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Gender Differences in Learning Game Preferences: Results Using a Multi-dimensional Gender Framework

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Abstract. Prompted by findings of gender differences in learning game preferences and outcomes, education researchers have proposed adapting games by gender to foster learning and engagement. However, such recommendations typically rely on intuition, rather than empirical data, and are rooted in a binary representation of gender. On the other hand, recent evidence from several disciplines indicates that gender is best understood through multiple dimensions, including gender-typed occupational interests, activities, and traits. Our research seeks to provide learning game designers with empirical guidance incorporating this framework in developing digital learning games that are inclusive, equitable, and effective for all students. To this end, we conducted a survey study among 333 5th and 6th grade students in five urban and suburban schools in a mid-sized U.S. city, with the goal of investigating how game preferences differ by gender identity or gender-typed measures. Our findings uncovered consistent differences in game preferences from both a binary and multi-dimensional gender perspective, with gender-typed measures being more predictive of game preferences than binary gender identity. We also report on preference trends for different game genres and discuss their implications on learning game design. Ultimately, this work supports using multiple dimensions of gender to inform the customization of learning games that meet individual students' interests and preferences, instead of relying on vague gender stereotypes.

Keywords: digital learning games, gender studies, game preferences, survey study

1 Introduction

While digital learning games have been shown to be a promising form of instruction thanks to their motivational and learning benefits [22], designing effective games requires a clear understanding of the preferences of different player populations. For instance, there are consistent gender differences in game preferences, such that boys tend to prefer faster paced, action-style games, while girls tend to prefer games with puzzle and social interaction elements [2, 5]. With digital learning games specifically, girls tend to rank goal clarity and social interaction as more important than boys, while boys tend to prefer challenge, progress feedback, and visual appeal [11]. These gendered preferences can produce meaningful differences in learning behaviors and outcomes. For example, girls have sometimes been shown to enjoy learning games

more [1] and have greater learning outcomes [24, 30] than boys. Different features of learning games have also been shown to induce gendered effects, such as girls benefiting more from a digital learning companion [4].

Prompted by these findings, researchers have proposed adapting digital learning games based on gender to create more inclusive and equitable learning experiences [25, 35]. However, such recommendations for gender-based adaptation typically rely on game designers' intuitions, stereotypes, or preferences observed through playtesting and focus groups [13, 33], rather than experimental studies. Moreover, such efforts are limited by a grounding in the gender binary, which views gender as one of two discrete categories, male and female, framed as biologically-based, apparent at birth, and stable over time [23]. Conflating gender with binary, birth-assigned sex is not only imprecise, but may also contribute to gender-stereotyped interests and gender disparities in academic achievement [6, 15]. In contrast, evidence from multiple disciplines has demonstrated that gender is complex, fluid and dynamic, comprising multiple interrelated but separate dimensions [23].

Thus, a more sophisticated and nuanced approach to understanding gender differences in learning game preferences should take into account not only self-reported gender identity (e.g, male, female, non-binary, trans), but also other gender dimensions – such as gender-typed occupational interests, activities, and traits [26] – which are continuous and more fine-grained than gender identity. Such an approach is consistent with best practices in gender studies research, including with late elementary and middle school youth [14, 23], among whom these dimensions of gender are only modestly correlated with one another [8, 31]. Notably, prior work has shown that middle school children can be differentiated along these dimensions of gender and can reliably report on their gender-typed behaviors [8, 26, 27].

Motivated by this multi-dimensional approach, our work seeks to better understand students' digital game preferences and how they relate to different dimensions of gender, through a survey deployed to 333 young students. The first half of the survey asked students to rank their preferred game genres (e.g., *action*, *strategy*, *sandbox*) and game narratives (the overarching game world and story – e.g., fighting pirates, hunting treasures), while the second half queried about dimensions of gender identity and gender-typed occupational interests, activities, and traits. With this survey design, our primary research questions are as follows.

RQ1*: Are there significant gender differences – based on gender identity or gender-typed interests, activities, and traits – in game genre preferences?*

RQ2: *Are there significant gender differences – based on gender identity or gender-typed interests, activities, and traits – in game narrative preferences?*

By addressing these questions, our work contributes to research on young students' preferences in digital games. We also demonstrate, through statistical testing and qualitative analyses, how additional dimensions of gender can better reflect individual preferences than binary gender identity. In turn, this knowledge can enable the design and development of more inclusive and effective learning games.

