An Investigation Of Digital Games Features That Appeal To Young Females And Males

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Abstract: This research is part of an attempt to address the well-known problem of female underrepresentation in computer science education and industry. This problem starts between ages 11 to 14 and gets progressively worse in what is often referred to as the "shrinking pipeline effect". There has been considerable research into the causes of the shrinking pipeline and attempts to halt or reverse it. In spite of this, the causes remain unclear and there is evidence that the problem may be worsening.

Digital games are increasingly used in education because of their ability to engage and motivate young learners. Unfortunately, digital games used in the teaching of IT and computer science have been found to appeal less to females than males. This is in spite of the fact that digital games intended for entertainment, as opposed to education, are now very popular with girls. There has been some research into this issue, however more is needed, especially into what game features do and do not appeal to girls at the age that the pipeline starts to shrink.

The study reported here aims to identify what characteristics of digital entertainment games appeal to young females and males. The results can be used to guide educators, researchers and game developers and provide criteria for evaluating the suitability of digital educational games for use with specific age groups and genders.

We used open card sort with participants aged 11 to 14 to explore their attitude to a range of digital entertainment games. Open card sort allows participants to categorise items in ways that are meaningful to them. There were 32 participants (24 females and 8 males) from four schools in south-east England. They were shown video clips of ten popular games. The participants were then given ten cards, each representing one of the games and asked to sort them into categories based on shared characteristics. This process elicited 131 features (95 from the females and 36 from the males). The data was analysed to identify the features that were a) most significant and b) most appealing to the participants.

The findings indicate that there are some gender differences in which game features are perceived as most significant. Some features, such as game action, are significant to the males whereas others, such as game levels, are significant to the females. Interestingly, some features that both genders find significant have different degrees of appeal for example "fun" and "violence".

We are currently using the findings in an experiment with 480 young people. Two digital educational games have been created: one includes features found to appeal to young females and the other includes the opposite or neutral features. The results of this experiment will be used to validate the findings of the initial investigation and form the basis for a framework to facilitate the inclusion of characteristics that appeal to specific groups in educational games and other software.

Keywords: Computing education; Card sort; Gaming features; Game appeal; Gender differences

1. Introduction

The underrepresentation of females in computer science education and industry is a progressive problem, often referred to as the "shrinking pipeline effect" (Camp, 1997). It starts between late primary school years and early secondary education stages - age 11-14 (Krendl, Broihier and Fleetwood, 1989; Dryburg, 2000). Over the years, a number of intervention strategies including the use of digital educational games have been implemented to try to halt or reverse the problem.

Unfortunately, digital games used in the teaching of IT and computer science have been found to appeal less to females than males. In contrast to this trend in education, digital entertainment games are becoming more and more popular with girls. Although there has been some research into this issue, further investigation is required into what game features appeal and do not appeal to girls at the age the pipeline starts to shrink.

An attempt to improve the appeal of digital educational games to young females needs to tackle two key issues: gender-specific preference(s) (Salisch, Oppl and Kristen, 2006; Klimmt and Hartmann, 2007) and gender stereotypic game features (Huff, 2002; Heemskerk et al., 2011).

The study reported here investigates digital entertainment games rather than educational games. This is because entertainment games are successful with both genders. The aim is to identify the differences and similarities in the significant game features that appeal to 11-14 year olds. The findings will be used to create digital education games that might appeal to girls of the target age group. The research question addressed in this paper is: "*What are the differences and similarities in the significant digital game features that appeal to young females and males of age 11-14"?*

The term 'computer game' is often used interchangeably with 'video game' in related literature: the term 'computer game' being used to refer to personal computer based games and 'video game' for console-based games. In this paper, the term 'digital game' will be used to represent both usages ('computer game' and 'video game'). A digital game is defined as "*one that provides some visual digital information to one or more players; takes input from players; processes input according to a set of programmed game rules and alters the digital information provided to players*" (Kirriemuir and McFarlane, 2004, pp.6).

The rest of this paper includes an overview of relevant literature, a discussion of how the investigation was carried out and the results of the investigation. It concludes with a discussion of the results, conclusion and future work.

2. Digital game features that appeal to young females and males

Whereas a number of game features appeal to both females and males, others have been shown to appeal more to one gender and some are unappealing to the other gender (Beasley and Standley, 2002; Downs and Smith, 2010). Consequently, it would be inaccurate to assume that young females and males are passive recipients of the gaming environment we provide through software (McCartney, 1988).

