

Educational Technology – Summer 2018: Influence of Gender Appeals in Game-Based Learning Tools

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INTRODUCTION

As part of Summer 2018 Education Technology project, I am investigating the area of game-based learning in general, and the analysis of game-based learning outcomes, in particular.

In order to thoroughly understand the field of game-based learning, detailed research is performed in the dominant education theories and their adaptations in game-based learning, advantages of game-based learning over traditional learning methodologies, and the differentiation in learning outcomes depending on who the player is competing against, the player's gender and the player's choices.

As a result of the studies done in the game-based learning area, the question that is identified and addressed through my research project is:

Is gender-based differentiation of games and game elements beneficial with respect to learner performance and learning outcomes? Are some activities irrelevant, or unachievable for any gender?

RELATED WORK

To obtain an in-detail understanding of the game-based learning field and existing platforms, techniques and methodologies, along with their benefits/limitations, a wide-scale (taking into consideration multiple existing studies and techniques) exploration is done in the below given topics.

1. **Dominant education theories and how game-based learning techniques implement and execute these theories.** As per the information given in [1] Art of Teaching Science (2018), David Ausubel's Meaningful Learning Model is investigated and from [2] Eck, R.V. (2006), it is substantiated that Meaningful Learning Model is adopted in game-based learning techniques, substantiated with the help of the techniques followed in RollerCoaster Tycoon game. Also, after analyzing the Experiential Learning Theory put forward by David A. Kolb as obtained from [3] Learning Theories (2018), it was found that game-based learning techniques support this theory (substantiated in [4] Perrotta, C. et. al. (2013)).
2. **Advantages of using game-based techniques for learning as compared to traditional learning methodologies.** While exploring the existing game-based learning techniques, as per [5] Huhn, J

(2013), it was found out that game-based learning provides more engagement, motivation, higher performance, and encourages more voluntary hard work in students.

3. **Whether the learning outcomes differ depending on whom the player is competing against.** Multiple existing studies (Pew Internet and American Life Project as mentioned in [6] Lenhart et. al. 2008, [7] Plass, J.L. et.al.2015, [8] Ryan, R. M. et. al. 2000) inferred that interest-driven and friendship-driven constructive competition increases the motivation and engagement factors for the learners. Also, self-Perception obtained by playing against competitors promotes a sense of presence, game enjoyment, and an intention for future play, provided the player is not constantly getting defeated by the competitors. In such a case, the player should consider going down levels, until he/she is confident enough in all the required skills to compete again.
4. **Whether learning outcome changes depending on the player's gender.** From multiple studies, it was observed that female students lacked previous gaming experiences and it adversely affected their attitude towards gaming. But once they are supported with game-based platform learning companions, and as they get familiarized with gaming techniques, it was found that they quickly got adapted to the techniques and outperformed their male counterparts in many scenarios ([9] Buffum, P.S. et.al. 2015, [10] Yen, J. et.al. 2011, [11] Tsai, F. 2017, [12] Lukosch, H. et.al. 2017).
5. **Whether the learning outcomes differ depending upon the choices the player makes while playing the different levels.** As per [13] Schwartz, D.L. et. al. (2013), it was observed that the learner's choice patterns do affect their learning outcomes. Hence, assessment also is to be adapted based on the choices the learner's make while attempting different gaming levels and sections.

NULL HYPOTHESIS

The null hypothesis which is tried to be proved against, in this research is: **“Gender-based differentiation of games and game elements yields higher learner performance**

and higher learning outcomes. Some activities are irrelevant, or unachievable for a given gender.”

RESEARCH CONDUCTED, AND METHODOLOGIES USED

Case Study: To research on the problem statement, the first methodology used is to perform quantitative case study on two game-based learning platforms for elementary aged students named [14] Reading Eggs (2018) (helps in English Language Reading skill development), and [15] Reflex Math (2018) (helps in developing addition, subtraction, multiplication, and division skills). Both the tools have games which appear to appeal to either boys or girls. There are many neutrally designed games and game elements too.



Figure 1. [1] Reading Eggs Home Page – Story Lands (appeals to girls), Driving Tests (appeals to boys), all others (neutral)



Figure 2. [2] Reflex Math – Alien Sundae (appeals to girls), Ninja Stars (appeals to boys). There are many similar differentiator game choices. There are many neutral games too.