2 Methods

2.1 Participants

Our sample comprises $n = 333$ students who participated in a classroom study in 5th ($n = 100$) and 6th grades ($n = 233$) across five urban and suburban public schools in a mid-sized U.S. city. Students ranged in age from 10 to 13 years ($M = 11.06$, $SD = .69$). In terms of self-reported gender identity, 52.0% ($n = 173$) described themselves as male, 47.0% ($n = 156$) as female, 0.3% ($n = 1$) as trans or nonbinary, and 0.6% ($n = 2$) preferred not to disclose their gender. Because the subsample of students in the last two categories was small, these 3 students were excluded from statistical analyses of gender identity.

2.2 Materials and Procedures

Surveys were administered as part of a classroom study of a digital learning game in mathematics. Students first filled out a demographic questionnaire that queried about their age, grade level, and an open-ended item to self-identify their gender. Next, they completed two sets of surveys related to gender dimensions and game preferences.

Gender-Typed Behaviors. This survey is based on the Children's Occupational Interests, Activities, and Traits-Personal Measure (COAT-PM - [26]), which assesses youth's interests, activities, and traits in relation to gender-stereotyped norms. The COAT-PM has two scale scores comprising masculine- and feminine-typed occupational interests, activities, and traits. For brevity, we adapted the measure by removing 9 gender-neutral items, 6 masculine-typed items, and 6 feminine-typed items, such that it consisted of 54 items in total (out of the original 75), rated on Likert scales from 1 to 4. The *occupational interests* domain indicates how much one wants to pursue certain jobs, and includes 18 items rated from 1 (not at all) to 4 (very much), such as "hairstylist" or "nurse" (feminine) and "construction worker" or "engineer" (masculine). The *activity* domain indicates how often one performs certain activities, and includes 18 items rated from 1 (never) to 4 (often or very often), such as "make jewelry" or "take dance lessons" (feminine) and "play basketball" or "go fishing" (masculine). The *traits* domain indicates how much one would describe themselves, and includes 18 items rated from 1 (not at all like me) to 4 (very much like me), such as "gentle" or "neat" (feminine) and "adventurous" or "confident" (masculine). Note that these items do not reflect actual gender differences (e.g., we do not assume "confidence" is a male-only trait); rather, they only portray *stereotypical* perceptions of gender differences. Our goal in analyzing students' ratings of these items is to quantify how much they shape their behaviors around traditional gender norms and stereotypes [26]. Each domain also included two gender-neutral items for filler which are excluded from analysis (e.g., "YouTuber," "practice an instrument," "friendly"). The internal consistency (Cronbach's α) was good for both the masculine-typed occupational interests, activities, and traits scale ($\alpha = .80$) and the feminine-typed occupational interests, activities, and traits scale ($\alpha = .85$).

Game Genre and Narrative Preferences. We examined digital learning game preferences in terms of game genres and narratives. First, students were asked to indicate their top three preferred game genres from a list of seven options, selected to

capture the most popular genres among young players [16, 37], and then rank them from most to least liked. The game genres (and example games) listed were: *action* (e.g., Fortnite, Splatoon); *sports & racing* (e.g., Rocket League, FIFA); *strategy* (e.g., Age of Empires, Civilization); *sandbox* (e.g., Roblox, Minecraft); *music & party* (e.g., Pianista, Just Dance); *role-playing* (e.g., Stardew Valley, Legend of Zelda); and *casual* (e.g., Bejeweled, Animal Crossing).

Next, students were given the descriptions of four game narratives: *Amusement Park* (lead new alien friends around an amusement park), *Treasure Hunt* (search for hidden treasure among ocean landmarks, racing against an arch-nemesis), *Helping a Sea Friend* (help a sea creature save an underwater city that has lost power before it's too late), and *War at Sea* (fight criminal naval masterminds and disable their secret weapon to save the world). The narratives were brainstormed by the research team to vary along multiple dimensions – such as world building, goal focus and presence of competition or cooperation – that were shown to be differentially preferred by boys and girls in prior work [4, 11]. Based on the provided descriptions, students were asked to rank the four game narratives from most to least interesting.