2.1 Digital game features and young females

Research has identified non-violent content, significant social interaction, meaningful dialogue and non-competitive structures as key characteristics of digital games that appeal to young females (Jansz, 2005; Hartmann and Klimmt, 2006). These characteristics are associated with genres such as adventure games and puzzle-solving games. These game genres tend to have non-competitive structures that reduce time pressure and threats of failure (Lucas and Sherry, 2004). They provide immediate positive feedback which improves the level of independence during play and ensures that correct choices are made as players progress in the gaming environment (Dickey, 2007; Robertson, 2012).

In addition, young females find narrative games appealing due to their interest in storytelling (Beard and Burrell, 2010). Storytelling has been shown to provide a social platform for sharing experiences with friends and classmates. This improves female interest in games providing the opportunity for self-expression in the gaming environment, making links with real life situations and playing variety of roles (Kelleher, 2008). Likewise, the imaginative structure of the storyline gives a clear purpose to the digital game and provides opportunities for exploration rather than purely hierarchical scoring (Robertson, 2012).

2.2 Digital game features and young males

Young males have been shown to find goal-oriented games appealing as they are designed to be challenging with precise targets or outcomes. The use of game technology, such as acquiring new characters and accessories, has been identified as a common method used in the achievement of goals during game play and thus appeal to young males (Kafai, 1998; Hayes and Games, 2008).

Furthermore, it has also been reported that young males are more likely than females to play digital games for competition and challenge. This is often related to the fact that they play games for longer periods than females and thus become expert in game technologies and strategies, which boosts their confidence in their abilities. For young males mastering the game is often seen as a “social plus” within their peer group (Olson, 2010). Other studies also report that young males find action games with strategic play activities appealing (Gorriz and Medina, 2000; Kinzie and Joseph, 2008). This has been shown to be influenced by other game characteristics such as high hand-eye coordination requiring quick paced interactions. A number of game features such as game exploration, narratives and feedback have been identified as unappealing to young males because they are less goal-oriented (Bead and Burrell, 2010; Robertson, 2012).

3. Survey methodology

Our survey used an adapted version of the open card sort methodology with groups of females and males of age 11-14. Each participant was shown video clips of a selection of games. They were then asked to identify a way in which some of the games were similar to each other but different from others. For instance a participant might choose “fun”. This would be termed a “construct”. Having identified a construct the participant was then asked to order the cards representing the games into groups based on the construct. For example the participant might put the cards in three groups: lots of fun, some fun, not fun. These grouping are termed “categories”. This is done repeatedly until the participant could think of no more constructs for grouping the cards. During the sorting process, participants were also requested to verbalise the thought process captured as a “think–aloud” protocol. This process provides further qualitative insight into participants’ decision making process while sorting (Righi, James, Beasley, Day, Fox, Gieber and Ruby, 2013). At the close of each session, the participant sorted the picture cards according to their likelihood of playing the game into three groups: "Most Likely to Play", "Likely to Play" and "Never Likely to Play".

The terms game “feature” and “construct” are used more or less interchangeably in this report. The term “construct” is used where reference is made to the criteria used by participants in the study to group games that they perceived to have something in common. This technical term comes from the card sort methodology used in the study. Elsewhere the more everyday term “feature” is used.

The methodology was applied in one-to-one sessions by the researcher. This was to avoid the danger inherent in working with a group where a dominant individual might impose his or her opinion on the group. The methodology excludes constraints associated with expertise of game play and rather focuses on the game features that appeal from the video narrative and previous experience of playing similar games.

3.1 Survey materials

The materials used for the survey were 10 top game play video clips each 5-15 minutes long, selected from a variety of game genres. The video game clips were viewed on a personal computer at the start of the session.

