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Examining Gender Differences when using Avatars for Educational Games

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Gender Differences when Adopting Avatars for Educational Games

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ABSTRACT

Avatars act as digital representations of players or non-playing characters in games and other online environments, and also play a key role key in educational games. This study looks at gender differences that may impact on human avatar interactions, exploring the impact of player gender differences and avatar gender differences that might impact on acceptance of game technology for education. We also consider gender preferences for avatars across a range of subject areas. We survey 332 participants and examine general acceptance of educational games using the UTAUT framework. We find both males (n=202) and females (n=131) rank performance expectancy, effort expectancy, social influence, facilitating conditions and hedonic motivation, along with their behavioural intention to use the technology favourably, although female rankings on all scales are significantly lower than male ratings. This suggests that females are less confident in adopting game technology than males for use in education. Participants also ranked a series of 5 male and 5 female avatars on how well they might be applied to various educational domains. In most cases, the male and female participants rank avatars consistently, although there are a few exceptions. Most evident is the way the female avatars and male avatars are ranked for use in educational games, indicating clear preferences by users for how avatar gender should be selected. The survey also identifies potential benefits and issues associated with using avatars in educational games.

1 Introduction

Widespread access to personal computers, internet connectivity, and specific application areas such as computer games, have all grown dramatically since the 1990s. As a consequence, technology underpinning computer games for entertainment has been adapted for more serious uses such as education. Virtual humans, or avatars, are one specific example of this evolving technology and it might be expected that avatars will be a critical design component of many digital experiences. The broader adoption of game technology for education seems inevitable, yet it is not clear if there might be gender differences in the uptake of this technology. This study is motivated to explore some specific gender issues in relation to adoption of game technology but also to gain a better understanding of avatar design issues that must be considered if educational support is to be provided for the broadest range of students.

The term "avatar" derives from the Sanskrit word "Avatara", meaning descent and is used to refer to the descent of a god down into the world of mortals [46] and has become a common term in some computer application domains where it is used to refer to the way a user or other virtual characters are represented when they descend into a virtual computer world. The term appeared in foundational cyberpunk literature such as "Neuromancer" [33] and later spread in science fiction novels such as "Snow Crash" [68]. One of the earliest well-known uses of a digital avatar was "Ananova", a green-haired female avatar designed to deliver news across the internet, appearing in August, 2000 [49]. The terminology has been reinforced in movies such as "The Lawnmower Man" [26] and "Avatar" [15]. In 2020, the term is ubiquitous with the notion of virtual humans used in computer gaming, virtual worlds and in many online applications.

While digital or virtual humans play an important role in many video games, they are also widely used for a range of serious tasks across many domains. For example, avatars are used as standardised patients for medicinal training ([32, 64]), educational instructors for teaching students [6], pedagogical agents to assist and support learning [10], and to act as participants in live-action role play for military simulation and training [39, 69, 1]. In general, the primary uses of avatars include entertainment and social interactions [23, 31]. However, avatar augmented role play has also emerged as a significant field for simulation and training [13, 24].

In video games, there are typically two types of avatars that help the player learn new skills. Most commonly, an avatar will appear briefly at the start of the game and teach the player the basics of the game before leaving the player to expand their knowledge independently through experience. An example of this is in the game Portal 2 [77] where a tutorial avatar is used to teach the player basic movement skills and introduce the portal gun before leaving the player to build on their existing knowledge and puzzle solving skills and advance further into the story. The second type of avatar is more ubiquitous in the game, and responds to the player's situation, trying to provide help when the player requires it. This avatar will appear at the start of the game to teach basic skills and then disappear until either the story needs them, or the player is found struggling and needing further instruction. This type of avatar is used in Total War: Warhammer II [20], with the tutorial avatar appearing every few rounds to remind a player of activities that they may have forgotten or to provide new tips on how to overcome a challenge.

Using avatars for more traditional education, particularly in remote education, suggests itself as a natural evolution of online gaming and other digital experiences that already use avatars. Although it is not clear

how game technology for education is accepted and if there are gender differences in the potential uptake of this technology. This is one question addressed in this study by using the Unified Theory Of Acceptance And Use Of Technology (UTAUT) framework [80] to survey participants and then examine any gender differences in how the use of video games in education might be accepted. The UTAUT framework is discussed in more detail in the materials section.

It might be expected that designing appropriate cosmetic and functional attributes of educational avatars can enhance behavioural, affective, and cognitive components of user engagement [53, 38]. Therefore, another element of this study is to look at how the gender of the avatar might be important in various educational roles. For example, do both male and female users prefer the same gender for an educational avatar, and is this consistent across different subject areas? Might it be best to adopt different avatar genders when teaching different topic areas? This question is addressed in the study by using a set of 10 different avatars (5 male and 5 female) and allowing participants to rank their suitability for education across the varied domains of mathematics, science, computing, art, language and history. More detail of this area of the study is also described in the materials section.

Finally, the survey gathers open feedback from the participants about the possible advantages and issues associated with both avatars and computer games being used in an educational context. In the following section we consider previous literature in human avatar interaction to provide further context for our own study.

2 Background

There are many design factors that can impact on a user's perception of an avatar. The look and feel of an avatar may be critical in contexts such as education, so the general appearance and aesthetic qualities of an avatar need to be considered. Avatar attributes such as age, attractiveness [42], biological sex [86, 29] and ethnicity [59] are all identified factors that may impact on the way the user perceives, and interacts, with the avatar. More specific elements such as face shape, hair colour, hair style, eye colour and eye shape should also be considered [75]. These, and other cosmetic attributes, such as, clothing and accessories [60] are reviewed in Section 2.1

The realism and humanness of the avatar is an overarching property related to both the cosmetic and functional properties of an avatar. Users can sometimes experience a sense of uncanniness when cosmetic and functional avatar properties fail to meet expectations of realism [47]. This traditional issue associated with avatar realism and the notion of the "Uncanny Valley" [54] are likely to be ongoing issues in educational games and therefore this topic is reviewed in Section 2.2. More background to the area of educational games is also provided n Section 2.3

2.1 Avatar Attributes

The look of an avatar is likely to be an important factor in educational games. Avatars that are considered more attractive may be perceived as more credible than less attractive avatars [42]. Attractiveness can be affected by the sex [21], with evolutionary and sociocultural theories suggesting that males may place a higher value on physical attractiveness for mate selection than females [27]. In general, rounder shapes tend to be associated with positive emotional valence giving rise to pleasant and positive assessments, while angular shapes tend to be associated with more negative emotional valence and hence unpleasant and negative assessments when viewing emotional expressions and faces [82].

An avatar might appear to be a child, someone in their mid-20s, or someone from an older age group. The apparent age of an avatar relates directly to the physical appearance of the avatar, and this factor may be critical in some applications. For example, when using avatars as standard patients in medicinal training scenarios where the age of the avatar might need to be changed to suit the situation [5]. Clothing and accessories can reinforce cues about age as well as the role or personality of an avatar. For example, an avatar dressed in a military uniform may be viewed as highly disciplined and well equipped, and thus be perceived as more trustworthy than an avatar dressed in a ballgown [45]. Like age, the level of trustworthiness an avatar displays may be especially important in learning contexts [55].

The cultural identity of an avatar may be interpreted from physical features and additional cues such as gestures or clothing choices. As a visual cue, ethnicity may be used to categorise other human and human-like individuals [3]. Avatars that are more ethnically similar to the end-user are often seen as more trustworthy and socially attractive [59]. When designing avatars for a global audience, it is therefore crucial to ensure the appearance of an avatar is accepted by the user as culturally appropriate. In general, the self-similarity of an avatar may have a significant impact on user behaviour [84]. For example, if the avatar has a similar appearance to the end-user the chance of enacting behavioural change is higher [84].

One way to help with avatar acceptance is the ability to customise the appearance of an avatar's hair; face shape, eye colour, age, clothing and accessories. This can be an important way for the end-user to express identity, and so careful thought needs to be given to the variety of options provided to users [60]. This may lead to a greater sense of connection or ownership of an avatar which is important for representing identity in a virtual context [76, 87, 37]. Previous studies also suggest that allowing users to customise their avatars increases satisfaction and loyalty to a video/computer game [70]. While most end-users build avatars based on their offline appearance [48] many end-users improve or alter their online looks when designing their avatar [51]. As well as individual-identity, customisation may allow end-users to form a group-identity in online communities, using the projected identity of the avatar to better engage with the group [48].

Central to this study is a consideration of possible impacts of avatar gender on experience. Patterned use of avatars of different genders is already evident, with male avatars more likely to represent the primary and secondary characters within a game than female avatars [83]. Despite the ability to customize and change an avatar, the distinctions between feminine and masculine attributes appear more exaggerated in cyberspace [62]. The appearance of the biological sex for an avatar may include, female, male, and intersex forms, and the importance of this attribute has been highlighted in previous research [8, 24, 43]. For example, it was found that men were more likely to seek help when 'disguised' as a female avatar [43]. The authors describe men as traditionally reluctant to ask for help, due to social expectations placed on them because of their sex roles. Therefore, gender choice may be based on preconceived social cues and expectations. There may also be perceived social benefits to gender-swapping in online gaming, such as male players engaging as a female avatar to be treated better by other male players [40]. Female avatars may also be preferred by both males and females when the avatar is required to display a sad emotional expression [8].

The Proteus Effect [85] suggests that users will conform to the behavioural expectations associated with the avatars' appearance. In serious games, the choice of the avatar's sex may be related to the purpose or role of the avatar. A particular sex may be thought to have an advantage or 'natural fit' for

that role. For example, virtual assistants are commonly female as there is a perception that females possess 'natural skills' such as a willingness to offer help and anticipate the needs of others, making them stereotypically more suited for this role [36]. In learning contexts, the sex of the avatar may be influenced by these sex-based stereotypes, which in turn influences how learners engage with the avatars [53]. In a study using virtual characters to gauge whether the avatars gender could persuade the listener to change their attitude, female avatars were considered more persuasive by male participants [86]. By contrast, female participants found the male avatar to be more persuasive [86]. This suggests that gender stereotypes that are common in social interaction studies [16, 25] are also likely to impact on human-avatar interaction [86]. Avatar sex and personality may have considerable implications for online self-representation and self-presentation [24] and so stereotypical notions of the role of sex also suggest themselves as important in the design of an avatar for education.

Further, functional characteristics, such as movement and general behaviour, may also impact on how an avatar is perceived [17]. The differentiation between cosmetic and functional characteristics may also blur, for example, where a cosmetic characteristic such as 'grey hair' may imply a functional characteristic such as the agility of the avatar's movement. Likewise, gender appearance of the avatar might suggest a stereotypical role for an avatar that the user unconsciously expects it to perform in a preconceived way. The failure for an avatar to meet expected 'real' humanness in terms of visual realism or behavioural realism is discussed further in the next section.

2.2 Avatar Realism

The level of avatar realism sits as an over-riding factor which impacts both the aesthetic and functional characteristics of an avatar. Realism has many levels and can refer to an avatar's behaviour, appearance, or ability to communicate [61]. Things that may affect this perception are the visual and behavioural cues displayed; the visual fidelity; the degree of anthropomorphism; the kinetic conformity and the social appropriateness of an avatars' behaviour [41].

Increasing the level of realism does not necessarily mean that the approval of the avatar will increase or that it will be more effective at a task [74]. Findings of a study using human avatars and anthropomorphized cat avatars [86] found that the level of visual realism did not impact on the persuasiveness of the avatar's message and end-users tended to respond to the cat avatars as though they were real people [86].

Lower realism avatars can have the appearance of a more cartoonish style with exaggerated features. While less human avatars with a lower realism are often more accepted because the cartoon-like avatars are not held to the same standards as humans [47]. In comparison, avatars with a higher realism level could be described as those that are developed to be as close to human as possible [67]. A danger is that increasing the level of realism in avatars intensifies the sensitivity to cues perceived by end-users highlighting falsehoods in the appearance and behaviour of the avatar [14]. In contrast, lowering the realism level of an avatar's appearance may lower the end-user's expectations, thereby making the flaws in the appearance and behaviour less obvious.

Human perception of realism has also been shown to vary amongst individuals and there may be value in using more realistic avatars for male students, as these higher realism avatars may positively affect the transfer of learning [11]. However, this is not the case for the female students, as females have been found more likely to choose an unrealistic or cartoonish avatar [11, 35]. Although this gender difference may be contextual, as an alternative study found no significant differences between female

and male participants in terms of learning achievements when their participants were exposed to avatars with varying levels of realism [65].

A traditional problem with realism is that users can be disturbed, experiencing a sense of uncanniness when a human-like entity fails to meet the expected kinetic fidelity of a human being [47]. This negative emotional response can be attributed to the notion of the "uncanny valley" [54]. Human-like entities, such as robots or avatars, that fail to meet our expectations of human behaviour fall into the uncanny valley, and are described as unpleasant, eerie and akin to zombies or corpses. Although initially applied to robotics, this notion has now been applied to human-like avatars that have been created using computer graphic capabilities with a focus on boundary-pushing realism [71].

Common issues that cause uncanniness in avatars can be attributed to facial attributes such as the eyes [66], mouth [18], forehead region [72], skin colouring [2], texturing [56] and wrinkling [19]. Further issues may also include the level of authority [63], attractiveness [42], humanness [12], or emotional expression capability an avatar displays to the end-users [73].