3 Results

3.1 Game Genre Preferences

We focused our analyses on students' first and second choices among game genres. A series of chi-square analyses of gender identity (boy or girl) by preference for each game genre revealed significant binary gender differences in most game preferences, such that boys tended to prefer the genres of *action* and *sports & racing*, whereas girls tended to prefer *sandbox*, *music & party*, *role-playing*, and *casual* games. Boys and girls were similarly likely to prefer *strategy* games. Table 1 displays the percentage of boys and girls who ranked each game genre as their 1st or 2nd ranked options. Following Cohen's guidelines [7], the reported significant gender identity differences on game preferences all have small to medium effect sizes ($.10 < \phi < .50$).

Table 1. Gender differences in game genre preferences according to gender identity. Percentages sum to 200 to represent first and second rank choices. (***) $p < .001$, (**) $p < .01$, (*) $p < .05$.

Game Genre	% Boys	% Girls	χ^2 (1)	ϕ
Action	70.5	39.1	32.80***	-.32
Sports & Racing	45.1	14.1	37.22***	-.34
Strategy	11.6	5.8	3.42	-.10
Sandbox	46.8	59.0	4.86*	.12
Music & Party	5.2	37.8	53.23***	.40
Role-Playing	12.7	21.2	4.19*	.11
Casual	8.1	23.1	14.29***	.21

To test for significant differences in digital game genre preferences based on masculine- and feminine-typing, we ran a series of one-way between-subject ANOVAs comparing the masculine- and feminine-typed behaviors of students who ranked specific game genres as their 1st or 2nd options. We found that students who preferred the genres of *action* and *sports & racing* reported significantly higher masculine-typed behaviors, whereas students who preferred the genres of *sandbox*, *music & party*, and *casual* games reported significantly lower masculine-typed behaviors. By contrast, students who preferred the genres of *action* and *sports & racing* reported significantly lower feminine-typed behaviors, and students who preferred the *music & party* genre reported significantly higher feminine-typed behaviors. See Table 2 for the descriptive statistics, effect sizes and *F*-statistics; here a game genre is considered not preferred (Not P.) if it is not within the top two ranked options. Following Cohen [7], most of the significant gender-typing differences in game preferences can be interpreted as medium ($d \cong .50$), with the exception of the large gender difference in preferring *music & party* games ($d > .80$).

Table 2. Gender differences in game genre preferences according to feminine- and masculine-typed occupational interests, activities, and traits.

Game Genre	Feminine-typed				Masculine-typed			
	Pref. *M (SD)*	Not P. *M (SD)*	*F*	*d*	Pref. *M (SD)*	Not P. *M (SD)*	*F*	*d*
Action	2.17 (.47)	2.32 (.48)	8.04**	-.31	2.42 (.47)	2..23 (.42)	14.64** *	.41
Sports & Racing	2.09 (.42)	2.30 (.49)	14.40***	-.44	2.52 (.39)	2.26 (.46)	24.14** *	.57
Strategy	2.08 (.42)	2.25 (.48)	3.34	-.35	2.38 (.45)	2.33 (.46)	.29	.10
Sandbox	2.24 (.49)	2.23 (.47)	.01	.01	2.25 (.44)	2.44 (.46)	15.40** *	-.42
Music & Party	2.56 (.43)	2.15 (.45)	45.62***	.86	2.22 (.49)	2.37 (.44)	6.41*	-.34
Role-Playing	2.31 (.42)	2.22 (.49)	1.775	.19	2.26 (.43)	2.36 (.46)	2.16	-.21
Casual	2.32 (.51)	2.22 (.47)	2.03	.22	2.22 (.44)	2.36 (.46)	3.96*	-.30

Next, we computed the correlations between gender dimensions. Binary gender identity (with "female" coded as 1 and "male" coded as 0) was positively correlated with feminine-typed scales ($r = .62$) and negatively correlated with masculine-typed scales ($r = -.33$). In addition, feminine-typed scales were positively correlated with masculine-typed scales ($r = .19$). Thus, these three gender dimensions were moderately correlated but not redundant. Because there is no evidence of multicollinearity, our next analysis involves a series of logistic regressions predicting each game genre preference (i.e.,

whether it is included in the top two choices) with binary gender, masculine-typed scale, and feminine-typed scale (Table 3). This allowed us to assess how much each variable predicted preferences when controlling for the other variables. For the *action, sports & racing*, *sandbox*, and *music & party* genres, masculine- and feminine-type scales were significant predictors of preference while binary gender was not. For only one genre - *casual* games - was binary gender a significant predictor while masculine- and feminine-types were not. Models predicting *role-playing* and *strategy* genres were not significant and are excluded from Table 3.