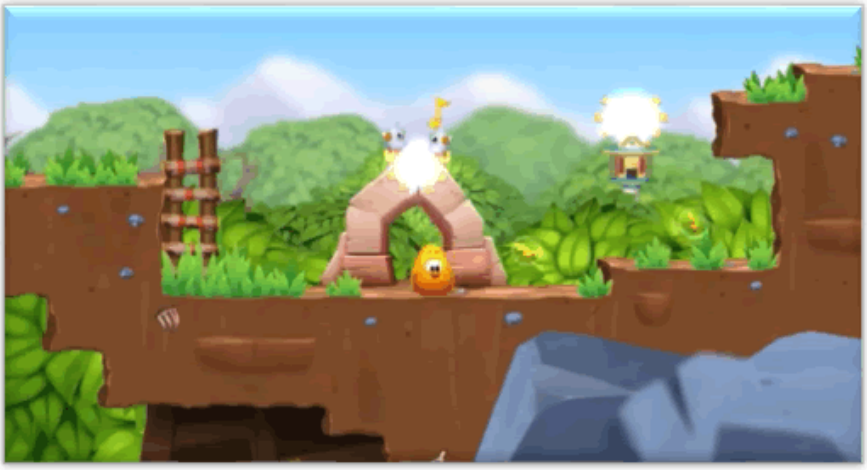

Figure 1: A sample game play video of Toki Tori (© 2013, Two Tribes)

The videos highlighted the play environment and features of the games. 10 picture cards were designed, one for each game as illustrated in table 1.

Table 1: The card number, game genre and game title used in the picture cards

Card	Game Genre	Game Title
#1	Action	Lego City
#2	Maze	Pac-Man
#3	Adventure	Luigi's Mansion
#4	Role Play	World of WarCraft
#5	Simulation	SimCity
#6	Strategy	Fire Emblem
#7	Arcade	Super Mario
#8	Music	Just Dance
#9	Puzzle	Toki Tori
#10	Casual	Angry Birds

The picture card also included an image of the game, a card number and key information about each game such as: the game plot, the game platform, player mode (single or multiple) and how scores are awarded.

The picture cards (figure 2) were of uniform size to ensure participants did not consider any one card more important than the other (Rugg and McGeorge, 1997).

Figure 2: A sample of a picture card with text (Adapted from Toki Tori)

3.2 The study sample size

A total number of 32 participants (*N=32*) of age 11-14 years old, comprising of 24 girls (n_g=*24*) and eight boys (n_b=*8*) from two girls' secondary schools and two mixed secondary schools in south-east England.

4. Results

A total of 131 constructs were initially generated by the participants (95 from the females and 36 from the males). The constructs generated were organised into super-ordinate groups and classified based on their commonality. A super-ordinate group provides a common construct name to capture the gist of several constructs (Rugg & McGeorge, 1997) as generated by the participants. An example is the super-ordinate group "Age appropriateness" which includes constructs such as "age", "age group" and "age limit".

An aggregation of the constructs conducted, using a *Construct by Gender Matrix* established the agreement levels. For the male participants, game graphics, action and fun appear to have the highest levels of agreement. For the female participants the number of players, fun, age appropriateness, game violence, graphics, colour used, popularity, storyline, device, character and play levels have the highest levels of agreement. A graphical representation of both female and male constructs generated with corresponding agreement values are illustrated in figures 3 and 4.