The sensation of uncanniness itself can be traced to Freud's [30] theory of the unfamiliar familiar (unheimlich heimliche) that can be described as a familiar instance or event occurring in an unfamiliar way. Uncanniness is a major consideration for developers of avatars as users may experience a negative emotional response and disengage from the avatar. In terms of both appearance and behaviour, realism remains one of the significant issues for avatar developers. In this study the focus is on gender differences but a range of realism across both the male and female avatars was used as a control for this effect.

2.3 Educational Games

Serious Games are defined as videos games that are designed for purposes other than just entertainment [96]. When used in education, Serious Games are designed so the user can experience a more entertaining experience while learning, compared to traditional teaching methods [92]. Due to the rising use of Serious Games in recent years, there been a corresponding increase in the investigation of the technology to help determine its effectiveness in education [98]. This research has investigated the adoption of serious games in physical environments, such as schools of varying educational levels [91, 93] and also includes theoretical studies aiming to improve the effectiveness and educational value of serious games [88, 97].

Some studies conducted in educational facilities found mostly positive results from their research. A study conducted in 2008 found that students had a positive outlook on their learning and had reported higher levels of enjoyment when using Serious Games compared to other means of learning [93]. Other studies found that Serious Games had effectively improved the participants' cognitive abilities [94, 98]. An analysis of 46 empirical papers found the common observation that when participants used Serious Games they had gained a boost to their cognitive ability [98]. Through self-reports the players felt they were happier and had a more pleasant mood and females also felt they had achieved more success using educational games for learning [98].

Though many studies did find an improvement in the user's mental outlook on their work, they also showed no significant signs of scholastic improvement when compared to current teaching methods. [98, 89]. A potential reason for this result was due to a heavy mental load which resulted in the learning effect on the participants declining, but this could also work the other way around as well, with a lighter

mental load resulting in a higher learning effect. This was also noted as a potential cause for a lack of difference to in-depth learning when compared with traditional learning methods [90].

Arguably many serious games do not have the resources for development and so are not designed, implemented or tested to the same level of quality as commercial computer games. As a result, many researchers have been investigating ways to create both a more engaging and a more educational experience. One theory that was suggested was for both the learning mechanics and game mechanics, both important factors in making an engaging educational game, be planned, and implemented by teachers [95]. This would then allow teachers to better integrate educational games into their teaching plans in a more relevant way.

Another study identified five influencing factors that could help improve the success rate of learning new information [88]. These five factors aim at the core educational mechanics of serious games such as realism, artificial intelligence, adaptivity, backstory, production, interaction, and feedback [88]. These factors aim to personalise the game and provide the user with an easy-to-understand, educational experience through personal user feedback, user experience and in-game adjustments to suit the user's needs. Other studies have observed further influencing factors [96, 97]. This includes the use of surprises [97] which can stimulate the user's cognitive structures and lift user engagement. This technique used in a narrative like game could peak user engagement levels as well as help stimulate more advanced level users to further improve reasoning skills [97]. One final influencing factor found was the user's age as it was found that younger aged audiences performed at a higher level when compared to older audiences when using educational games [96,98].

In this study the focus is on the uptake, or acceptance, of Serious Games for education. This is considered using a more general technology acceptance model, called Unified Theory of Acceptance and Use of Technology model (UTAUT) which is further explained in the following materials section.

3 Materials

The main material used in this study is a purpose-built, online survey with four main parts. Firstly, the survey contains a series of demographic questions that are used to distinguish gender, educational background, avatar experience, game experience, and broad age groupings of participants. Secondly, a series of questions related to the acceptance of game technology for education and based on the Unified Theory of Acceptance and Use of Technology model [79] was included (See Section 3.1). Thirdly, a set of avatar ranking questions were used to explore how avatars with different cosmetic attributes, including gender, might be perceived (See Section 3.2). Participants ranked a set of five male and five female avatars with various levels of realism. The ranking was related to general usability of each avatar in educational games and also the suitability of each avatar for teaching specific topic areas. Finally a set of open questions collected open feedback from participants.

3.1 UTAUT questions

The Unified Theory of Acceptance and Use of Technology model [79] was derived from the Technology Acceptance Model [22, 78] and has been validated across a broad range of technologies [81]. Known as UTAUT, the framework consists of a number of dimensions that are intended to measure factors that impact on the acceptance of new of technology. The questions for each dimension are typically modified to suit each domain under investigation. Each dimension of the framework is examined using a series of Likert-scale questions designed to measure Performance Expectancy, Effort Expectancy,

Social Influence, Facilitating Conditions, Hedonic Motivations, and Behavioural Intentions. In this study a seven-point Likert Scale was used and questions were modified for each UTAUT dimension are shown in Table 1.

3.2 Ranking Avatars

A ranking task was devised to allow participants to rank a set of 10 facial avatars for suitability of use in both educational games generally and more specifically, for six different subject areas: Mathematics, English, History, Science, Art and Computing. These 10 avatars have been categorised in previous research (Bailey and Blackmore, 2017) and vary in level of fidelity and gender (See Table 2, 3). In total, five male and five female avatars were used, with each gender group of five consisting of one real human, one each of a high fidelity and medium fidelity avatar, and two low fidelity avatars.

Table 1: UTAUT Questions related to acceptance of educational games

Dimension	Description	Question
Performance Expectancy	The degree to which using educational games will provide benefits to students in their learning activities.	PE 1. I think using game technology for education will provide a useful mode of learning. PE 2. Using educational games could help me achieve educational outcomes that are important to me. PE 3. Using games that help me learn will help me achieve my educational goals more quickly.
Effort Expectancy	The degree of ease associated with using educational games.	EE 1. My interactions with computer games is clear and understandable. EE 2. I find computer games easy to use. EE 3. Learning to use a computer game is easy for me.
Social Influence	The extent to which students perceive that important others believe educational games will provide benefits to students in their learning activities educational games.	SI 1. People who are important to me think computer games should be used for education. SI 2. People who influence my behaviour think that computer games should be used for education. SI 3. People whose opinions I value would support the use of educational games. SI 4. I believe educational authorities would support the use of computer games for education.
Facilitating Conditions	Perception of the resources and support available to use educational games for learning.	FC 1. I have the computer resources necessary to use educational games. FC 2. I have the knowledge necessary to use educational games. FC 3. Educational games are compatible with other forms of education. FC 4. I could get help from others if I had difficulties using educational games
Hedonic Motivation	The fun or pleasure derived from using educational games.	PE 1. I think using game technology for education will provide a useful mode of learning. PE 2. Using educational games could help me achieve educational outcomes that are important to me PE 3. Using games that help me learn will help me achieve my educational goals more quickly
Behavioural Intentions	The intention to use computer games for education	PE 1. I think using game technology for education will provide a useful mode of learning. PE 2. Using educational games could help me achieve educational outcomes that are important to me. PE 3. Using games that help me learn will help me achieve my educational goals more quickly.

The avatar faces (See Table 2, 3) were obtained from six different sources. Two real human faces were included in the set (F1-Rose, M1-Rycroft) and these were obtained from a database of kinetic facial expressions [9]. In addition to the two real human faces, there were two high fidelity avatars produced and used with the permission of the University of California and Image Metrics (F2-Emily, M2-Ira). Four of the lower fidelity avatars are sourced from commercial software, two of these (F3-Ilana, M3-Victor) from Faceware [52] and another two (M4-Macaw, M5-Leo) from Faceshift [4]. One avatar (F4-Liliwen) was sourced from YouTube to be representative of a user developed avatar from a commercial game [58] and the final female avatar (F5-Bailie) was created in the 3D Avatar Store [7].

In the ranking section of the survey, the 10 avatars are first displayed and then participants are asked to order the avatars from most to least suitable for use in an educational game. Participants can simply drag and drop pictures of the avatars into position in the ranking list, reordering as required, until they satisfied with the overall ranking. When participants are asked to choose the most suitable subject area for each of the 10 avatars to teach, they can select only a single option from either Mathematics, English, History, Science, Art or Computing for each avatar.

3.3 Open Questions

The final part of the survey consisted of four open questions:

1. What do you see as the possible advantages of using avatars for educational purposes?
2. What do you see as the possible issues, or problems, of using avatars for education?
3. Do you see any potential advantages of using game technology for educational purposes?
4. Do you see any potential issues, or problems, of using game technology for education?

Table 2: Set of Female Avatars used in the ranking process

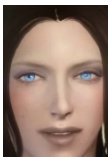
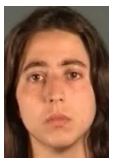
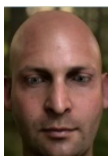
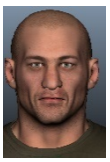
F1 - Rose	F2 - Emily	F3 - Ilana	F4 - Liliwen	F5 - Baillie
				
Real - 1	High - 2	Mid - 3	Low - 4	Low - 4

Table 3: Set of Male Avatars used in the ranking process

M1 - Rycroft	M2 - Ira	M3 - Victor	M4 - Macaw	M5 - Leo
				
Real - 1	High - 2	Mid - 3	Low - 4	Low - 4

4 Method

The study was approved by the University of Newcastle Human Research Ethics Committee. An online survey was created and hosted using Limesurvey [34]. The survey was then distributed on the Amazon Mechanical Turk website [57]. Participants were restricted to those with English language proficiency and it was designed to be completed in under 20 minutes. The survey remained online until 350 participants had responded. Of these, 19 invalid responses were received.

In the first part of the survey, participants answered a series of demographic questions (See Table 4). Next, participants were required to rank the set of 10 avatars (See Table 2, 3) from most to least suitable for educational games. The participants were then asked to choose for each of the 10 avatars a subject area that best suited that avatar. Subject areas choices were: Mathematics, English, History, Science, Art, and Computing. Next, participants completed a series of three or four Likert questions (see Table 1) for each of the six dimensions of the UTAUT framework (Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivations, Behavioural Intentions). A seven-point Likert scale was used (1-Strongly Disagree, 2-Disagree, 3-Slightly Disagree, 4-Neutral, 5-Slightly Agree, 6-Agree, 7-Strongly Agree). Finally, participants responded to the four open questions.

Table 4: Demographic Questions Used in Survey

Demographic	Question
Biological Sex	Please indicate your biological sex (Male, Female, Transgender, Other, Prefer not to say)
Age	Please indicate your current age (in years)
Education	Please select the highest level of education you have achieved (Did not complete high-school, High School/Secondary school, Some College, Bachelor Degree, Master's Degree, Advanced Graduate work or PhD, Trade School, Other)
Game Experience	Would you consider yourself a computer/video gamer (Yes, No, Unsure)
Avatar Experience	Where do you see and/or interact with avatars/virtual humans? (Movies, Games, Television shows, Internet, Other, I do not see/interact with them)
Media Time	On average, how many hours would you spend viewing or interacting with any form of media that contains virtual humans/avatars a week (0-5 hours, 6-10 hours, 11-15 hours, 16-20 hours, 21-25 hours, 25+ hours, I do not view or interact with avatars)

5 Results

5.1 Demographic Results

In total, 332 participants successfully completed the survey, with 201 male and 131 female respondents. The age of all participants (M=33.8, SD=10.2) varied. Because age was not distributed uniformly around the mean, a Mann-Whitney U test was used to compare male and female ages, finding no significant difference ($p = 0.49$) between the male (M=32.8, SD=8.5) and female (M=35.3, SD=12.2) groups. In terms of other demographics (See Figure 1) there were some observed differences, with male participants having a larger proportion of higher education and also identifying more often as gamers, as well as spending more time interacting with avatars. Although these differences were observed, they did not test significantly.

5.2 UTAUT Results

The descriptive statistics for each dimension of the UTUAT questions are reported in Table 5 and shown in Figure 2. Due to the asymmetric distribution of scores around some means, the more robust Mann-Whitney U test was used to compare male and female scores on the six UTAUT dimensions.

Note that for all dimensions, the female scores are significantly lower than the male scores. These results are also reported in Table 5.

As typical in UTUAT scores, the five dimensions of Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions and Hedonic Motivations are checked for correlation against Behavioural Intentions. For both male and female groups, all of these dimensions were found to be significantly correlated using both Pearson and Spearman calculations. The more robust non-parametric Spearman calculations are reported in Table 6. To determine if the differences in any of the male and female correlations were significant, these values were checked using a one-tailed Fisher's r_s to z transformation. A significant difference was found between the male and female correlations between Hedonic Motivation and Behavioural Intentions ($z=1.81$, $p < .05$).