Table 3. Logistic regressions predicting genre preferences according to gender identity (female = 0), masculine-typed scale, and feminine-typed scale. *Exp(B)* represents the change in odds corresponding to a unit change in the coefficient.

Game Genre	Constant	Binary gender	Feminine-typed scale	Masculine-typed scale
Action	*B* = -2.10*, *Exp(B)* = .12	*B* = .27, *Exp(B)* = 1.31	*B* = -.68*, *Exp(B)* = .51	*B* =1.07***, *Exp(B)* = 2.91
Sports & Racing	*B* = -1.87, *Exp(B)* = .15	*B* = .60, *Exp(B)* = 1.82	*B* = -1.48***, *Exp(B)* = .23	*B* = 1.22**, *Exp(B)* = 3.37
Sandbox	*B* = .044, *Exp(B)* = 1.05	*B* = -.13, *Exp(B)* = .88	*B* = .72*, *Exp(B)* = .2.06	*B* = -1.03***, *Exp(B)* = .36
Music & Party	*B* = -2.69*, *Exp(B)* = .07	*B* = -1.22, *Exp(B)* = .30	*B* = 1.54*, *Exp(B)* = .4.67	*B* = -1.33*, *Exp(B)* = .27
Casual	*B* = -1.73, *Exp(B)* = .18	*B* = -2.75**, *Exp(B)* = .064	*B* = -.74, *Exp(B)* = .48	*B* = -.58, *Exp(B)* = 1.78

3.2 **Game Narrative Preferences**

A series of chi-square analyses of gender identity (boy or girl) by preference for each game narrative revealed significant gender differences in two of the four narrative preferences, such that the *War at Sea* narrative was preferred by boys and *Help a Sea Friend* narrative was preferred by girls (Table 4). Following Cohen [7], these effect sizes are medium. On the other hand, boys and girls were similarly likely to prefer the *Amusement Park* and *Treasure Hunt* narratives.

Table 4. Gender differences in game narrative preferences according to gender identity.

Game Narrative	% Boys	% Girls	χ^2 (1)	ϕ
Amusement Park	42.8	50.0	1.72	.07
Treasure Hunt	50.3	56.4	1.23	.06
Help a Sea Friend	32.9	53.2	13.77***	.21
War at Sea	74.0	40.4	38.04***	-.34

Table 5. Gender differences in game narrative preferences according to feminine- and masculine-typed occupational interests, activities, and traits.

Game Narrative	Feminine-typed				Masculine-typed			
	Pref. *M (SD)*	Not P. *M (SD)*	*F*	*d*	Pref. *M (SD)*	Not P. *M (SD)*	*F*	*d*
Amusement Park	2.25 (.48)	2.23 (.48)	.18	.05	2.33 (.45)	2.35 (.47)	.13	-.04
Treasure Hunt	2.25 (.46)	2.22 (.50)	.21	.05	2.34 (.43)	2.34 (.50)	.01	.01
Help a Sea Friend	2.36 (.52)	2.13 (.42)	18.07***	.46	2.28 (.50)	2.38 (.42)	4.59*	-.24
War at Sea	2.12 (.44)	2.39 (.49)	27.44***	-.56	2.39 (.46)	2.27 (.45)	5.80*	.27

To test for significant differences in game narrative preferences based on masculine- and feminine-typing, we ran four one-way between-subjects ANOVAs comparing the masculine- and feminine-typed behaviors of students who ranked specific game narratives as their 1st or 2nd option. With regards to feminine-typed occupational interests, activities, and traits, there were medium effects of students who preferred the *Help a Sea Friend* narrative reporting significantly higher feminine-typed behaviors, and those who preferred the *War at Sea* narrative reporting significantly lower feminine-typed behaviors. In addition, there were small effects of students who preferred the *War at Sea* narrative reporting significantly higher masculine-typed behaviors, and those who preferred the *Help a Sea Friend* narrative reporting significantly lower masculine-typed behaviors. See Table 5 for descriptive statistics, effect sizes (Cohen's *d*), and *F*-statistics.