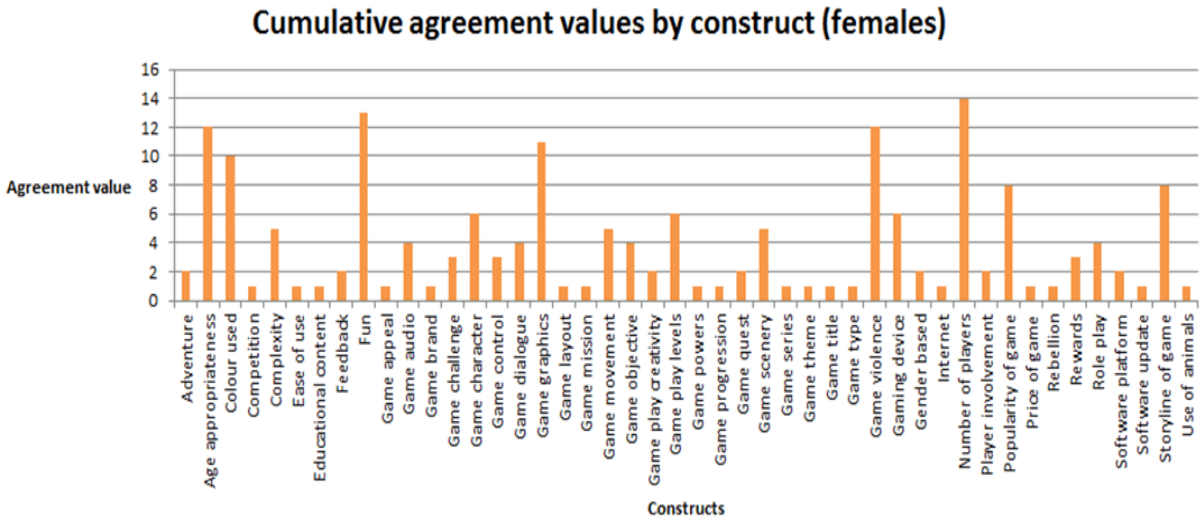

Figure 3: The agreement values of constructs from female participants

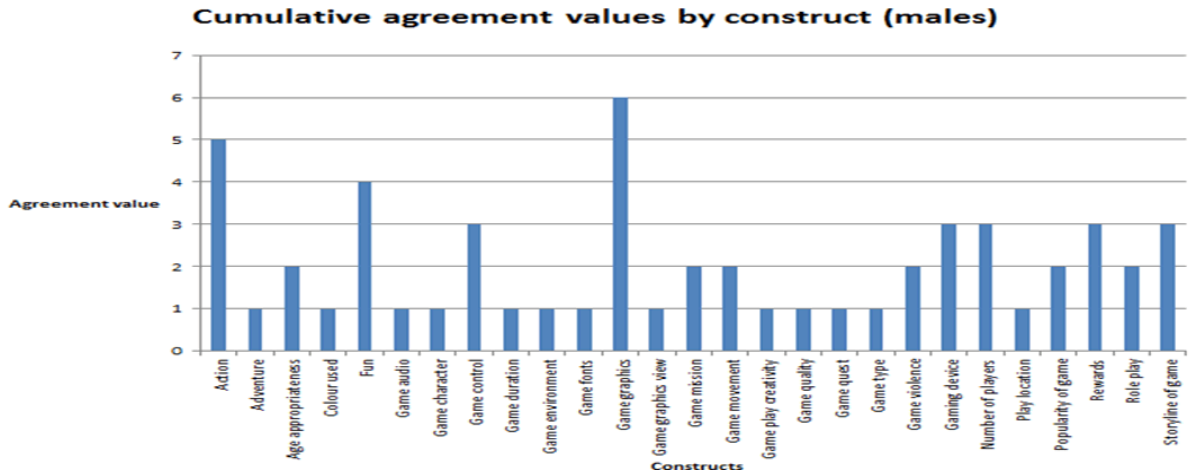

Figure 4: The agreement values of constructs from male participants

From the illustration in figure 3, the number of players, fun, age appropriateness, game violence and graphics have the highest agreement levels for female participants. The constructs with high agreement levels include colours used, popularity of game and storyline of game. For male participants in figure 4, game action, fun and graphics have the highest agreement levels. Other constructs of high agreement levels include game control, device, rewards, storyline of game and number of players. A comparative review of the results from female and male participants identified game fun and graphics as constructs of highest agreement levels with both genders. Furthermore, game storyline and number of players were also of high agreement levels between both genders.

Table 2 presents some of the "think aloud" comments for constructs with the highest levels of agreement. It is interesting that although there is agreement over the significance of some constructs between the two groups, the actual appeal differs. For example the level of violence is of significance to both groups, whereas several of the girls expressed dislike for what they perceived as too much violence.