The case study is performed for the following sections:

1. Performance of Reading Eggs Games - Data Set 1 – Boys on boy appealed games, girls on girl appealed games

2. Performance of Reading Eggs Games, Data Set 2 – Boys on girl appealed games, girls on boy appealed games
3. Performance of Reading Eggs Games, Data Set 3 – neutral games
4. Performance of Reflex Math Games - Data Set 4 – Boys on boy appealed games, girls on girl appealed games
5. Performance of Reflex Math Games, Data Set 5 – Boys on girl appealed games, girls on boy appealed games
6. Performance of Reflex Math Games, Data Set 6 – neutral games

Survey Methodology: The second research methodology followed is to perform a survey with questions formulated to collect data points on the dependent variables of attempt count, pass percent, return count etc. on game activities (the questions are relevant to elementary game-based learning platforms and Reading Eggs and Reflex Math tools). The survey was published in [16] PeerSurvey (2018), <http://peersurvey.cc.gatech.edu>. The information regarding the purpose of the survey and PeerSurvey link were posted in Piazza and OMSCS Google + group. The survey received 28 responses.

DATA SET ANALYSIS – CHI SQUARE TEST RESULTS

For data analysis, I made use of **Chi-Square Test** methodology. **The independent variable is chosen as gender category (girls, boys).** Chosen dependent variables are attempt count, pass count, and return count for boy-appealing, girl-appealing, and neutral games for both categories. If children returned to the same game level multiple times, each attempt is added into the attempt count and each second and subsequent attempt is added into the return count.

No: of boys = 34

No: of girls = 17

Chi-Square test is chosen as the methodology for analysis since the distribution of boys and girls are unequal. In Chi-Square test, we are comparing against expected values and observed values of dependent variables for each independent variable category. An example of expected value calculation of a dependent variable ‘attempts on girl appealing games’ by the independent variable category ‘girls’ can be calculated as ‘% of girl applier game attempts against total attempts multiplied by total number of attempts by girls’. **Thus, if the number of girls is less, the expected values will come down proportionately, and thus will automatically be taken into consideration in the Chi-Square test comparison.**

The step by step procedure of analysis performance is given below:

Data Set 1:

Reading Eggs - Data Set 1 : Boys on Boy Games, Girls on Girl Games

Independent Variable	Dependent Variable: Attempt Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	25		
Girls		12	

Independent Variable	Dependent Variable: Pass Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	16		
Girls		10	

Independent Variable	Dependent Variable: Return Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	14		
Girls		8	

Table 1: Data Set 1: Reading Eggs data obtained from Boys performing Boy Appealing Games and Girls performing Girl Appealing Games

Data Set 2:

Reading Eggs - Data Set 2 : Boys on Girl Games, Girls on Boy Games

Independent Variable	Dependent Variable: Attempt Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys		4	
Girls	2		

Independent Variable	Dependent Variable: Pass Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys		3	
Girls	2		

Independent Variable	Dependent Variable: Return Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys		2	
Girls	2		

Table 2: Data Set 2: Reading Eggs data obtained from Boys performing Girl Appealing Games and Girls performing Boy Appealing Games

Data Set 3:

Reading Eggs - Data Set 3 : Boys on Neutral Games, Girls on Neutral Games

Independent Variable	Dependent Variable: Attempt Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys			20
Girls			15

Independent Variable	Dependent Variable: Pass Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys			14
Girls			11

Independent Variable	Dependent Variable: Return Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys			13
Girls			11

Table 3: Data Set 3: Reading Eggs data obtained from Boys performing Neutral Games and Girls performing Neutral Games

Data Set 4:

Reflex Math - Data Set 4 : Boys on Boy Games, Girls on Girl Games

Independent Variable	Dependent Variable: Attempt Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	30		
Girls		16	

Independent Variable	Dependent Variable: Pass Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	20		
Girls		12	

Independent Variable	Dependent Variable: Return Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	19		
Girls		12	

Table 4: Data Set 4: Reflex Math data obtained from Boys performing Boy Appealing Games and Girls performing Girl Appealing Games