Next, we conducted a series of logistic regressions predicting each game narrative preference with binary gender, masculine-typed scale, and feminine-typed scale in a single model (Table 6). For the *Help a Sea Friend* narrative, masculine- and feminine-type scales were significant predictors of preference, while binary gender was not. For the *War at Sea* narrative, both binary gender and the feminine-type scale were significant predictors. Models predicting the *Amusement Park* and *Treasure Hunt* narratives were not significant and are excluded.

Table 6. Logistic regressions predicting game preferences according to gender identity (female = 0), masculine-typed scale, and feminine-typed scale. (*) $p < .05$, (**) $p < .01$, (***) $p < .001$.

Game Narrative	Constant	Binary gender	Feminine-typed scale	Masculine-typed scale
Help a Sea Friend	*B* = -.82, *Exp(B)* = .44	*B* = -.24, *Exp(B)* = .79	*B* = .98**, *Exp(B)* = 2.67	*B* = -.68*, *Exp(B)* = .51
War at Sea	*B* = .52, *Exp(B)* = 1.69	*B* = .84**, *Exp(B)* = 2.33	*B* = -.82*, *Exp(B)* = .44	*B* = .53, *Exp(B)* = 1.70

3.3 Post-hoc Analyses

As a follow-up, we analyzed whether the additional gender dimensions, reflected by the masculine- and feminine-typed scores, would reveal more nuances about students' game preferences. We identified 13 boys who had stronger feminine-typed ($M = 2.18$, $SD = 0.29$) than masculine-typed ($M = 1.95$, $SD = 0.30$) behaviors and 31 girls who had stronger masculine-typed ($M = 2.52$, $SD = 0.47$) than feminine-typed ($M = 2.31$, $SD = 0.41$) behaviors. In each of these groups, the *action* and *sandbox* genres were most popular. Additionally, *Treasure Hunt* was the most preferred narrative among the 13 boys, and *War at Sea* was the most preferred narrative among the 31 girls.

4 Discussion and Conclusion

In this work, we examined young students' game preferences through the lens of a multi-dimensional gender framework. Our research was motivated by the need to characterize gender differences in game preferences while considering additional gender dimensions beyond binary gender identity, including gender-typed occupational interests, activities and traits [23, 26]. This topic is especially relevant to the design of inclusive learning games that match students' gaming interests without relying upon vague or outdated gender stereotypes. Beyond reporting students' preferred game genres and narratives, our work also supports the analysis of multiple gender dimensions in educational research. We discuss the insights from these results below.

Overall, we observed consistent gender differences in game preferences when representing gender as binary categories and as continuous gender-typed scores. In particular, boys and those with strong masculine-typed behaviors tended to prefer the *action* and *sports & racing* genres, as well as the battle-oriented game narrative, *War at Sea*. Meanwhile, girls and those with strong feminine-typed behaviors reported more interest in the *casual* and *music & party* genres, and the co-operative game narrative, *Help a Sea Friend*. These patterns are consistent with those reported in past surveys [2, 5], indicating that gender-based game preferences have remained stable over the years.

However, our results suggest two significant advantages of using a multi-dimensional gender representation over the traditional binary one. First, based on Cohen's interpretation guidelines [7], we observed gender differences with medium to large effect sizes using gender-typing measures, but only small to medium effect sizes using gender identity, suggesting that the former approach better reflects the influence of gender on children's game interests. This observation is further supported by logistic regression analyses showing that gender-typed scales predicted game preferences better than binary gender identity, when both were included in the same models. In short, a more nuanced assessment of gender is a more powerful predictor of game preferences. Second, our post-hoc analysis revealed distinct preferences from boys with stronger feminine-typed behaviors and from girls with stronger masculine-typed behaviors, compared to other students in their respective gender identity groups. Thus, when the students' gender identity and gender-typed behaviors do not completely align, their gaming interests can be better distinguished by measures of gender-typed interests, activities, and traits. That is, the multi-dimensional assessment of gender is more

precise. Based on these findings, we encourage AIED researchers to adopt multidimensional gender measures in their future studies to more closely examine how students' background factors may influence their learning interest and experience.