Table 2: Female and male "think aloud" comments

Game construct	Participant comments (females)	Participant comments (males)
Number of players	*"The number of players in a gaming environment determines the level of communication which is important in a game";*	*"Multiplayer games are fun";*
	"When there a number of players, it becomes educational in a way as we can share ideas".	*"I prefer a game many people can play".*
Fun	*"How involving the game is must have levels of play and can be played by a number of people. It must not be too difficult as well";*	*"Rewards and being able to complete the game makes it fun";*
	"*It provides the opportunity to interact with other people and this creates more fun";*	*" There is an urge to return to a fun game";*
	"Learning something new makes playing games fun".	*"Multiplayer games are fun".*
Age appropriateness	*"There is not a lot of appeal in a game if the age is not right for me";*	*"if the game is not at my age it may be too easy or difficult to play";*
	"It (the game) becomes unchallenging if the age is not right as the game would be too easy to play";	*"I would not play a game that is not for my age group".*
	"This game has the features I would like but it is too easy to play and the graphics are similar to that for little children of age 3-9 years of age";	
	"Unappealing if the age is not right as it might be difficult and require a lot of thinking and movement".	
Game violence	*"I do not mind some violence, but a lot of it becomes off putting";*	*"I like extremely violent games".*
	"boys game";	
	"*I do not mind playing games with some violence, but I will not play one that is extremely violent*".	
Game graphics	*"This game has the features I would like but it is too easy to play and the graphics are similar to that for little children of age 3-9 years of age".*	*"The game graphics affects the game design";*
		"The game graphics is how the game looks like".

An independent t-test analysis to determine the difference in the mean values for each game construct between genders was conducted. The hypotheses for the statistical test are as follows:

H_0: There is no remarkable difference in game construct between females and males

(where H_0 is the null hypothesis and p value=>0.05)

H_1: There is remarkable difference in game construct between females and males

(where H_1 is the alternative hypothesis and p value=<0.05)

Table 3: Statistical significance test for constructs of importance

Game construct	**Gender (Female =24 Male = 8)**	**Mean *(M)***	**Std. Deviation *(SD)***	**Sig. (2-tailed)**	**Hypothesis accepted (H_0 or H_1)**	**Effect size (Partial Eta squared-R squared)**
Number of players	female	.583	.504	.322	H_0	.000
	male	.375	.518			
Game fun	female	.542	.509	.844	H_0	.000
	male	.500	.535			
Age appropriateness	female	.500	.511	.220	H_0	.000
	male	.250	.463			
Game violence	female	.500	.511	.220	H_0	.000
	male	.250	.463			
Game graphics	female	.458	.509	.156	H_0	.000
	male	.750	.463			
Game colour	female	.417	.504	.000	H_1	.089 (large effect)
	male	.000	.000			
Game popularity	female	.333	.482	.003	H_1	.111 (large effect)
	male	.000	.000			
Game storyline	female	.333	.482	.836	H_0	.000
	male	.375	.518			
Game Device	female	.250	.442	.512	H_0	.000
	male	.375	.518			
Game character	female	.250	.442	.011	H_1	.077 (large effect)
	male	.000	.000			
Game levels	female	.250	.442	.011	H_1	.077(large effect)
	male	.000	.000			
Game action	female	.000	.000	.011	H_1	.556 (large effect)
	male	.625	.518			
Game control	female	.000	.000	.080	H_0	.000
	male	.375	.518			
Game reward	female	.000	.000	.080	H_0	.000
	male	.375	.518			
Game mission	female	.000	.000	.170	H_0	.000
	male	.250	.463			

Table 3 presents the mean values (*M*), standard deviation (*SD*) and the significance (2-tailed) test value which is also the *p value* for each game feature for both female and male population. The *p value* was used to make conclusions on the statistical significance of each game construct between both genders. The game constructs with H_1 indicate remarkable difference between both genders.

In other to investigate the extent of difference the Partial Eta squared effect size test (*0.010 = small; 0.060 = moderate; 0.138=large)* was conducted. This type of effect size test is applied due to the unequal sample numbers used for the independent variable gender (female and male). From the analysis of the result, all the game constructs that are statistically different will present large effects within the population

The data about the participants' likelihood of playing each game was correlated with the constructs and categories to determine the measure of appeal. Table 4 shows a summary of the results of this analysis. Notice the "game violence" construct. This correlation of the categories identified for this construct with the likelihood of play shows that girls are likely to play games with moderate violence whereas boys are likely to play games that they perceive as very violent. This confirms the data gathered for the think aloud protocols.