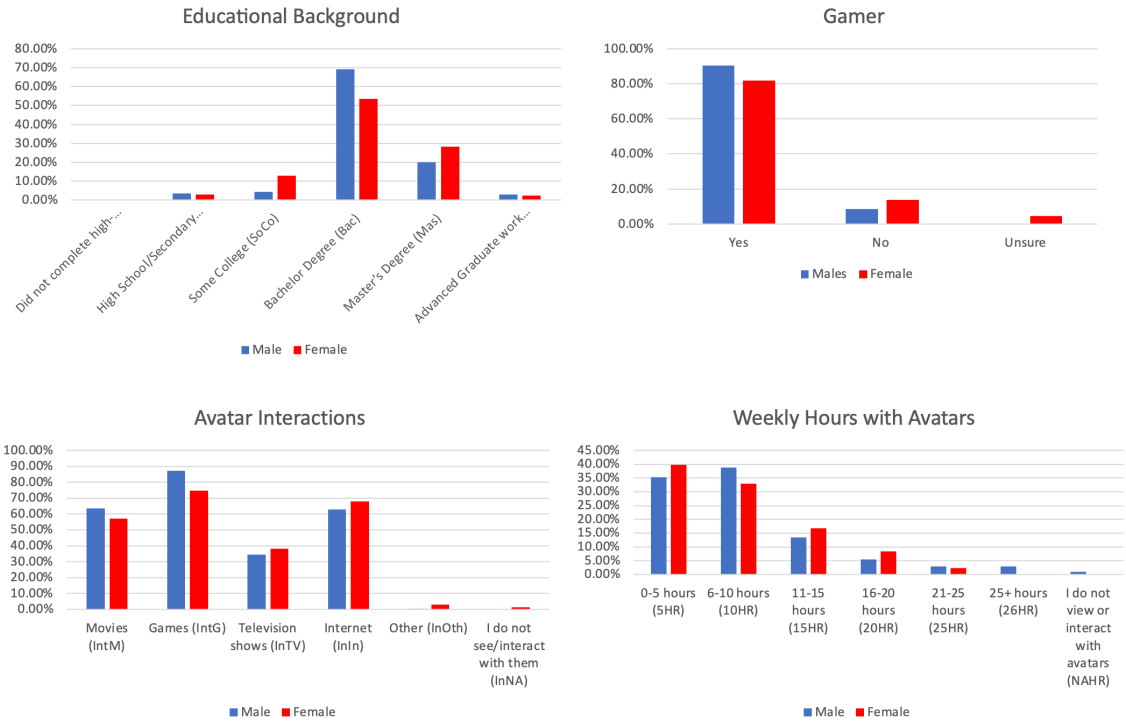


Figure 1: Comparison of Male and Female responses to demographic questions

Table 5: Male and Female Results for the six dimensions of UTAUT

Dimension	Male (n=201)		Female (n=131)		Mann Whitney U (two-tailed)
	M	SD	M	SD	
Performance Expectancy	5.61	1.11	5.44	1.15	$U(PE_{male}, PE_{female}) = 1208$, $z=2.42$, $p=0.02$*
Effort Expectancy	5.81	1.06	5.60	1.14	$U(EE_{male}, EE_{female}) = 603$, $z=2.83$, $p=0.01$*
Social Influence	5.50	1.15	5.26	1.28	$U(SI_{male}, SI_{female}) = 804$, $z=3.31$, $p<0.001$*
Facilitating Conditions	5.73	1.06	5.54	1.19	$U(FC_{male}, FC_{female}) = 804$, $z=2.36$, $p=0.02$*
Hedonic Motivations	5.89	1.02	5.60	1.17	$U(HM_{male}, HM_{female}) = 603$, $z=3.81$, $p<0.001$*
Behavioural Intentions	5.73	1.08	5.37	1.22	$U(BI_{male}, BI_{emale}) = 603$, $z=4.45$, $p<0.001$*

Table 6: Spearman correlations for Male and Female Behavioural Intentions and other dimensions of UTAUT

Dimension	Male (n=201)		Female (n=131)	
	Spearmans r	p	Spearmans r	P
Performance Expectancy	0.64	< .00001	0.70	p <.00001*
Effort Expectancy	0.68	< .00001	0.54	p < .00001*
Social Influence	0.58	< .00001	0.63	p < .00001*
Facilitating Conditions	0.72	< .00001	0.68	p < .00001*
Hedonic Motivations	0.67	< .00001	0.78	p < .00001*

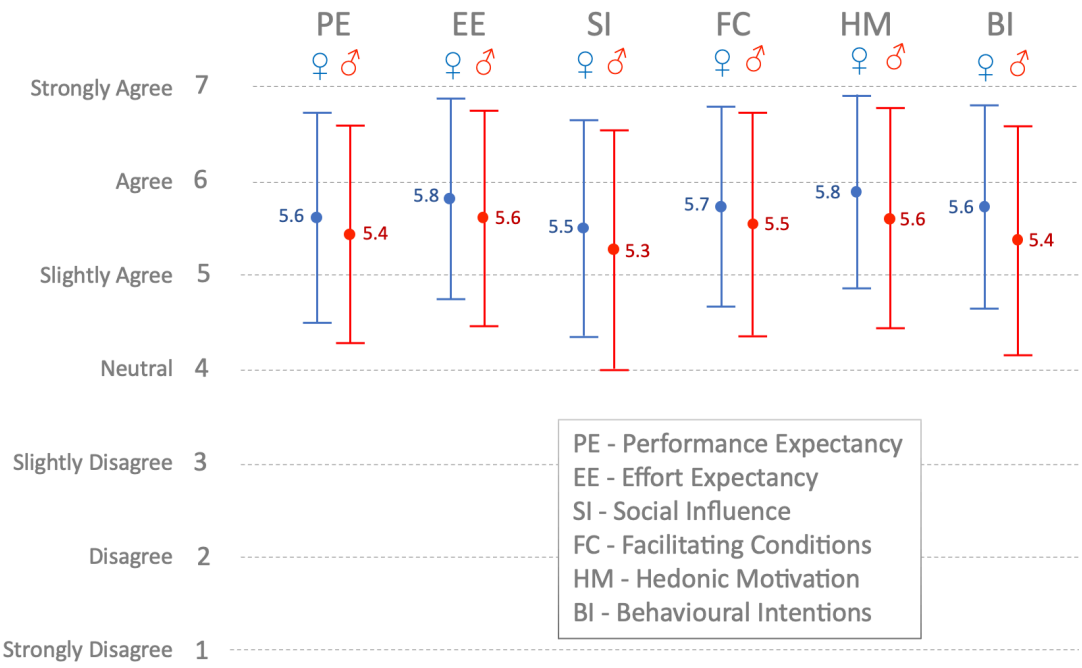


Figure 2: Comparison of Male and Female scores on each dimension of the UTAUT survey.

5.3 Ranking Results

To compare overall rankings, we used a weighting mechanism, assigning a weight of 10 for each first ranking, 9 for each second ranking, continuing in this way to assign a weight of 1 for a last ranking of any avatar. We then calculated a weighted ranking for each of the 10 avatars based on rankings for each participant in the male and female groups. The order of each avatar for both male and female groups are shown in Table 7. Note that the top three and bottom three ranked avatars are very similar for both male and female participants. The most variation occurs around "F1 - Rose" avatar which is ranked 3 places higher by males compared to females. All the other avatars in this middle group are within 2 places in the list. Due to the complexity of interpreting these ranking lists, no statistical tests were used to check for the significance of these rankings.

Table 7: Overall ranking of avatars from highest (1) to lowest (10), as ordered by male and female participants

Avatar Ranking Male Participants	Avatar Ranking Female Participants	Avatar ID	Avatar Fidelity	Avatar Gender
1	1	F2 - Emily	High – 2	Female
2	3	F3 - Ilana	Mid – 3	Female
3	2	F4 - Liliwen	Low – 4	Female
4	6	M2 - Ira	High – 2	Male
5	8	F1 - Rose	Real - 1	Female
6	4	F5 - Bailie	Low – 4	Female
7	5	M4 - Macaw	Low – 4	Male
8	7	M1 - Rycroft	Real - 1	Male
9	9	M5 - Leo	Low – 4	Male
10	10	M3 - Victor	Mid – 3	Male

Participants also assigned a preferred subject area (Mathematics, English, History, Science, Art and Computing) for each of the ten avatars. We collated the results to examine the distribution of subject selections for each avatar, again separating the data into male and female groups. Because of the unequal male and female group sizes the results are presented using percentages in Table 8 and Table 9. A summary of the percentage variations between male and female participants in the way they allocated subjects to avatars is included in these tables. All individual variations greater than 5% for a subject and overall variations greater than 25% for the avatar are shown shaded in Table 8 and Table 9. Table 10 shows the top and bottom ranked avatars for each subject, as selected overall and by the male and female groups. The appendix contains further analysis of subject rankings for female avatars (Appendix B) and male avatars (Appendix C).

Table 8: Male and female participant rankings of the five female avatars (F1, F2, F3, F4, F5)

Avatar	F1 - Rose Rankings %		F2 - Emily Rankings %		F3 - Ilana Rankings %		F4 - Liliwen Rankings %		F5 - Baillie Rankings %	
	M	F	M	F	M	F	M	F	M	F
Mathematics	8%	8%	10%	11%	8%	9%	5%	3%	8%	11%
English	21%	21%	30%	29%	22%	15%	14%	11%	17%	12%
History	23%	25%	13%	12%	12%	16%	18%	18%	13%	15%
Science	23%	21%	18%	19%	26%	21%	18%	27%	21%	21%
Art	15%	18%	20%	23%	18%	25%	25%	24%	21%	18%
Computing	9%	5%	8%	5%	13%	15%	19%	18%	18%	21%
Variation	12.2%		9.4%		25.3%		16.6%		16.6%	

Table 9: Male and female participant rankings of the five male avatars (M1, M2, M3, M4, M5)

Avatar	M1 - Rycroft Rankings %		M2 - Ira Rankings %		M3 - Victor Rankings %		M4 - Macaw Rankings %		M5 - Leo Rankings %	
	M	F	M	F	M	F	M	F	M	F
Mathematics	12%	8%	14%	13%	13%	11%	12%	13%	14%	9%
English	16%	21%	14%	11%	8%	10%	12%	11%	10%	13%
History	22%	20%	24%	21%	23%	27%	19%	23%	23%	20%
Science	19%	22%	20%	26%	24%	26%	21%	16%	21%	29%
Art	16%	21%	20%	14%	18%	14%	15%	15%	22%	16%
Computing	15%	8%	7%	15%	12%	13%	20%	21%	10%	13%
Variation	26.8%		26.2%		13.8%		11.7%		27.4%	

Table 10: Top and Bottom ranked avatars for each subject, as selected overall, and by male and female participants

Subject	Top Ranked Avatars			Bottom Ranked Avatars		
	Male	Female	Overall	Male	Female	Overall
Mathematics	**M2**, M5	**M2**, M4	M2	**F4**	**F4**	F4
English	**F2**	**F2**	F2	**M3**	**M3**	M3
History	M2	M3	M3	F3	F2	F2
Science	F3	M5	M3	F2, F4	M4	F2
Art	F4	F3	F4	F4	M2, M3	M4
Computing	M4	F5, M5	M4	M2	F1, F2	F1

5.4 Open Question Results

The responses for the four open questions have been collated into tables A1, A2, A3, A4 in the Appendix. For all four questions there was not a noticeable difference between the type of responses made by male and female respondents with common themes emerging from both groups, regardless of gender.

For the first open question, "What do you see as the possible advantages of using avatars for educational purposes?" (See Table A1), the advantages of avatars fall into related categories. Both genders highlight the possibility of avatars providing more fun and engagement for students, with the potential for providing greater versatility, repeatability and structure to lessons. It is noted that lessons might be more adaptive for individual needs and that avatars may provide a less threatening and more approachable teacher for some students. Potential costs saving from repeated use of technology is also highlighted.

For the second open question, "What do you see as the possible issues, or problems, of using avatars for education?" (See Table A2) again both genders respond in similar ways, highlighting issues directly related to technology, such as the cost, training needs and potential disparity between student groups. Educational impacts include a potential for less responsive, less adaptive, non-human feedback from poor quality interaction with avatars. A number of potential social issues are also recognized in student-teacher and student-student interactions are replaced by poorer quality student-avatar interaction. There are also some potential management issues in terms of teachers being replaced by machines and additional curriculum requirements not being well-integrated.

For the third open question, "Do you see any potential advantages of using game technology for educational purposes?" (See Table A3) Both gender groups highlight a number of potential benefits to be gained from using game technology for education. These include improved engagement and fun for students as well as educational benefits such as improved versatility and individual support for student learning. Respondents also highlight the common move to use this type of technology and the benefit of integrating computer technology as much as possible into the classroom to familiarize students with its use.

For the fourth open question, "Do you see any potential issues, or problems, of using game technology for education?" (See Table A4). Both gender groups highlight a number of technology difficulties as well as potential behavioural impacts and issues that may reduce educational outcomes. Section 6.3 of the following discussion section includes further analysis of the responses to these open questions by using a SWOT analysis related to examine the uptake of game technology and of avatars in education.

6 Discussion

This study was designed to look at potential gender differences in the general uptake of educational games and the more specific use of avatars in various educational roles. The results from the UTUAT survey, avatar ranking process and open survey questions are discussed below.

6.1 Gender Differences in the Acceptance of Educational Games

The overall scores for both males (M=5.72, SD=1.08) and females (M=5.47, SD=1.21) for the combined dimensions of the UTAUT survey were positive. Despite this general positivity, there was a significant difference found between males and females scores across all the UTAUT factors that support adoption (Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivations) and also the intention to use educational games. In all cases female scores were lower, suggesting that there is a less intent by females for educational games.