The findings from our survey also have implications for learning game design. First, we observed that the *strategy*, *role-playing* and *casual* genres were preferred by only 5-25% of students. Notably, these three genres often feature game elements – such as slow pace, reflection and study of the environment – that are frequently used in learning games [3] because they can foster a playful experience without inducing high cognitive load and interfering with learning. At the same time, they may cause the identified genres to be less favored by students, for several possible reasons. First, many modern games, regardless of genre, tend to incorporate elements that require fast and accurate decision making from the players [10]. If children are used to this style of game play, games that feature slower and more methodical play may be less engaging. Alternatively, prior work has shown that middle-school students may omit reporting that they enjoy games which do not fit with the gamer identity they are attempting to project [18]. Further work is needed to disambiguate these conjectures, but in both cases, increasing children's exposure to slow and reflective entertainment games is likely to improve their reaction to those features in digital learning games.

The remaining four game genres – *action*, *sports and racing*, *sandbox*, *music and party* – were all highly favored by both boys and girls. Among them, the *sandbox* genre was the most universally popular, being included in the top two genres of close to half of the boys and girls in the study. This attribute may be explained by the rapid rise in popularity of sandbox games, most notably *Minecraft* and *Roblox*, during the COVID-19 pandemic [9, 19]. These platforms allow players to not only play games created by others, but also to freely design their own activities. In this way, they are effective at fostering player connections [9] and have also been used for educational purposes [12]. Digital learning game researchers can take advantage of this trend by introducing sandbox elements, such as player agency [32], into their games to promote engagement. Incorporating player agency has also been shown to result in better learning efficiency [17] and outcomes [36] in learning games. Additionally, there are successful examples of full-fledged sandbox digital learning games, such as *Physics Playground*, which utilize stealth assessment techniques to measure student learning without disrupting the sandbox experience [34]. In turn, this prior work provides a solid foundation for investigating how digital learning games can take advantage of the sandbox genre's increasing popularity among young students.

One limitation of this study is that students may not have a clear picture of all the game genres and narratives included in the survey, given their brief text descriptions. Providing graphical illustrations of the example games in each genre and the storylines in each narrative would likely help students make more informed selections. At the same time, the findings thus far suggest several novel research directions. First, we could evaluate the role of additional gender dimensions, such as gender typicality (i.e., perceived similarity to other children of one's own and other gender [27]), in explaining students' game preferences. In addition, future research should investigate the connection between gender differences in game preferences and in learning outcomes, for example by manipulating a learning game's narrative to be either masculine- or feminine-oriented while retaining the game mechanics and instructional materials. This comparison would be particularly interesting for learning games that have been shown

to produce gender differences in learning outcomes [4, 24, 30]. For instance, the math game *Decimal Point* [28], which features an amusement park metaphor, has yielded consistent learning benefits for girls over boys across several studies [20, 21, 30]. To follow up, one could investigate the outcomes of an alternate version of the game with a more masculine-oriented narrative, such as *War at Sea* – in this case, would gender differences in learning favoring girls still emerge, or would boys have an advantage instead? More generally, the study of how gender-based preferences interact with the game features and instructional materials is an important step towards understanding the nuanced role of gender in shaping students' playing and learning experience.

In conclusion, our results indicate that a nuanced approach to gender is more predictive of game preferences than binary gender. That is, assessing multiple dimensions of gender is more precise, particularly for students whose activities, interests, and traits are less stereotypical of their binary gender identity. To our knowledge, this is the first research that utilizes a multi-dimensional gender framework for examining children's game preferences, and it suggests that this approach is more appropriate for game designers seeking to customize learning games to better suit individual students' interests and preferences. Ultimately, we envision that these customizations may also be driven by AI techniques which construct accurate and inclusive models of students' learning and preferences, using our identified multi-dimensional gender features as a starting point.

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