Table 4: Construct/categories with appeal to male and female participants

Game construct	**Construct category with appeal (female)**	**Construct category with appeal (male)**
Game graphics	Cartoons	Photographs
Fun	Lot of fun	Lot of fun
Game control	Moderate control	Full control
Gaming device	Any device	Specialised
Number of players	Multiple players	Single
Rewards	Progression	Points
Storyline of game	Good storyline	Satisfactory storyline
Age appropriateness	Specific age group	Teenage games- suited for age group
Game mission	Not based on character mission	Based on character mission
Game violence	Moderate violence	Very violent
Popularity of game	Very popular	Popular games
Colour used	Bright colours	Dark colours
Game character	Human with real scenarios	Fantasy scenarios
Game action	-	Lots of action
Game levels	Game with levels	-

5. Discussion

Game action and game levels are evidenced to be gender-specific preferences from this study. Game action is peculiar to young males as there seems to be a preference for high hand-eye coordination requiring quick paced interactions (Gorriz and Medina, 2000). For young females the preference for game levels can be associated with the requirement for a game to be purposeful. It also encourages a non-competitive structure, exploration, less time pressure and failure threats (Lucas and Sherry, 2004).

There is another group of game features that are significant to both genders but differ in their appeal. Examples of such game features include: game graphics, fun, character, violence, control, device, storylines, mission and number of players. Female participants' preferred cartoon graphic images while the males preferred photographic images. This difference is supported in related work on computer graphics for young females and males by Jakobsdóttir, Krey and Sales (1994). The statistical significance analysis of this game feature indicates that the difference is not remarkable.

Jakobsdóttir, Krey and Sales further argued that it is possible to design gender neutral graphics for the gaming environment that can appeal to both groups.

Furthermore, game fun is significant to both female and male participants. However, the game characteristics that create fun vary between genders. From the think aloud comments, game levels, number of players, exploration, progression, complexity of game and game interactivity contribute to the fun of the game for young females. For the males, it includes game violence, game action, number of players, reward and challenge makes the game fun.

The number of players is also significant to both female and male players. Both genders are community gamers but differ in how they engage with other players. Young males prefer to play in a single mode but engage with other players in the community through challenges, competition and action-oriented environments. In contrast, the females prefer collaboration in the gaming community by sharing ideas, effective communication and team play. The think aloud protocol comments further indicate that social interaction is an effective communication tool for females. Consequently, it is beneficial to ensure that the appropriate multiple player tools and a social interaction platform are included in games designed to attract females of age 11-14.

In addition, game violence is significant to females and males but varies in appeal depending on the amount of violence. Females would play games with moderate violence as indicated from the think aloud comments and likelihood analysis, while males prefer extremely violent games in most cases. The female acceptance of moderate violence is supported by Anderson (2004); Eastin (2006) and rejected by Jansz (2005); Hartmann and Klimmt (2006). Further statistical evidence from our analysis does indicate that there are no significant differences for violence between both genders. Consequently from our study, moderate game violence should not inhibit females from engaging with digital games. Other game features such as game control, device, storyline and mission differ in preference between the genders but do not significantly differ statistically.

Game colour differs significantly between females and males. Females prefer bright colours and males dark colours. Related work on effective use of colours and graphics in applications for children of age 7-14 by Naranjo-Bock (2011) and Nielsen, Smith and Tosca (2013) supported this finding. Females were identified to find bright colours appealing and males dark colours. This game feature from our study can largely affect the appeal of games between genders as $p<0.050$ and *R squared* = 0.152.

Finally, game character and popularity can also greatly affect the appeal of games to both genders. The females prefer games that are very popular. This provides opportunities to share ideas and information with other players. However, males prefer games that are moderately popular. There is also a difference in the preference for game characters and their use in the gaming environment. From the analysed study data, young males prefer games built around the game character such as the first person and third person games in a fantasy scenario. This may be as a result of the preference for goal-oriented and action games. Conversely, females prefer games that are not built around the character, such as life simulation games. The characters are preferably humans in a realistic setting or real life scenario due to preference for social interaction, exploration and excellent storylines.

6. Conclusion and future work

The findings of this study indicate that there are differences and similarities in the digital game features that are significant to young females and males of age 11-14. Even where there is agreement about the significance of a feature there are sometimes differences in ways that feature affects the appeal of the game. From this study, seven significant game features have been identified for further investigation: game violence, graphics, character, storyline, number of players and age appropriateness. A follow-on experiment is now in progress based on two digital educational games, which have been constructed for learning basic computer science concepts. One game includes features found to be of positive appeal to girls and the other includes the opposite or neutral features. The experiment involves 480 female and male participants of age 11-14. The participants play each game and record their experiences before and after the sessions using questionnaires. The data collected from the experiment will be analysed and used to inform the creation of a framework for the design of digital educational games.

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