Data Set 5:

Reflex Math - Data Set 5 : Boys on Girl Games, Girls on Boy Games

Independent Variable	Dependent Variable: Attempt Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys		8	
Girls	6		

Independent Variable	Dependent Variable: Pass Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys		6	
Girls	4		

Independent Variable	Dependent Variable: Return Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys		5	
Girls	3		

Table 5: Data Set 5: Reflex Math data obtained from Boys performing Girl Appealing Games and Girls performing Boy Appealing Games

Data Set 6:

Reflex Math - Data Set 6 : Boys on Neutral Games, Girls on Neutral Games

Independent Variable	Dependent Variable: Attempt Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys			24
Girls			16

Independent Variable	Dependent Variable: Pass Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys			18
Girls			12

Independent Variable	Dependent Variable: Return Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys			16
Girls			12

Table 6: Data Set 6: Reflex Math data obtained from Boys performing Neutral Games and Girls performing Neutral Games

Combined Data for Reading Eggs:

Reading Eggs

Independent Variable	Dependent Variable: Attempt Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	25	4	20
Girls	2	12	15

Independent Variable	Dependent Variable: Pass Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	16	3	14
Girls	2	10	11

Independent Variable	Dependent Variable: Return Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	14	2	13
Girls	2	8	11

Table 7: Combined Data for Reading Eggs

Combined Data for Reflex Math:

Reflex Math

Independent Variable	Dependent Variable: Attempt Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	30	8	24
Girls	6	16	16

Independent Variable	Dependent Variable: Pass Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	20	6	18
Girls	4	12	12

Independent Variable	Dependent Variable: Return Count		
	Boy Appealers	Girl Appealers	Neutral Games
Boys	19	5	16
Girls	3	12	12

Table 8: Combined Data for Reflex Math

Total Attempt Counts:

Total Counts - Attempts				
Independent Variable	Dependent Variable: Attempt Count			
	Boy Appealers	Girl Appealers	Neutral Games	Total
Boys	55	12	44	111
Girls	8	28	31	67
Total	63	40	75	178

Table 9: Total Attempt counts combining Reading Eggs and Reflex Math Attempt counts

Chi-Square Expected Value Calculations for Attempts:

Chi-Square Expected Value Calculations - Attempts	
% of boy appealer attempts	$(63/178) * 100 = 35.39$
% of girl appealer attempts	$(40/178) * 100 = 22.47$
% of neutral attempts	$(75/178) * 100 = 42.13$
Expected attempts of boys for boy appealers	$0.3539 * 111 = 39.28$
Expected attempts of girls for boy appealers	$0.3539 * 67 = 23.71$
Expected attempts of boys for girl appealers	$0.2247 * 111 = 24.94$
Expected attempts of girls for girl appealers	$0.2247 * 67 = 15.05$
Expected attempts of boys for neutral games	$0.4213 * 111 = 46.76$
Expected attempts of girls for neutral games	$0.4213 * 67 = 28.23$

Table 10: Chi – Square Expected Value Calculations for Attempts

Chi – Square Analysis – Boy Attempt Rate

Chi- Square Analysis - Boy Attempt Rate			
	Boy Appealers	Girl Appealers	Neutral Games
Expected	39.28	24.94	46.76
Observed	55	12	44
P Value	0.001382332		

Table 11: Chi – Square Analysis – Boy Attempt Rate

Chi – Square Analysis – Girl Attempt Rate

Chi- Square Analysis - Girl Attempt Rate			
	Boy Appealers	Girl Appealers	Neutral Games
Expected	23.71	15.05	28.23
Observed	8	28	31
P Value	1.82371E-05		

Table 12: Chi – Square Analysis – Girl Attempt Rate

Total Pass Counts:

Total Counts - Pass				
Independent Variable	Dependent Variable: Pass Count			
	Boy Appealers	Girl Appealers	Neutral Games	Total
Boys	36	9	32	77
Girls	6	22	23	51
Total	42	31	55	128

Table 13: Total Pass counts combining Reading Eggs and Reflex Math Pass counts

Chi-Square Expected Value Calculations for Pass Counts:

