Playing a Mobile, Exhibit-Based STEM Game: Gender Differences in Behaviors and Perceptions

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Abstract: This study examines gender differences in affective outcomes, gameplay behaviors, and perceptions of gameplay of fifth to eighth grade students who played an exhibit-based mobile game during a group field trip to a hands-on science center. This mixed-method, quasi-experimental study used a pre-/post- administration of the Motivation to Learn Science Questionnaire, first-person GoPro video, and follow-up interviews. Results indicated that girls had higher science self-efficacy before their visit to the science center and outperformed boys on every measure of game achievement. The content of the qualitative data suggested that Lazzaro's 4-Keys to Fun (2004) was a good fit framework for describing participants' behaviors and perceptions of the game and visit to the science center. Data revealed that girls tended to be more goal-oriented, persistent in the face of difficulty, and appreciative of "hard fun". However, gender differences in science self-efficacy did not exist on the post-measure.

Introduction

This study examined affective outcomes of playing a mobile game during a group field trip to a hands-on science center. Designed for fifth through eighth grade students, *The Great STEM Caper* (*The GSC*) was a challenge-based game intended to guide and mediate players' experiences at the science center in a way that engaged them in STEM practices through problem solving with specific exhibits. The study was designed to answer particular questions: How does playing an exhibit-based mobile game during a group field trip to a hands-on science center affect students' science self-efficacy and overall motivation to learn? How does gender interact with perceptions of the game and self-efficacy? Are there differences in the way boys and girls play the game?

The Game

An open-source, location-based game platform called ARIS (Augmented Reality and Interactive Storytelling) was used to create the game. *The GSC* used QR codes and a challenge-based game structure to encourage engagement in STEM practices at specific exhibits and created opportunities for student collaboration. Participants played in same-gender pairs sharing one iPad. *The GSC* preserved free choice but enhanced the traditional discovery-oriented exhibit interaction with goal-oriented motivation provided by a game-based learning experience. Players earned "skill units" in the categories of science, technology, engineering, and mathematics by completing challenges found throughout the science center. When players earned three skill units in any one category, they earned a badge in that category. A total of seven skill units were needed to win the game. Because self-efficacy is a strong predictor of performance and motivation to learn (Brophy, 1987) and mastery experiences lead to increased self-efficacy (Bandura, 1997), this research explored whether game-based mastery experiences, described as "fiero" moments by McGonigal (2011), would result in increased self-efficacy when compared to a traditional discovery-based visit to the science center.

Research Methods

This design-based, mixed-methods research study began with the development and pilot testing of *The Great STEM Caper* game over the summer of 2013 with small groups of children. After small-group pilot testing and game adjustments, the game was playtested with a school group of 17 seventh and eighth grade students. The final phase of data collection included four main types of data: a pre/post Motivation to Learn Science Questionnaire (MLSQ), first-person Go-Pro video recording during gameplay or science center visit, in-game player rating of the individual challenges, and follow-up interviews with a sample of players from each trial. Outcomes were compared between two groups: the *game group* played *The GSC* during their visit (n=79) and the *comparison group* explored the science center in the traditional discovery-oriented way (n=42). Both groups consisted of fifth to eighth grade students who completed the pre-visit survey approximately a week before the group visit to the science center. All groups completed the post-visit survey on-site before departing the science center. In each group, a boy and a girl wore the GoPro camera throughout the two-hour visit. Samples of six students in each group were interviewed after the visit to the science center.

Results

Overall, there were no significant differences between the game and comparison groups from pre- to post- on the MLSQ. Girls scored significantly higher than boys on the pre-measure of the science self-efficacy subscale of the MLSQ, but after the visit, their scores were statistically similar. Remarkably, the game group girls' post-visit self-efficacy scores decreased despite the fact that the girls outperformed boys on every measure of game achievement (see Table 1). In-game "fiero" experiences did not translate into a positive change in self-efficacy for girls.

	Male (n=34)			Female (n=26)		
	Total	Mean	Mode	Total	Mean	Mode
# Challenges Completed	90	2.65	3	130	5	5
# Skill Units Earned	204	6.00	6	241	9.27	7
# Badges Earned	22	0.65	0	47	1.81	2
WINS	15	0.44	N/A	21	0.81	N/A

Table 1: Game performance by gender.

All qualitative data (i.e., 40 hours of GoPro video, 26 interviews, and open-ended survey responses) was analyzed in NVIVO using a general inductive analysis approach. After all themes (approx. 80) had emerged and been analyzed for redundancy and overlap, it was determined that Lazzaro's 4-Keys to Fun (2004) was a good fit framework for the data. Lazzaro describes four motivating factors for game players: hard fun, easy fun, serious fun, and people fun. Table 2 shows the percentage of references in the data for each type of fun disaggregated by gender. Both genders enjoyed the "hard fun" afforded by a goal-oriented science center experience that included playing *The Great STEM Caper*; but girls were slightly more likely to be motivated by "hard fun" than boys, and boys were slightly more likely to be motivated by "easy fun" than girls.

	A : Easy Fun	B : Hard Fun	C : People Fun	D : Serious Fun
1 : Female	25.09%	42.78%	23.01%	9.12%
2 : Male	31.58%	36.61%	27.01%	4.81%

Table 2: Types of fun references by Gender.

Conclusions

Although girls exhibited higher levels of science self-efficacy than boys on the pre-MLSQ and outperformed boys on every measure of game achievement, their in-game "fiero" experiences did not translate into a positive change in self-efficacy. Girls enjoyed the challenge and having a goal to work toward during their science center visit; they enjoyed the "hard fun" nature of the gameplay experience. However, girls expressed more confusion and frustration related to gameplay than did boys. They were also more likely to seek and/or receive adult help. It may be that girls found the application of STEM problem solving required by the game more challenging than their experiences in school science. Success in the game may have been more difficult than previous in-school science experiences, and therefore may not have been perceived as a mastery experience at all.

References

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