The reason for this difference in the acceptance of educational games is not clear. All the UTAUT acceptance factors dimensions are significantly correlated with the Behavioural Intention to adopt educational games. The largest gender variation in the strength of these results is for the correlation between Effort Expectancy and Behavioural Intention (Male r_s = 0.68, Female r_s=0.54) and the correlation between Hedonic Motivation and Behavioural Intention (Male r_s = 0.67, Female r_s=0.78). This suggests that the intention to use educational games for the female group is less aligned to the amount of effort required as it to the fun to be gained while playing. For the male group, both of these factors are equally important.

Some other demographic differences can be observed between the male and female groups, with a higher percentage of males identifying as "gamers" and the amount of weekly time they spend on games. so further work needs to be done to identify more accurately the cause for these differences and how it might impact on acceptance rates of educational games between genders.

6.2 Gender Differences in Avatar Ranking

Participants in the survey first performed an overall ranking of the 5 male and 5 female avatars, which all varied in fidelity. In this task males and female participants tended to rank avatars in a very similar way, selecting the same three top avatars and the same three bottom avatars. The top three avatars were all female, while the bottom three ranked avatars were all male. There was no observed pattern in fidelity, with a mix of high, medium and low fidelity avatars occurring in both the top and bottom ranked groups. The most variation in male and female rankings occurred for the realistic female avatar (F1-Rose), with male participants ranking this avatar more highly than females.

As discussed in Section2, avatar preferences can be complex and influenced by a number of factors, including self-similarity, attractiveness and cultural appropriateness. All of these factors might explain the outcome seen in these results. These factors were not well-controlled in the survey, which could be extended to include a broader range of demographic factors. The ranking process itself might be improved by using pair-wise ranking of the avatars.

Participants also selected the most appropriate subject area (Mathematics, English, History, Science, Art, Computing) for each of the 10 avatars. Male and female participants were in agreement on the most suitable avatar for Mathematics (M2-) and English (F2) as well as the least appropriate avatar for Mathematics (F4) and English (M3). However other results were more mixed as shown in Table 10.

There is more overall variation in how males and female participants select topics for the male avatars, with three of the avatars (M1, M2, M5) varying by over 25%. In comparison, for female avatars, for males there is only one avatar (F3) where male and female rankings vary by 25% (F3). All the other female avatars (F1, F2, F3, F4) show a similar pattern of distribution to subject areas. By contrast only the two male avatars (M3, M4) are allocated to subjects in a similar way by the male and female participants. Some caution needs to be taken in assessing these rankings as the survey was only designed to explore for possible differences. These patterns should be validated more carefully using a larger range of avatars and more targeted design that includes pair-wise comparison of avatars in each role. However, in general there is good evidence for differences in how males and females select avatars for some subject areas, and also what gender of avatar was selected for subjects such as Mathematics and Computing (male avatars) and Art (female avatars).

As previously discussed, sex is a defining characteristic that is an unavoidable stereotypical marker of an individual, with each sex carrying their own assumptions and stereotypes for expected behaviours. Therefore, it is perhaps not surprising that gender differences might be present in avatar ranking. Although, the reasons for the choices may be complex with many possible factors influencing the outcomes, this study identifies further work required to better understand the reasons for these differences.

6.3 SWOT Analysis of Open Responses

From the responses received in the extended response questions section a SWOT analysis was performed and these results are summarised in Table 11. participants provided various points of interests on how Serious Games and more specifically how avatars are well equipped to assist with improving user engagement and their learning efficiency. A common supporting theme was the familiarity most students would have with game technology. In the modern era a large portion of students are considered gamers and are familiar with most game controls, mechanics, and differences in technology. The use of serious games and avatars are not limited to just students, but teachers who undergo training and assessments in a virtual environment could benefit from this approach as well. In these scenarios' teachers could be placed in a lifelike serious game where she must "teach" a virtual class of student avatars while managing behaviour, disengagement, and mastering strategies that may improve student critical thinking levels.

There were also several points in the responses that were noted with the improvement on societal issues that may affect both students and teachers when using avatars and serious games. The first two topics were based on individual users more so than on a community basis. One of which was the use of avatars and serious games to help shy or anxious users learn which may be harder for them in a normal classroom setting. Avatars can be used in place of students or teachers to simulate a classroom setting while helping calm the user's anxiety resulting in an increased work ethic and desire to learn.

Another strength of using avatars is the ability to adapt to a student's ethnicity or culture. Some students may feel a lack of representation for their beliefs or background which can lead to a cultural degradation and students feeling out of place. However, with the use of specially designed avatars for those ethnicities and races users could feel more welcomed and potentially increase their learning outcomes. Another strength identified theme was with the use of serious games, to help bridge learning gaps that may be present between regional and metropolitan schools. With the introduction of specific

serious games into the curriculum students could experience the same learning and achieve the same learning goals as other users in completely different areas regardless of the facilities that larger schools may have access to. This could help bridge the gap between students who live in disadvantaged areas who may not be able to receive the opportunities as others.

Table 11: SWOT Analysis examining the use of games and avatars for education

Strengths	Weaknesses
• Modern students are familiar with game technology (game controls, mechanics, etc) - so easy to use. • Good game design supports engagement (cognitive, affective and behavioural) of students. • Provides an additional way to support student learning. • Games can be adaptive to student ability and support one-to-one instructions and repeatable lessons. • Provide an interaction model that supports shy and socially distanced students. • Provide better equality in education for geographically distanced students. • Provide ethnically and culturally sensitive instruction for all students. • These technologies support a broad range of educational opportunities across many subject areas.	• Adding additional responsibilities and integration requirements to already busy teachers managing a complex syllabus. • Creating further technology gaps between students because of the technology cost and availability issues (both at school and home). • The technology needs to be well designed and lessons carefully integrated or the technology may be less engaging or even just a source of student distraction. • More technology may mean more bugs • Traditional teacher feedback can be carefully tailored to suit student requirements and poorly designed games/avatars may not support individual needs. • There are a number of social skills and interactions that are supported in traditional education that may not be supported in digital lessons.
Opportunities	**Threats**
• Simulation style games could be used to add realism for education (science history, etc.). • Teachers could also interact with virtual students to help their own training. • Research and development into more interactive human avatars to support adaptability and engagement. • Increased teacher involvement in the design and integration of serious games into the syllabus to ensure they provide the best educational value and are complementary to other lessons. • Students become better prepared for the digital future	• The costs of professional educational games may be too prohibitive. • Political pressures that associate game technology with time-wasting and low educational value may be bias against adoption of games in education. • Social engagement (with other students and teachers) that is present in face-to-face class's skills may be more engaging than more computer time - games may become more like homework than entertainment. • Increased computer time may be associated with poor mental or physical health for students.

Participants also noted areas that avatars and serious games could negatively impact on education. One issue was the impact this might have on teachers. With the introduction of this new technology,

teachers would need to be trained to correctly use the technology, manage it and also integrate it into the curriculum which could be costly in terms of time and money. Reliance on technology for education could even lead to potential loss of jobs and lower pay for teachers resulting in a lower interest in the future for people to become teachers. However, this financial issue is not just limited to each school and the potential impact it has on the teachers, but it extends to the users and anyone they rely on financially. A major part of schooling involves homework and at home assessments which, with current teaching methods, is easily managed from a financial perspective due to the lower cost. However, if serious games are used, the users will require an electronic device such as phone, laptop or for higher performing applications such as a high spec desktop computer. This can take a significant toll on families that struggle financially and increases the gap between high socio-economic areas and low socio-economic areas even further than what they are now.

The introduction of this technology could also cause stress in relation to bugs, internet issues and hardware problems that could hinder the user's learning efficiency and lower their engagement levels resulting in the complete rejection of this type of learning. These issues would not only be limited to the user but the individuals who are supervising the lesson could take on negative feedback from the participants if there are no countermeasures to fix these problems.

Avatars may need to be carefully designed, not only in terms of subject areas or user ethnicity and race but with avatar animations as well. For a more engaging lesson avatar animations can be used when they are talking and moving around a scenario, but poorly animated avatars can create an unwelcoming environment for users resulting in higher disengagement levels and lower learning efficiency. Traditional teaching relies on significant teacher knowledge and experience to adapt lessons and feedback at both a class and individual level and even with significant improvements in the artificial intelligence used in games and avatars this level of adaption may not be possible.

Though many of the issues stated above seem difficult to manage in the moment, they could be avoided if in the development process of the avatars and serious games they used professional equipment to design humanlike avatars and professional feedback to cover the learning goals that would be required in a serious game. There are a number of opportunities identified and this may be good areas for further research or investment.

In the development of avatars, there are several ways that animations are made. The cheapest method is with keyframe animations where they run several pictures frame by frame with added sound effects over the top to create speaking avatars. However, this can sometimes be poorly executed and can look robot like creating an uncanny valley affect. A way to combat this would be through motion capture animation. This creates life like animations through videoing human faces when they speak or move and copying their movements over to an avatar that replicates those movements. With the use of this technology avatars could be made more life-like and avoid the potential affects the uncanny valley could have on some people.

To address some of the issues regarding learning outcomes that are provided in educational games suggest teachers need to be engaged in the development of the game, allowing developers to apply their game design expertise that also provides a game which closely follows the subject syllabus. Thus, teachers could better oversee the learning goals that are included in the game which in turn makes it easier for teachers to integrate the technology into their lessons. There are also a number of opportunities to provide more social equality in education by using the technology to be free of cultural,

ethnic and other social biases. Good games could be adaptable for each student, supporting their learning approach and skill levels in a culturally appropriate way.

Participants also identified some threats to the adoption of games and avatars in education and these include political pressures, higher economic costs and the decrease education in crucial social skills. Political pressure, for example from a negative media viewpoint on the time-wasting nature of video games may delay or prevent the use of games in education. The cost of implementing this technology into schools may also be prohibitive On a small scale the inclusion of avatar and serious game-based learning would not be too costly however when this technology expands to schools across states, territories, and even whole countries the amount of money needed increases dramatically. This increased cost would be needed to cover the development of games that cover different curriculums as well as the development of contrasting avatars for a wide variety of subjects and avatars that are better suited for students of varying races and ethnicities. It should also be noted that there may be negative impacts on the user's health, both physically and mentally from too much use of computer technology. Likewise, an over reliance on technology might decrease students from learning important social skills that occur in traditional educational modes.

7 Conclusion

This exploratory study was designed to investigate differences in male and female acceptance of educational games and to examine differences in avatar preferences, including the cosmetic attribute of avatar gender. An online of 332 participants examined general acceptance of educational games using the UTAUT framework. We find both males (n=202) and females (n=131) rank performance expectancy, effort expectancy, social influence, facilitating conditions and hedonic motivation, along with their behavioural intention to use the technology favourably, although female rankings on all scales are significantly lower than male ratings. This suggests less confidence by females in adopting game technology for use in education. Participants also ranked a range of 5 male and 5 female avatars and how well they might be applied to various educational domains. In most cases the male and female participants rank avatars consistently although there are a few exceptions. Most evident is the way the female avatars and male avatars are ranked for use in educational games, indicating clear preferences by all users for how avatar gender is selected. These results confirm the importance of considering avatar gender when creating educational games.

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APPENDIX A - Participant Responses to Open Questions

Table A1 - Identified Advantages of Using Avatars for Education

Q1 What do you see as the possible advantages of using avatars for educational purposes?	
Male	Female
FUN / ENGAGEMENT 1 It could help make the experience more interactive, like you are in a virtual classroom with a teacher. 2 Interactive, unique, fun, and interesting. 3 It will be fun and enjoyable for the candidates. 4 Learning will be more fun, 5 Provide a change of pace from a real teaching environment and a real teacher. 6 It would be something different and sometimes a different element is needed to learn. 7 It would also add a fun element to things and would make it less boring. 8 If our favourite avatars are used for educational purposes, we can concentrate more compared to traditional educational modes. 9 Can understand easily and will be fun learning while seeing avatars and children can easily learn from it 10 It will be far better than the traditional studying method. 11 For game players it will be pleasant and direct connect to the subject since they used to it. 12 Students will give more attention on the character and the concepts. 13 Children like avatars. And if we use unique avatars for education purposes, it will make learning more interesting for children. **INDIVIDUALISE / ADAPTIVE** 1 They are like having your own personal teachers when you need them. 2 They don't have any form of bias. **NON-THREATENING** 1 Students will be more relaxed knowing the teacher is not a human. 2 Allow peer review for individuals who may have difficulty facilitating such communication on a face-to-face basis. 3 Allows individuals to communicate and express themselves in ways they may have been incapable of doing otherwise, thereby "enhancing their level of social connection and feelings of confidence"	**FUN / ENGAGEMENT** 1 Can provide friendly knowledgeable teachers. 2 Immersion of students in the virtual world enables them to learn better. 3 It's a familiar thing to kids 4 Some students might like the avatars because they like how they look and it makes learning feel more like playing a game. 5 It will help the players to customize as per their interest, and when people have their own avatars, they tend to be more inclined to play a lead role in the game. 6 One way to create a more realistic and engaging learning environment is the use of "avatars," i.e., asking students to create unique characters in order to investigate and experience real world scenarios from different points of view. 7 It would be great to have historical figures for teaching history and literary figures to teach English, etc. **INDIVIDUALISE / ADAPTIVE** 1 Ability to teach one on one. 2 Using avatars supports students' understanding of the fact that teachers, principals, parents, and children are individuals 3 Provide for adaptive learning, focusing on problem areas for each learner - For example, pushing those questions that a student has struggled with into higher rotation. **NON-THREATENING** 1 Provide ease of learning and children will have fun while learning which make them observe well and learn quickly 2 Such learning activities don't feel like work and students enjoy the learning process. 3 Better for shy kids and help avoid any bullying that goes on. Children will not feel embarrassed to ask a question. secondly students might feel more comfortable showing work to an avatar than a human teacher. 4 If it is created avatar - it could be good because a person does not feel judged but still have that personalized feeling.