Chi-Square Expected Value Calculations - Pass	
% of boy appealer pass count against total pass count	$(42/128) * 100 = 32.81$
% of girl appealer pass count against total pass count	$(31/128) * 100 = 24.22$
% of neutral pass count against total pass count	$(55/128) * 100 = 42.97$
Expected passes of boys for boy appealers	$0.3281 * 77 = 25.26$
Expected passes of girls for boy appealers	$0.3281 * 51 = 16.73$
Expected passes of boys for girl appealers	$0.2422 * 77 = 18.65$
Expected passes of girls for girl appealers	$0.2422 * 51 = 12.35$
Expected passes of boys for neutral games	$0.4297 * 77 = 33.09$
Expected passes of girls for neutral games	$0.4297 * 51 = 21.91$

Table 14: Chi – Square Expected Value Calculations for Pass Counts

Chi – Square Analysis – Boy Pass Rate

Chi- Square Analysis - Boy Pass Rate			
	Boy Appealers	Girl Appealers	Neutral Games
Expected	25.26	18.65	33.09
Observed	36	9	32
P Value	0.008248359		

Table 15: Chi – Square Analysis – Boy Pass Rate

Chi – Square Analysis – Girl Pass Rate

Chi- Square Analysis - Girl Pass Rate			
	Boy Appealers	Girl Appealers	Neutral Games
Expected	16.73	12.35	21.91
Observed	6	22	23
P Value	0.000718628		

Table 16: Chi – Square Analysis – Girl Pass Rate

Total Return Counts:

Total Counts - Return				
Independent Variable	Dependent Variable: Return Count			
	Boy Appealers	Girl Appealers	Neutral Games	Total
Boys	33	7	29	69
Girls	5	20	23	48
Total	38	27	52	117

Table 17: Total Return counts combining Reading Eggs and Reflex Math Return counts

Chi-Square Expected Value Calculations for Return Counts:

Chi-Square Expected Value Calculations - Returns	
% of boy appealer returns	$(38/117) * 100 = 32.48$
% of girl appealer returns	$(27/117) * 100 = 23.08$
% of neutral returns	$(52/117) * 100 = 44.44$
Expected returns of boys for boy appealers	$0.3248 * 69 = 22.41$
Expected returns of girls for boy appealers	$0.3248 * 48 = 15.59$
Expected returns of boys for girl appealers	$0.2308 * 69 = 15.93$
Expected returns of girls for girl appealers	$0.2308 * 48 = 11.08$
Expected returns of boys for neutral games	$0.4444 * 69 = 30.66$
Expected returns of girls for neutral games	$0.4444 * 48 = 21.33$

Table 18: Chi – Square Expected Value Calculations for Return Counts

Chi – Square Analysis – Boy Return Rate

Chi- Square Analysis - Boy Return Rate			
	Boy Appealers	Girl Appealers	Neutral Games
Expected	22.41	15.93	30.66
Observed	33	7	29
P Value	0.006408658		

Table 19: Chi – Square Analysis – Boy Return Rate

Chi – Square Analysis – Girl Return Rate

Chi- Square Analysis - Girl Return Rate			
	Boy Appealers	Girl Appealers	Neutral Games
Expected	15.59	11.08	21.33
Observed	5	20	23
P Value	0.000708251		

Table 20: Chi – Square Analysis – Girl Return Rate

Resultant P – Values obtained from Chi – Square Tests:

1. Boy Attempt Rate: 0.001382332
2. Girl Attempt Rate: 0.000012371
3. Boy Pass Rate: 0.008248359
4. Girl Pass Rate: 0.000718628
5. Boy Return Rate: 0.006408658
6. Girl Return Rate: 0.000708251

None of the resultant P – values are significant enough, i.e. all values are less than 0.05. Hence it can be inferred that there is no direct relationship between the gender appeals in games to the learner performance and learning outcomes. Also, the insignificant P – Values in the pass rate suggest that there is no activity which could be considered as unscalable or irrelevant to any given gender.

SURVEY RESPONSES

The survey responses provided certain insights into qualitative aspects of gender-based appeals in game activities.

1. Gender appeals help as a motivational ingredient. However, case study results suggested that it is not significant, as children attempted gender appealing games and neutral games quite often, and even opposite gender appealers at a lesser frequency.

