Types and Genres:

1) Fantasy: Fantasy represents the desire of women to engage in activities that they cannot or would not have involved themselves in real life [49]. Fantasy occurs immediately after a player begins playing a game through the game's graphics, audio, and gameplay mechanics [14]. Fantasy supports intrinsic motivation [15]. Fantasy is a part of female motivation preferences [49].

2) Roleplaying: Roleplaying increases player motivation, skills, and knowledge[18]. Role-playing games are the females' favorite type of game [40]. Roleplaying presents players' opportunities to complete a task in a virtual environment [18]. Role-playing in-game gives students the opportunity to hold the responsibility to complete the game's tasks [18]. In GBL, RPGs commonly offer the most roleplaying immersion education [18]. Roleplaying increases student engagement and education [18]. Multiple studies have shown that player concentration is increased when roleplaying elements are supported by the game's multimedia elements or in-game goals [18]. Roleplaying is a crucial component of engagement in digital gaming [18].

E. Social Gender Factor:

The low involvement of women in CT [5] is due to social, cultural, and socio-cultural factors [21]. These factors include social stereotypes, role models, family influences, cultural environment, peer influences, female perceptions of ICT as a male domain, female interest in the subject matter, and career opportunities [5], [10]. An analysis of the literature review on the factors that influence female involvement with ICT/STEM found gender influence factors to affect female participation in the STEM and ICT fields significantly.

The conceptual model for this study used some of the factors in game storylines to improve female awareness of the factors that discourage females from involving

themselves in CS. The following social gender factors were used in the conceptual model:

- Teacher influence: Teacher behavior can have both a negative or positive impact on the decision of female students to enroll in CS courses [5]. Teachers shape student aspirations.
- Schools, and common portrayals in the media [5].
- Parental influence: Parental influence shapes female aspirations to enroll in CS courses [5].
- Peer influence: Games supported by a women's peer group support intrinsic motivations [15].

These factors and their relationship with other elements are shown in Figure 1. Learning elements, female gaming preferences, flow state theory, female-preferred game types and genres, and social gender factors make up the conceptual model. This model can be used to guide the development of Serious Games focused on engaging with female players and encouraging enrolment in CS higher education courses. Computer Science is a sub-field of ICT and STEM. There is a lack in the number of female students, who are enrolled in Computer Science studies in many countries. One of the reasons contributing to this issue is the social and cultural factors [11].

Serious Games are one of the technologies, which motivate and engage players in learning [21]. Therefore, Serious Games can be used to motive and engage female students in studying in the computer network field. In order to do that, a conceptual model for gender-based engagement in Serious Games is proposed. The model will be used to design and develop Serious Games in the computer network field. To develop an effective educational game for female students in higher education, there is a need to know the female preferences in games. Cultural and social factors that contribute to the low number of females in the STEM field in some countries include parental, friends', and teachers' influence. Hence, these factors are included in the conceptual model in order to draw female awareness and attention to these factors.

The conceptual model consists of five components and 20 elements. The 20 elements make up flow, motivation, and engagement in games. The first component is the learning elements, which consist of two elements: pedagogy and learning objectives. These elements are the main difference between entertainment games and educational games since digital games do not have educational elements. Pedagogy means the subject curriculum, and pedagogy produces motivation, not engagement in games. Pedagogy is not part of the engagement grouping. Learning objectives means the objectives that have to be achieved after playing the game. Learning outcome affects motivation and engagement in games. These elements are important because students are expected to learn and gain knowledge while playing the game.

The second component is female preferences for digital games, which consist of 9 elements including exploration, character customization, storyline, social interaction, collaboration, challenges, fun, control, and feedback. These elements are included in the conceptual model because the target users in this study are female students. In order to motivate and engage them to play Serious Games, it is essential to use their preferences in digital game design. All of these nine elements produce engagement in the game, while 7 of them can promote motivation in the game.

The third component is the flow state theory, which consists of 8 elements; 4 of which are also female preferences elements in games. These elements are challenges, fun, control, and feedback. The remaining four elements are concentration, clear goals, skill, and immersion. All the eight elements of flow state theory affect motivation and engagement in games. The flow state theory is included to obtain player engagement with digital games [13]. The flow theory is based on intrinsic motivation, so an application developed based on the flow state theory will be highly motivational [18].

The fourth component is female game types and genres, which contains two elements: fantasy and role-playing games. These two elements produce motivation and engagement in games. The last component is social gender factors, which includes three sub-elements. They are parental, peers and teacher influence. Peers influence motivation and engagement, while parental and teacher influence can affect motivation. These three elements were included in the conceptual model because they affect the female engagement in STEM and Computer Technology studies.

IV. CONCLUSION

An extensive literature on learning elements, gender preferences in digital games, flow state theory, female game types, and social gender factors was reviewed. All components and elements that affect learner engagement with Serious Games were grouped to compose the conceptual model. The proposed conceptual model can be used to motivate and engage female students in studying Computer Science using Serious Games. Each element in the model plays a part to ensure that motivation and engagement are present during gameplay. For future work, a low-fidelity prototype based on this conceptual model will be developed and evaluated to validate the model.

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