4 I think avatars can become a close companion to students. It maybe smiling all the time to receive questions and answer them with patience. Treating students with respect.

5 Kids can feel at ease and assimilate better, supposing we got a class of only black kids, having a black avatar would be nice for instance. So it will not be tied to any racial issues.

6 Having a more neutral face and voice teaching you could prove more acceptable for most people, since we would be able to choose which face is more Satisfactory for each person.

REPEATABILITY / STRUCTURE

1 While doing experiments, practical knowledge that will help to improve the knowledge.

2 Makes the learner feel as if they are interacting in the real world. The avatar acts as a symbol for that.

3 Avatars convey the perception that you are interacting in real world situations. It is easy to view an avatar as an actual instructor.

COST and VERSATILITY

1 You could customize the lecture and learning experiences of many children without necessarily having to hire a lot of teachers.

2 Avatars can be used for teacher training. Instructional avatars could be used in a virtual classroom to train teachers-to-be by helping them master strategies like higher-level questioning or behaviour management.

3 Avatars could imitate different types of students to help teachers practice classroom management and learning to relate to their students. Could be used to help find solutions to particular problems arising in the classroom and underpin professional learning.

4 Can connect teacher with sources of information and networks of professional support.

REPEATABILITY / STRUCTURE

1 Machines are excellent at providing educational intervention, creating structure, reliability and promoting progression.

2 Lessons can be replayed over and over

COST and VERSATILITY

1 Cost savings as there are no teacher's salary to pay or health insurance

2 Can learn anywhere

3 Allow social distancing if required.

Table A2 - Identified Issues of Using Avatars for Education

Q2 What do you see as the possible issues, or problems, of using avatars for education?	
Male	Female
MANAGEMENT ISSUES 1 They could displace human teachers and depress their wages. There might also be issues with racial representation if it is not managed carefully. 2 Avatars would take the jobs of thousands of teachers around the globe, by being less expensive and having more information to give. 3 Teachers working too many roles at the same time. 4 Teachers may lose their job. **COST / TECHNOLOGY ISSUES** 1 Problems can be it is difficult for small schools to adopt to that and it may need more funds to purchase and apply avatars. 2 Some of the complex issues in the field of science education include the availability of appropriate textbooks and classroom resources; the preparation and training of science teachers. 3 Slow response time, occasional movements that seem robotic, displaying less emotion, less empathy and compassion 4 A lot of software needed. 5 Most of the students from lower-middle-class can't afford this. The parents won't support this because they don't know how this works. 6 Technical issues, user experience could have problems at times. 7 People having problems using software or the technology if they are unfamiliar with it. And then if you make it too easy for people like that, it becomes boring for people who are familiar with the tech. **EDUCATIONAL IMPACTS** 1 One of the hardest aspects of teaching is that you only have them for a short period of time to prepare them for the next level and this may reduce traditional class time. 2 Teaching aspiring teachers, in particular what it means to be a teacher, is complex. This may introduce further complexities into the classroom. 3 Spending too much time in front of computer applications may cause stress-related issues from childhood. 4 We may become overly reliant on technology to solve educational problems. 5 The avatar could have limited responses and may not be able to provide additional help as needed. 6 People might think that the avatar is only an algorithm that cannot understand my doubts like a human.	**MANAGEMENT ISSUES** 1 Requires additional Management and Training and teachers may become made accountable for more than they should. 2 Additional teaching activities leads to not enough time to plan and integrate lessons 3 Keeping up with the expectations of school admins. **COST / TECHNOLOGY ISSUES** 1 Cost money to provide additional technology in the classroom 2 Cost students/parents to provide technology at home 3 May leads to technology disparity between students. 4 One of the key challenges in online teaching is communicating without the help of body language. Misunderstandings, and student alienation can result. May not use language students will understand, be able to establish rapport. 5 The issue of glitches and people not taking the avatar seriously. **EDUCATIONAL IMPACTS** 1 Students may not find avatars as accessible as a traditional teacher. 2 The learner might not like the avatar and so not want to learn from him/her. 3 If the avatar is annoying or not liked by the student. 4 I think that if an avatar doesn't appear warm and friendly enough, it might make the concepts being taught harder for students to relate to and then they wouldn't get as much out of the game. 5 Feedback may be too general and not individualized for the student. 6 A student might get bored with the avatar if its role is not dynamic and realistic enough. For example, if the avatar just has generalized responses that don't always fit the situation. 7 May distracting students and waste time if content is not educational 8 Depends on the ability for avatar to ask and answer questions 9 They are not conscious and most likely will not be able to answer some of your questions **SOCIAL / RELATIONSHIP IMPACTS** 1 Less face time between students and teachers

7 Having students forget the purpose of the game is to act as a learning tool. 8 The problem of using avatars for education is children's can't able to interact with avatars easily and can't able to pause and play 9 The body and facial expressions of the avatars must be improved so that they can be of use to the participants. for example, to detect emotions. 10 Virtual learning isn't as effective as hands on experience. Being there in person is better than using an avatar. 11 It would be bugs, which could cause students to stress and end up discouraging, or bad programming that could be stressful, since it would not be as efficient to help students. 12 People selecting Weird Avatars that put off someone. 13 The avatar could be distracting and take the attention away from the lesson **SOCIAL /RELATIONSHIP IMPACTS** 1 May led to real time monitoring of the students and less privacy. 2 Having an avatar that doesn't relate to you. I could see that being an issue for some people. They need to concentrate more on that than the educational part of it. 3 An avatar cannot understand or identify the emotions of others. 4 Lack of empathy, and reduced learning of social skills by students not interacting 5 Some people may have trust issues and may not take it seriously when they see virtual avatar instead of an actual person's face. 6 Means losing contact with a human	2 May isolate students and lead to lack of teamwork, empathy, and support between students. 3 Not everyone has a computer to access these avatars, internet can be shoddy even in the best of circumstances, and avatars might lack the personalized help a teacher can give. 4 May impact on developing student-teacher relationship 5 The avatar appearing remote in many ways

Table A3 - Identified Advantages of Using Game Technology for Education

Q3 Do you see any potential advantages of using game technology for educational purposes?	
Male	Female
FUN / ENGAGEMENT 1 Using games in the classroom offers the following advantages: Student engagement. Classroom games encourage students to become more involved in the learning process and interact with other students. This type of engagement can help students understand new concepts or improve existing knowledge. 2 Games stimulates students to play together and compete. 3 Overall, gaming may create an educational future where teachers can recreate a more engaging and connected environment, and students may benefit by attending more exciting lessons. 4 Yes making education entertaining is a good way to motivate people to learn. Also using an interactive medium for learning will make the experience more engaging for the learner. 5 Games are the fever of the moment for young and old people, what makes learning more approachable. 6 It will be fun and enjoyable 7 Making use of video games in the classroom is simply another technique to engage with students. **EDUCATIONAL BENEFITS** 1 Instructional coaches use a virtual classroom to train teachers-to-be by helping them master strategies like higher-level questioning or behaviour management. 2 Teachers will be able to use platform built-in tools. 3 It will be far better than the traditional studying method. 4 Can help students refine communication skills by discussing games and this can improve relationships and student self-esteem. 5 Yes.it has the potential to interact with all the students in the class without having predetermined opinion about students in the class. It will surely help students to understand the basics 6 Students from age 10 up to university age will learn how to build, simulate and experiment, for example by setting up wind turbines and measuring their effect. 7 Increases a child's memory capacity, computer and simulation fluency., Helps with fast strategic thinking and problem-solving 8 It stimulates your imagination, and gets you more personally invested in the stakes- I know	**FUN / ENGAGEMENT** 1 Video games are an interactive entertainment. 2 Making use of video games in the classroom is simply another technique to engage with students. 3 Gaming stimulates students and children to play together. Many games require players to work together in teams to achieve goals or to compete against each other. In order to achieve that, students shall refine their communication skills: this will help them to establish better relationships and have high self-esteem. 4 Kids nowadays are very familiar with gaming so it seems like a natural progression to find a way to combine game technology and education. 5 Kids can be very motivated by games so perhaps this aspect would carry over into educational games if they were well-designed. 6 It is a medium that most students have grown up with and therefore and easy 7 Through videogames, kids may get interested in technology very soon in their life. 8 Overall, gaming may create an educational future where teachers can recreate a more engaging and connected environment, and students may benefit to develop critical skills by attending exciting lessons. 9 I think it can increase motivation to learn because winning at games, even educational games, provides a satisfying feeling and can activate the brain's reward centres. 10 I think it is a fun way to mix things up. 11 Games could make learning fun. Earning tangible rewards while learning will stimulate curiosity. 12 I feel like, learning as a game makes it more fun and makes it likely that you will remember. **EDUCATIONAL BENEFITS** 1 Improves coordination. Improves problem-solving skills. Enhances memory. Improves attention and concentration. It is a great source of learning. Improves the brain's speed. Enhances multitasking skills. Improves social skills. 2 Technology has the ability to enhance relationships between teachers and students. 3 It helps with hand-eye coordination. It improves problem-solving and strategic thinking. It expands memory capacity. 4 They promote intellectual skills that support academic achievement. In supplying students with educational subject matter, they demonstrated further advantage. The implementation of technology in schools helps close gaps between students.

	that in the case of children, it can be the only thing that will hold their attentions.	5	Gaming technology attracts young children to learn through gaming. It makes children play continuously and learn simultaneously.
9	It can change the outdated system in which we live and gives the young person the opportunity to learn in a more relaxed way.	6	Some people do learn better with visual aids and gaming would be a good way to help that kind of learner to learn
10	Specific application of gaming in education generates a lot of benefits in the learning process. Generally, educational video games and simulators teach many skills such as algebra, biology, computer programming and flight training. In particular, simulation games can develop the children's soft skills.	7	Many people learn in different ways, so have multiple avenues if learning would be beneficial.
11	They indeed may increase the children's sense of self-esteem and improve socialization skills, leadership skills and team building.	8	Educational games are really awesome and help students learn concept easily at any age, which leads to long term retention of the concepts.
12	Video games are an interactive entertainment. They promote intellectual skills that support academic achievement.	9	if you can incorporate games together the right amount, you can learn information while enjoying the game, hopefully making it stick more.
13	Digital learning is replacing traditional educational methods more and more each day. With how rapidly classrooms are changing, it is best to forget methods you may remember from when you were in school and start thinking about newer teaching and learning techniques based on digital learning tools and technologies.	10	Step to add education to the technology they are already using.

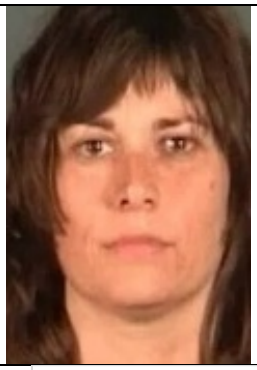
Table A4 - Identified issues of Using Game Technology for Education

Q4 Do you see any potential issues, or problems, of using game technology for education?	
Male	Female
TECHNOLOGY DIFFICULTIES 1 Older learners might have some issues with it if we're not into gaming. 2 Some of the issues that teachers can face relate to the technology itself. Others relate to student or parent expectations, or whether there's enough of the right professional development to help teachers become proficient in digital technology. 3 Most media portray games as dangerous and making you lose your time and violent, so most parents would be against having games and educational ways. 4 Many people have a hard type understanding the rules of the game 5 Somewhere in a school near you, a teacher is struggling to handle a query from a student whose laptop has a flat battery or another who's watching a funny cat video on a phone. Perhaps the wireless internet connection is dropping in and out, or the electronic whiteboard is playing up. 6 A certain amount of technology is needed and not everybody has it. 7 Hacking, cyberbullying may be problems to face. **BEHAVIOURAL IMPACTS** 1 It could be addictive, or an excuse to play more video games, rather than study. 2 You might develop an aversion to other forms of education. You might not learn core concepts properly. Too much dependency on technology. Might be bad for the eyes and brain. 3 It can cause a greater dependence on technology and end up motivating students not to do practical activities and this results in physical inactivity and lack of technical skills 4 See only fun and not learning. 5 Become overly dependent on technology for educational needs. 6 Students may use the absence of a physical teacher to their advantage. **EDUCATIONAL IMPACTS** 1 New study finds giving pupils access to laptops in the classroom has a negative effect. Giving school students access to iPads, laptops or e-books in the classroom appears to hurt their learning, new research has found. However, putting this technology in the hands of a teacher is associated with more positive results. 2 Getting too side-tracked with the game itself and not really wanting to learn anything	**TECHNOLOGY DIFFICULTIES** 1 It is difficult to make games fully accessible. 2 Combining engaging game design with learning objectives and curriculum. 3 Lack of alignment between technology, curriculum, and instruction. Lack of clarity about the purpose of 'school' 4 Creating a gaming atmosphere that is adapted to all the learners' ability. 5 Teachers need more professional development. 6 Technology can affect lesson time and flow. 7 Pace of change & cost. 8 Limited perceived effectiveness of technology. 9 It may be hard for some people to use if they are not good with computers 10 Some people may not want to put in the time if they feel like it is just a game and not actual learning. 11 Technology isn't perfect and does fail from time to time. 12 Introduced technology is not always preferred. 13 Differing device capabilities and instructions. 14 With all technology I think the issue is whether it works as it is supposed to. It could also be cost prohibitive. 15 Problems with the internet and hardware issues. 16 Some people might not enjoy educational video games as much as I would. **BEHAVIOURAL IMPACTS** 1 It can be a lot of screen time, and take a lot of resources, especially as technology changes quickly. 2 Overcoming the cultural barrier with faculty and parents 3 The purpose of the use of the technology has to be reinforced so that the students do not lose sight of what it is meant to do 4 Of course, sometimes, people start becoming addicted to games which leads to distraction and failure to focus on other things. So games should be designed and created in a way they are catchy, attractive and beautiful parallel to this they should not be addictive 5 Kids already spend too much time on "screens" and they probably won't consider the "learning game" as part of their "allowed screen time" so this will lead to more "screen time." 6 If students expect all learning situations to be like games then they will miss out on some really valuable lessons in life. 7 The issue is the children are not able to learn anymore and gaming may limit the knowledge children gain.