Is there any game element/activity/task (puzzles, arcade items, story characters, quizzes, tests, different kinds of games portraying princesses, ninja etc.) in any of those game-based platforms / tools which tries to attract/appeal children based on their gender?

1. no
2. Ninja Turtles
3. No
4. No
5. yes
6. yes
7. puzzles
8. na
9. yes
10. n/a
11. yes
12. Yes
13. n/a
14. Yes
15. N/A
16. NA
17. N/A
18. Yes
19. yeah, all of those
20. yes some ask for gender and customize the players accordingly
21. no
22. no
23. na
24. yes
25. Monsters and trucks for boys
26. NA
27. NA
28. No

Figure 3: Survey Response: Gender Appeal Presence in Game Activities

If yes, could you please provide corresponding details?

- 1.
2. Kids love Ninja Turtles and Batman
3. N/a
- 4.
5. no
6. the app doesn't ask gender, but it provides different kinds of characters like princesses
7. Learning by gaming definitely feels like your not in a class just playing
- 8.
9. puzzles for boys and story characters for girls
10. n/a
11. funny characters with lots of color
12. the characters I believe are the appeal for children
13. n/a
14. puzzles, characters and quizzes
- 15.
16. NA
17. N/A
18. Quizzes + interactive story
19. puzzles, quizzes, characters
20. abc mouse
- 21.
- 22.
23. na
24. They have different level of questions and you will go to next level once you are done with the current one.
25. Animated trucks and monsters from movies
26. NA
27. NA
28. N/a

Figure 4: Survey Response: More Details on Gender Appeal Presence in Game Activities

2. Survey responders think that there is no game activity which could be considered as insignificant or irrelevant.

Have you found any game task irrelevant or insignificant in any of the game-based learning platforms / tools?

1. no
2. Yes
3. N/a
4. No
5. yes
6. no
7. no
8. no
9. no
10. n/a
11. no
12. no
13. n/a
14. No
15. N/A
16. NA
17. N/A
18. No
19. no
20. no
21. no
22. no
23. na
24. no.
25. not specifically, no
26. NA
27. NA
28. no

Figure 5: Survey Response: Thoughts on Insignificance of Game Activities

LIMITATIONS

The following are the identified limitations of the research conducted.

1. My case study was conducted among elementary aged kids. Hence, it may not be generalizable across higher educational grades.
2. My case study was limited in using only two game-based learning tools: “Reading Eggs” and “Reflex Math”. Extending this to more such tools and platforms might yield a broader result.

CONCLUSION

Summarizing the problem statement, null hypothesis, and Chi – Square data analysis and survey results:

Problem statement: Is gender-based differentiation of games and game elements beneficial with respect to learner performance and learning outcomes? Are some activities irrelevant, or unachievable for any gender?

Null Hypothesis: Gender-based differentiation of games and game elements yields higher learner performance and higher learning outcomes. Some activities are irrelevant, or unachievable for a given gender.

Chi – Square Analysis Results: None of the resultant P – values are significant enough. Hence it can be inferred that there is no direct relationship between the gender appeals in games to the learner performance and learning outcomes. Also, the insignificant P – Values in the pass rate suggest that there is no activity which could be considered as unscalable or irrelevant to any given gender.

Survey Results: Gender appeals help as a motivational ingredient. Also, Survey responders think that there is no game activity which could be considered as insignificant or irrelevant.

Combining the observations obtained from Chi-Square data analysis and survey responses, it can be inferred that the null hypothesis can be proved against. The inferences from the research conducted can be concluded as below:

1. Insignificant P – Values in Attempt Rate, Pass Rate and Return Rate suggest that there is no direct relationship between the gender appeals in games to the learner performance and learning outcomes. Gender appeals only serve as a motivational factor for children to attempt or return to a game, but not to a significant level.
2. There is no activity which could be considered as unscalable or irrelevant to any given gender.

FUTURE WORK

The potential areas of extending my research study to make a very generalizable assertion on my conclusion are:

1. Conduct case studies on multiple game-based learning platforms and their specific gender-appealing games.
2. Conduct case studies with student of middle school, high school and college going ages.

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