3 If all learning is reduced to a game that can be scored, it seems like the education received would not be very deep. 4 In order to deliver content as a game, faculty members tend to divide the syllabus into levels through which the students must progress, with students getting feedback rather than grades. In order for it to be effective, the game: must align with learning outcomes; should not be competitive in the conventional sense. Sometimes, in fact, the game might require students to work collaboratively in order to solve problems, while in other contexts, game mechanics might make students compete against one another in order to reach a personal best.	8 It's easy for students to be distracted. 9 Different social dynamics. **EDUCATIONAL IMPACTS** 1 Instant access to information has revolutionized how students learn today but hindered students' ability to write and communicate face to face, and almost half said it hurt critical thinking and their ability to do homework. 2 I think it might be harder to provide individualized solutions for students who are having trouble than a traditional human teacher would, so it can never entirely replace the human element in teaching. 3 Part of the educational process is the socialization that occurs in the educational setting. Students have to navigate interactions with teachers and with other students. Some students are already socially isolated and may become more isolated with gaming technology unless the kids somehow interact. 4 May become too dependent on games only for learning 5 A student may not like games, so I think that there should always be a choice of using games or not.

APPENDIX B - Subject Rankings - Female Avatars (F1,F2,F3,F4,F5)

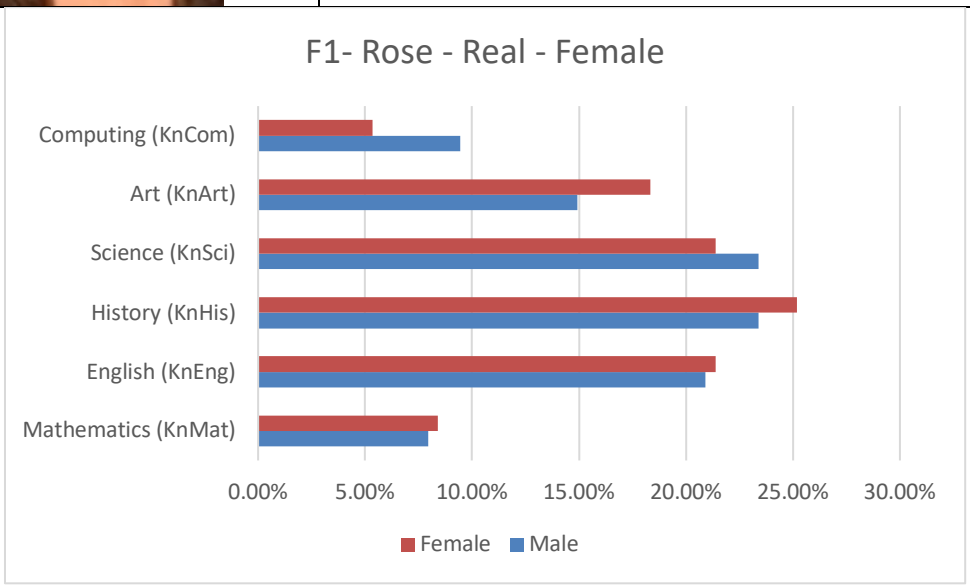
Figure B1: Ranking of F1 Avatar (Rose) by male and female participants



AVATAR: F1 - Rose

FIDELITY: Real - 1

GENDER: FEMALE



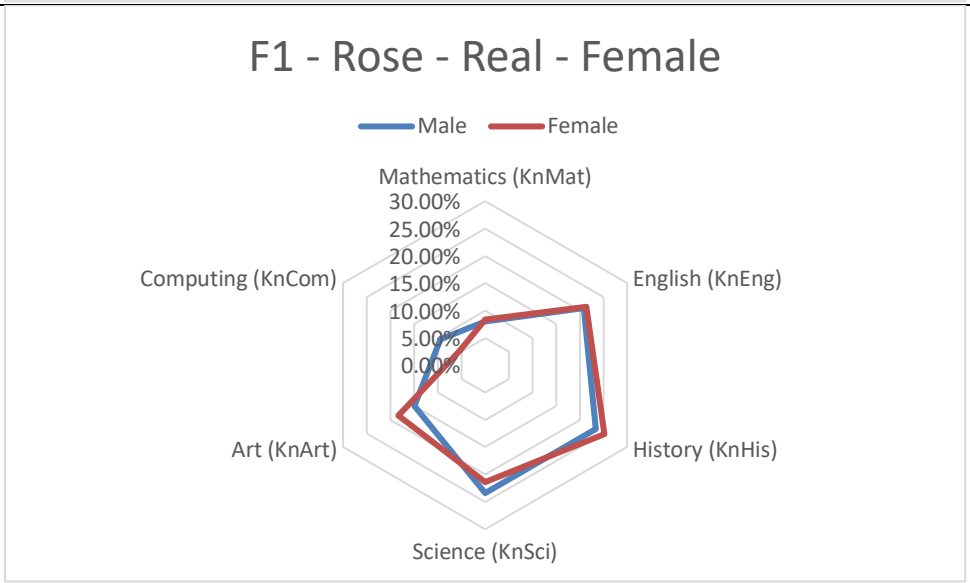
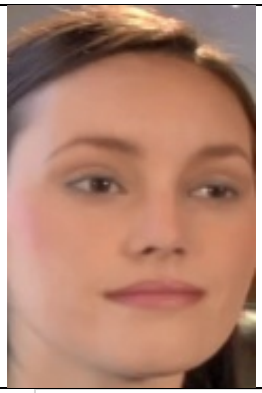


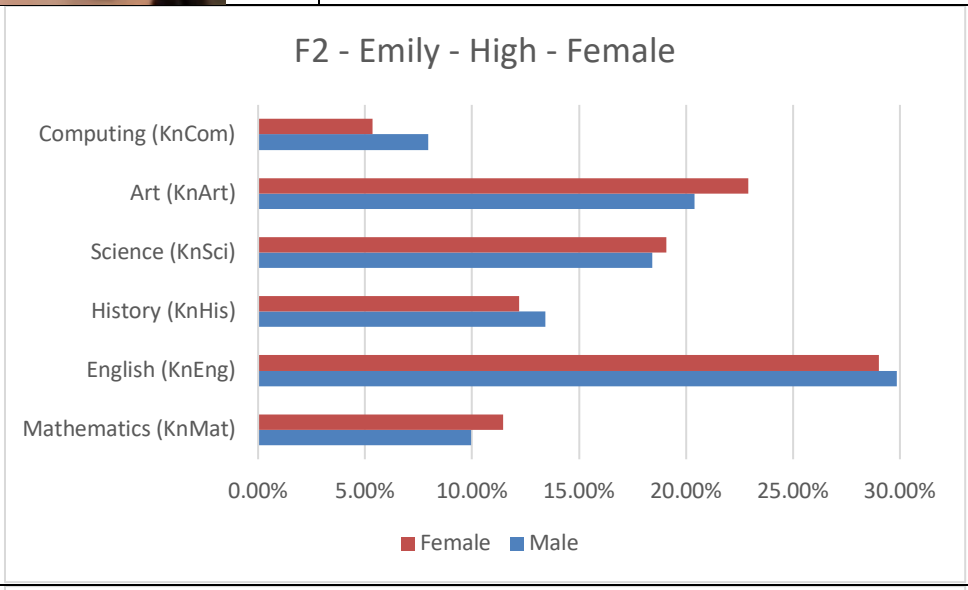
Figure B2: Ranking of F2 Avatar (Emily) by male and female participants



AVATAR: F2 - Emily

FIDELITY: High - 2

GENDER: FEMALE



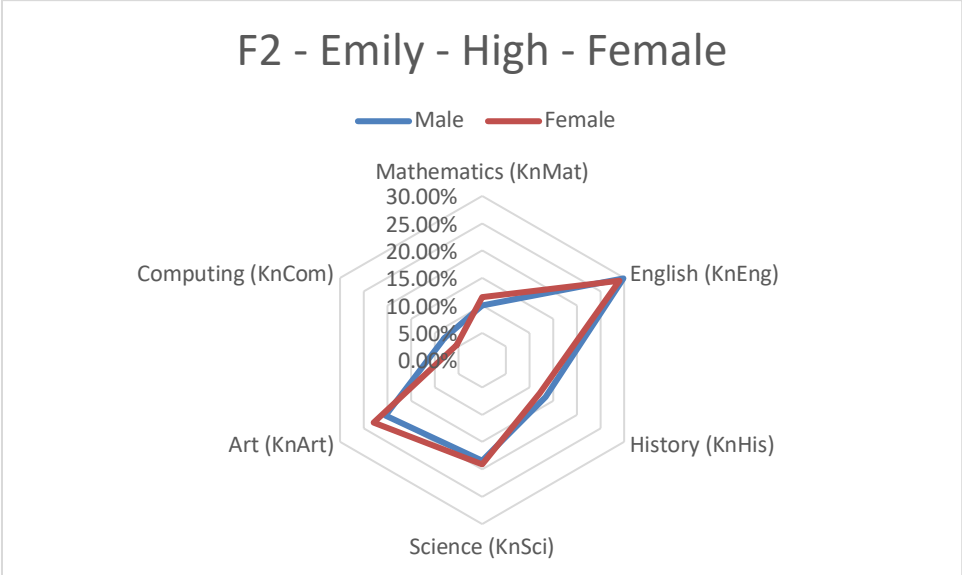
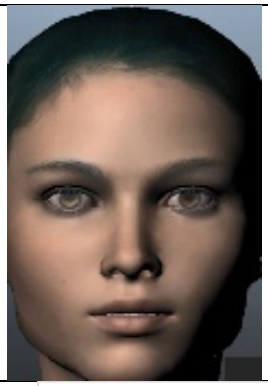


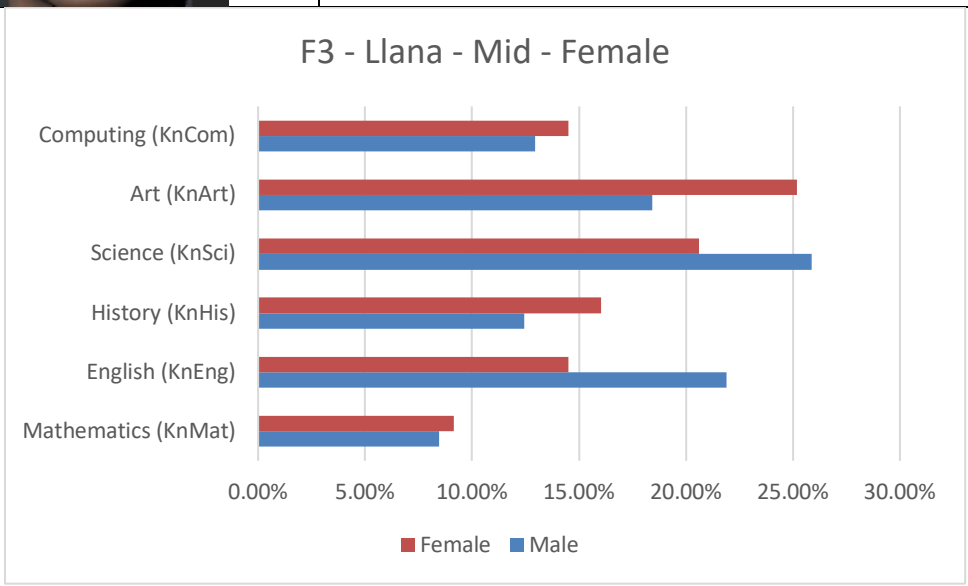
Figure B3: Ranking of F3 Avatar (Llana) by male and female participants



AVATAR: **F3 - Llana**

FIDELITY: **High - 2**

GENDER: **FEMALE**



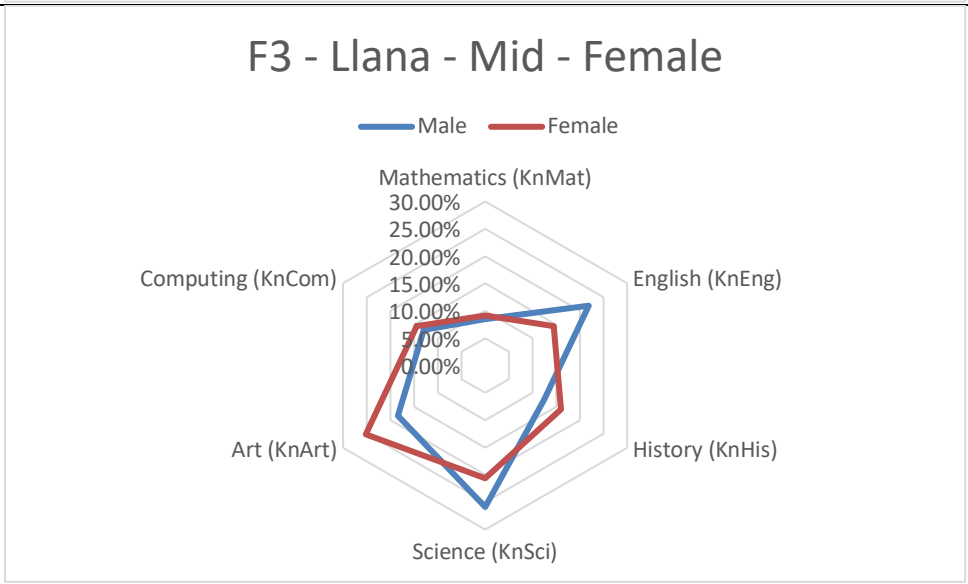
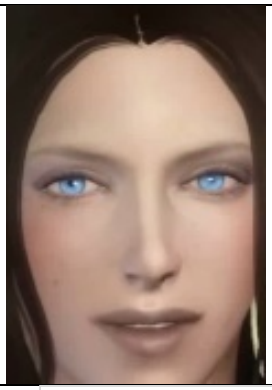


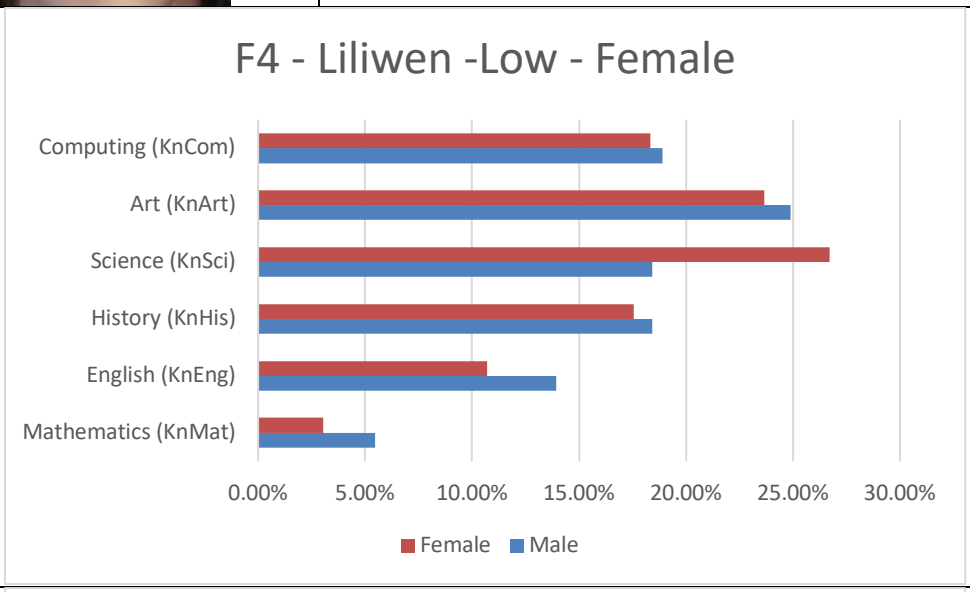
Figure B4: Ranking of F4 Avatar (Liliwen) by male and female participants



AVATAR: F4 - Liliwen

FIDELITY: Low - 4

GENDER: FEMALE



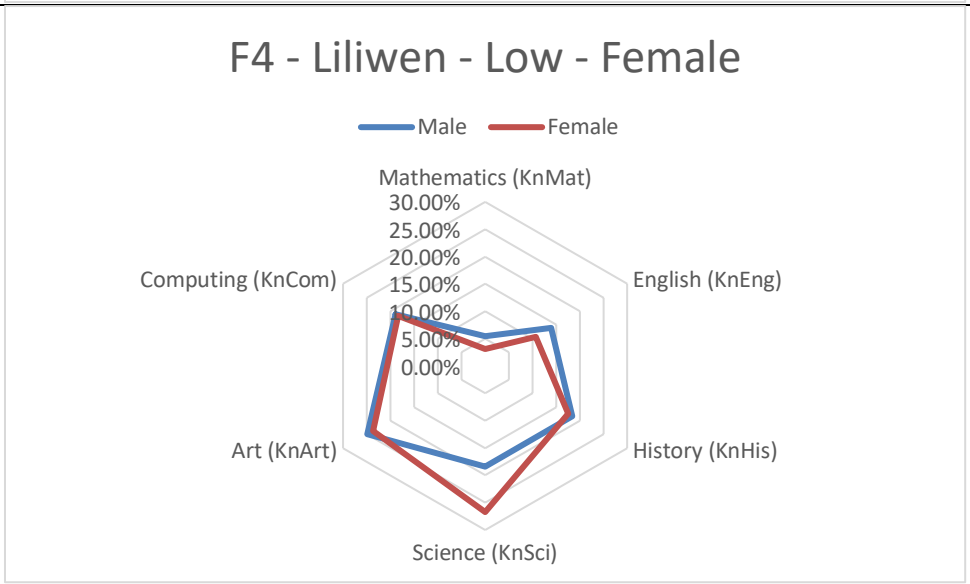
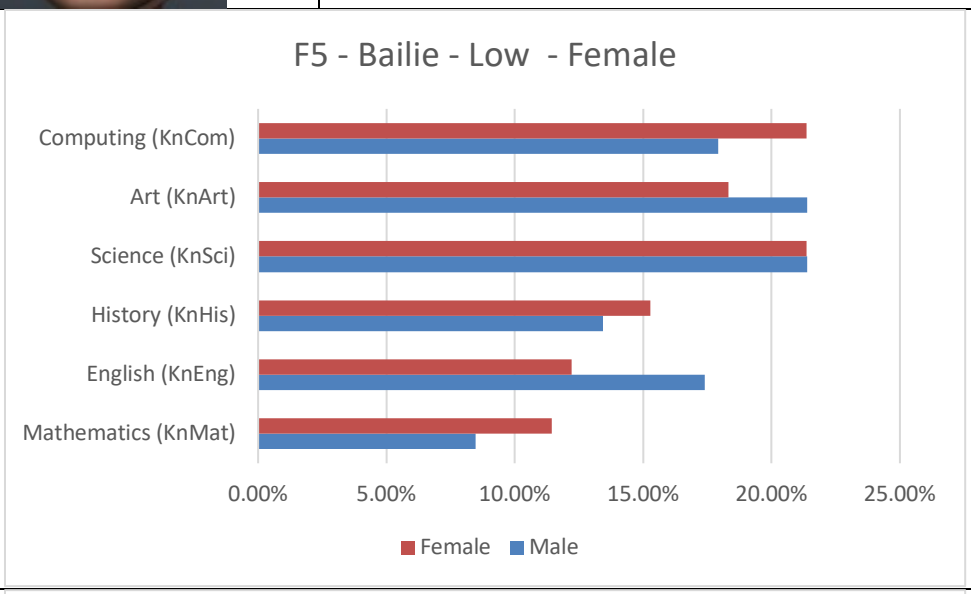


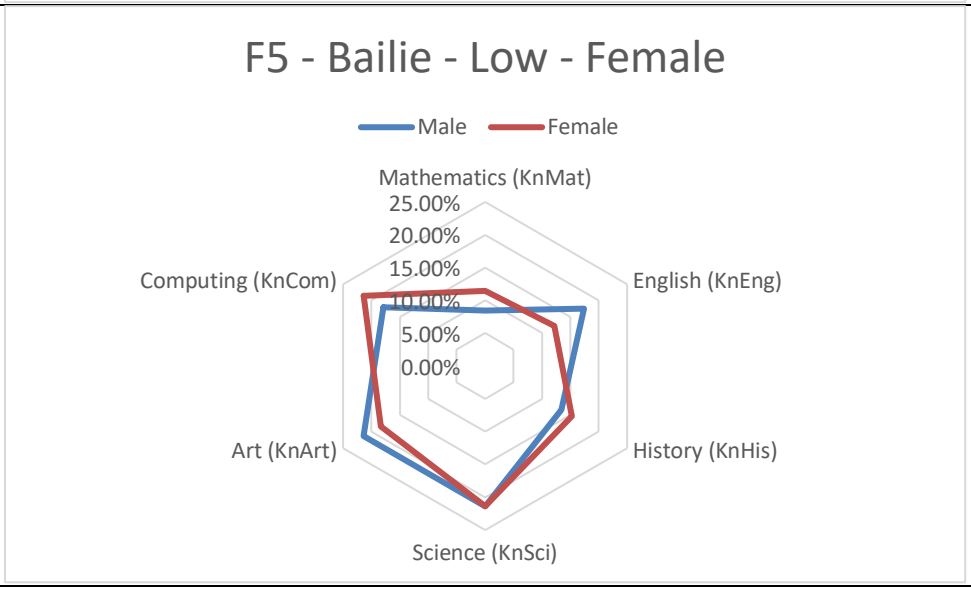
Figure B5: Ranking of F5 Avatar (Bailie) by male and female participants

AVATAR: **F5 - Bailie**

FIDELITY: **Low - 4**

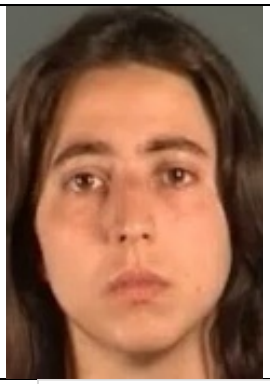
GENDER: **FEMALE**





APPENDIX C - Subject Rankings - Male Avatars (M1,M2,M3,M4,M5)

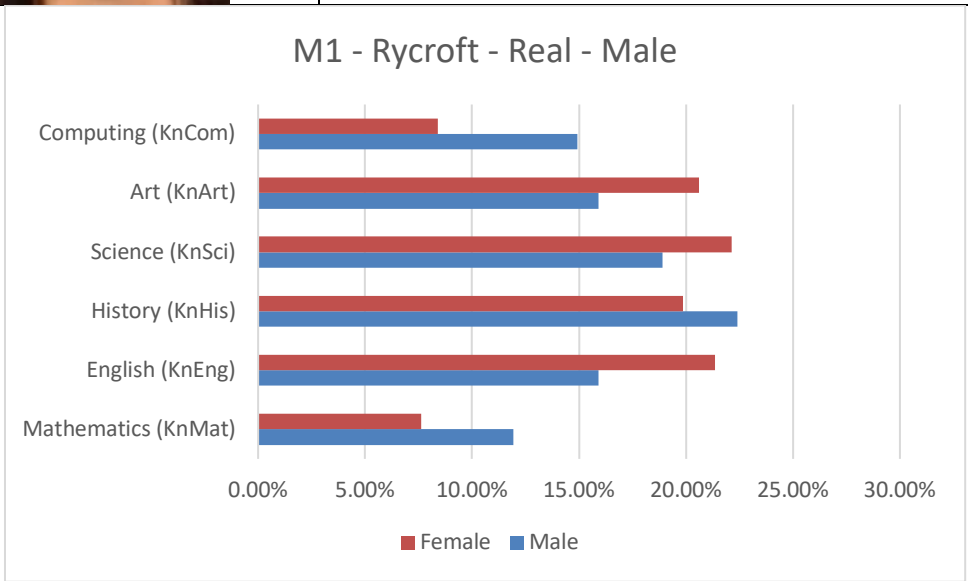
Figure C1: Ranking of M1 Avatar (Rycroft) by male and female participants



AVATAR: M1 - Rycroft

FIDELITY: Real - 1

GENDER: MALE



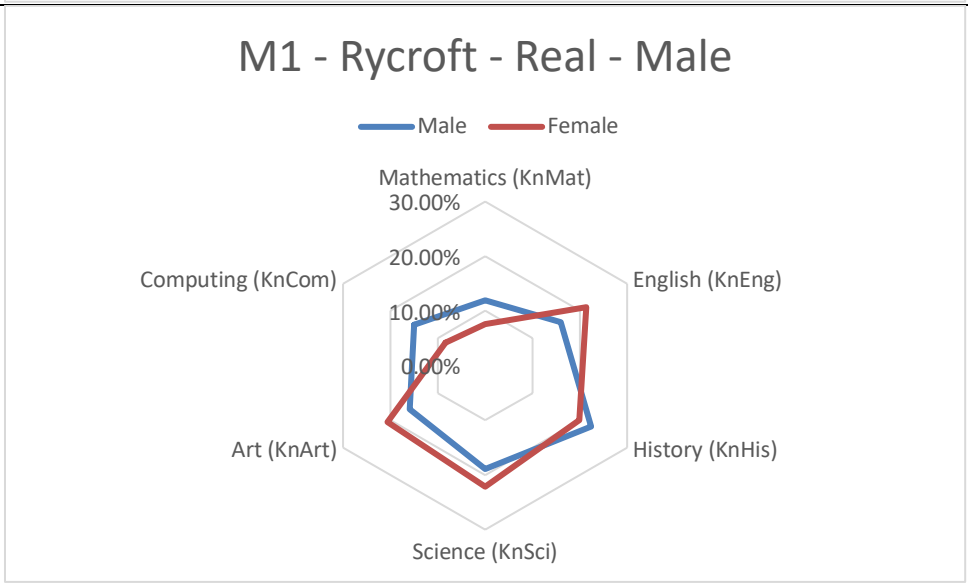
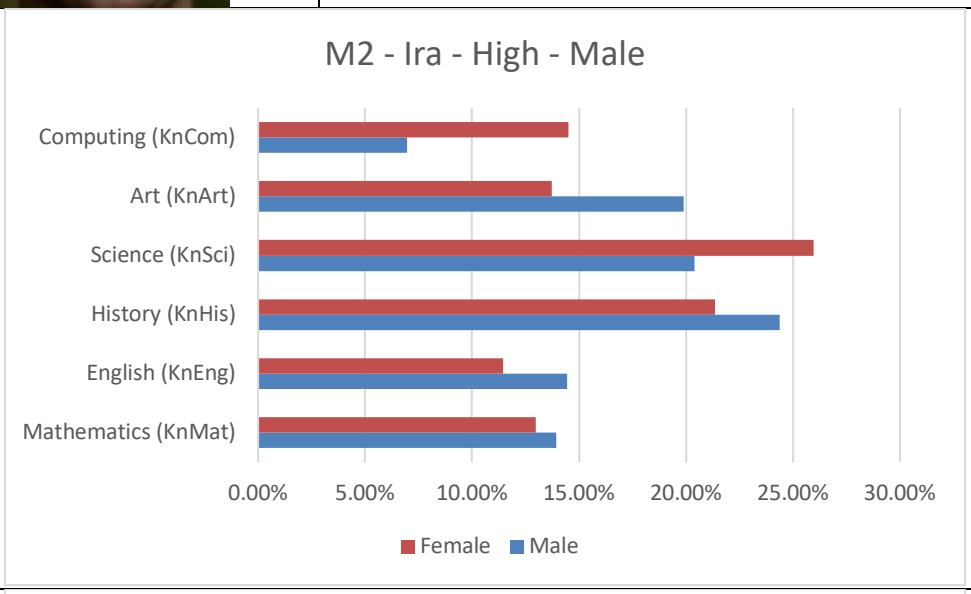


Figure C2: Ranking of M2 Avatar (Ira) by male and female participants

AVATAR: M2 - Ira

FIDELITY: High - 2

GENDER: MALE



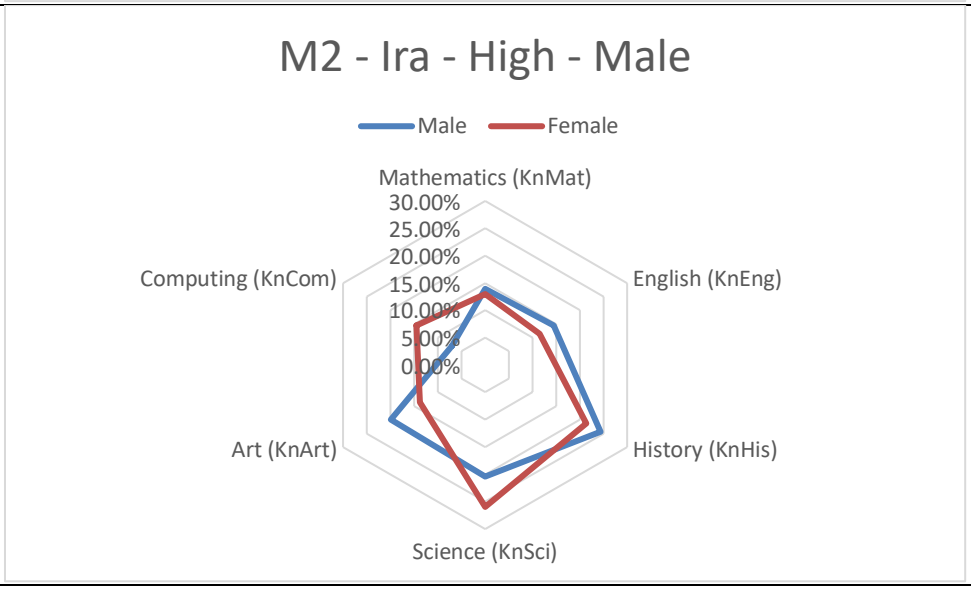
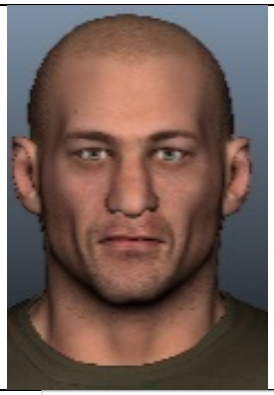


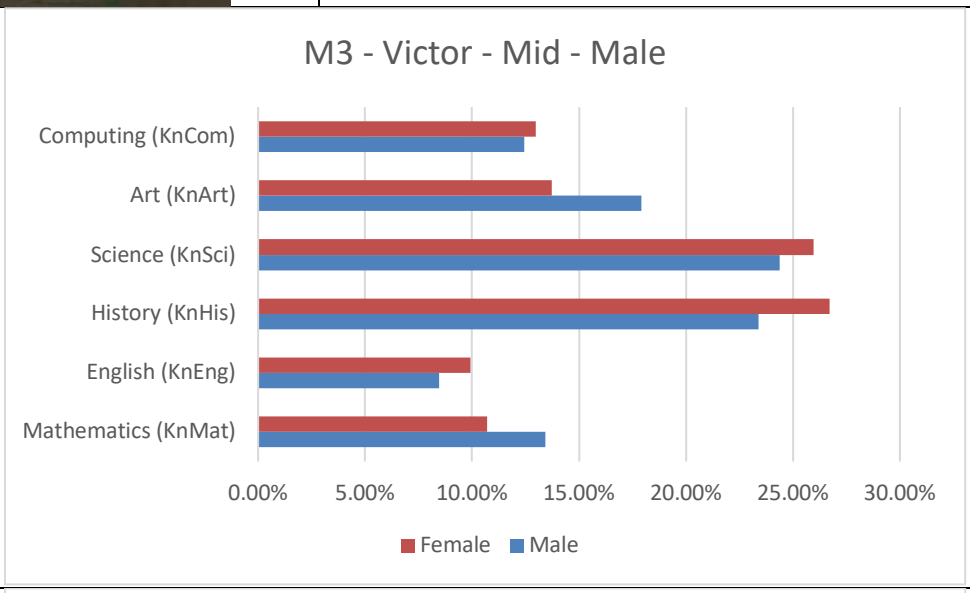
Figure C3: Ranking of M3 Avatar (Victor) by male and female participants



AVATAR: M3 - Victor

FIDELITY: Mid - 3

GENDER: MALE



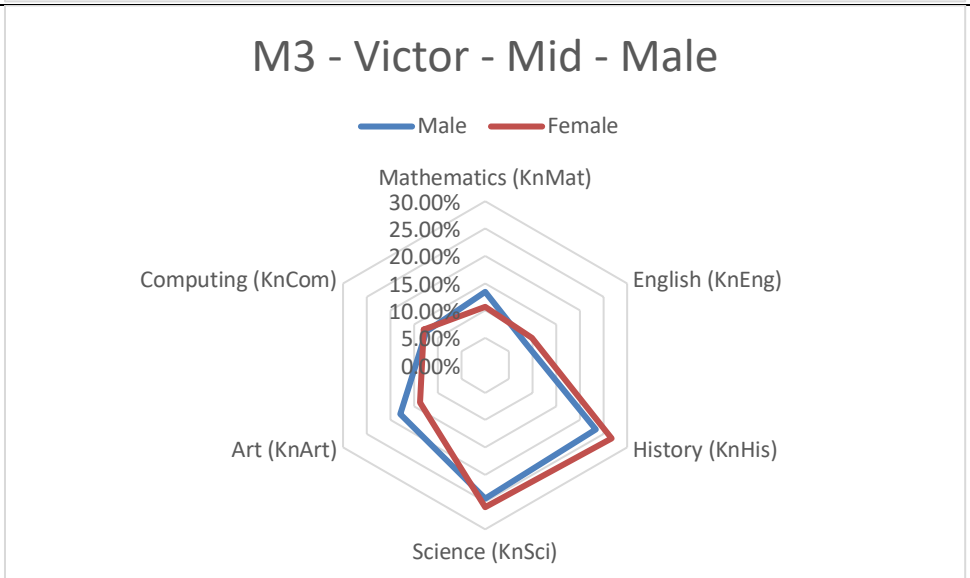
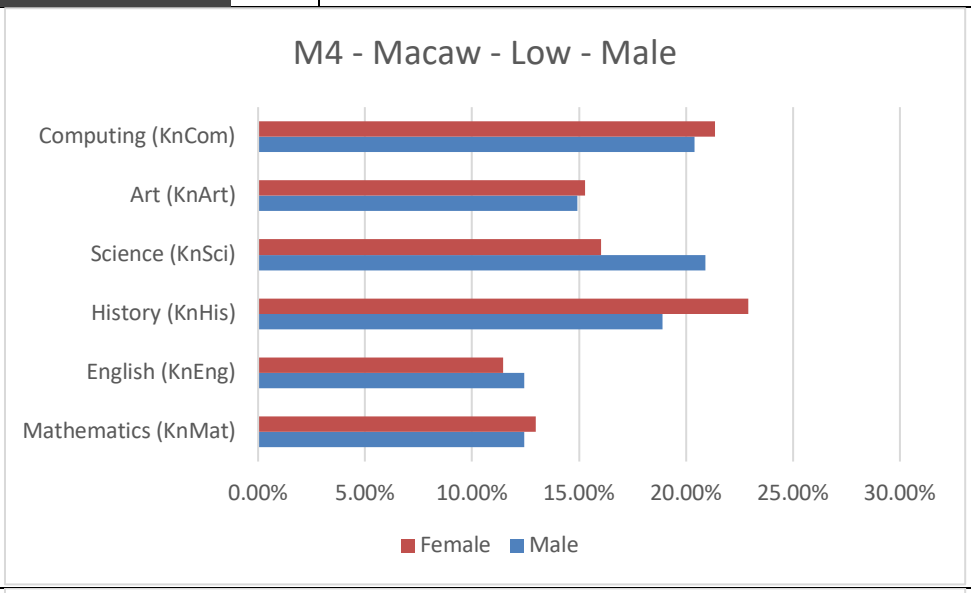


Figure C4: Ranking of M4 Avatar (Macaw) by male and female participants

AVATAR: **M4 - Macaw**

FIDELITY: **Low - 4**

GENDER: **MALE**



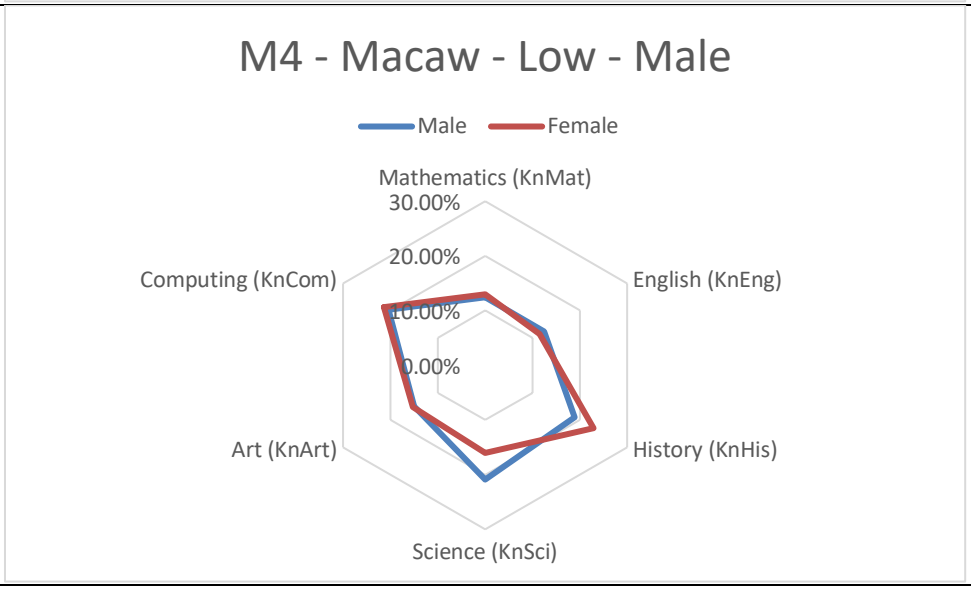


Figure C5: Ranking of M5 Avatar (Macaw) by male and female participants

AVATAR: M5 - Leo

FIDELITY: Low - 4

GENDER: MALE