

## Supplementary Materials

### Rowe, Asbell-Clarke, Baker, Eagle, Barnes, Hicks, Edwards & Brown (2017). Assessing Implicit Science Learning in Digital Games. To appear in *Computers and Human Behavior*.

Table 1 shows most students with complete data to be included in these analyses were from public schools with low percentages of students receiving free or reduced-price lunches. *Impulse* students were more likely to be in schools where fewer than half of the students are from minority groups. The opposite was true for students in the *Quantum Spectre* study.

Table 1: Distribution of students across school-level characteristics by game.

Percentage of students....	Impulse	Quantum Spectre
	(n=299)	(n=319)
In..	Public	Public
Public Schools	67%	87%
Private Schools	33%	13%
In schools with...	Low % FRL	Low % FRL
0-25% Free-Reduced Lunch	45%	28%
26-50% Free-Reduced Lunch	13%	40%
51-75% Free-Reduced Lunch	17%	0%
76-100% Free-Reduced Lunch	0%	24%
Don't know	25%	8%
In schools with...	low minority	high minority
0-50% Minority students	82%	32%
51-100% Minority Students	18%	68%

In Table 2, students playing both games were likely to be in non-Honors/AP classes where the majority of students were participating in the study. *Impulse* classes were more likely to be taught by a teacher with prior experience using games in their classroom. *Quantum Spectre* classrooms were more likely to be taught by a male teacher and have more than 21 students. They were equally likely to be taught by someone with prior game experience as by someone without that experience.

Table 2: Distribution of students across teacher and class-level characteristics by game.

Percentage of students....	<b>Impulse</b>	<b>Quantum Spectre</b>
	<b>(n=299)</b>	<b>(n=319)</b>
<b>In..</b>	<b>Non-Honors/AP</b>	<b>Non-Honors/AP</b>
Honors/AP class	34%	14%
Non Honors/AP class	66%	86%
<b>In classrooms with...</b>	<b>GT50</b>	<b>GT50</b>
< 50% in the study	16%	5%
50%+ in the study	84%	95%
<b>In classrooms with...</b>	<b>Balance</b>	<b>GT21</b>
20 or fewer students	54%	26%
21 or more students	46%	74%
<b>In classes taught by...</b>	<b>Balance</b>	<b>Male</b>
Female teacher	56%	40%
Male teacher	44%	60%
<b>In classes taught by teacher with...</b>	<b>Game experience</b>	<b>Balance</b>
Prior game experience	79%	51%
No prior game experience	21%	49%

NOTE: AP=Advanced Placement (college-level classes taught in high school).

In *Impulse* classes, students were evenly divided between males and females (Table 3). They were more likely to be upperclassman and have scored at least one standard deviation above the mean on the pre-assessment. Students in *Quantum Spectre* classes were more likely to be males who were freshman/sophomores. The scores on the *Quantum Spectre* pre-assessment were fairly balanced.

Table 3: Distribution of students across student-level characteristics by game.

	<b>Impulse</b>	<b>Quantum Spectre</b>
<b>Percentage of students....</b>	<b>(n=299)</b>	<b>(n=319)</b>
<b>Who were...</b>	<b>Balance</b>	<b>Male</b>
Female	46%	39%
Male	54%	61%
<b>Who were...</b>	<b>Younger</b>	<b>Balance</b>
Juniors/Seniors	39%	51%
Freshman/Sophomores	61%	49%
<b>Whose pre-assessment scores were...</b>	<b>Skew High</b>	<b>Balance</b>
Below 1 S.D.	9%	14%
Within +/- 1 S.D.	61%	73%
Above 1 S.D.	30%	13%

NOTE: “Balance” for characteristics with two levels mean both values are within 40–60%. For the pre-assessment, “Balance” means roughly equal percentages were below 1 S.D. and above 1 S.D.

*Data Arcade* records all game activity including, but not limited to, the duration of gameplay and the highest level of the game played. *Impulse* has 70 levels and *Quantum Spectre* has 180 levels. Given the non-normal distribution of the amount of time students played *Impulse* and *Quantum Spectre*, we categorized students as having played less than 30 minutes, 30–60 minutes, or more than 1 hour. Table 4 displays the percentage of students who played the game less than 30 minutes, 30–60 minutes, and more than 60 minutes as well as the highest game level reached.

Table 4: Duration of gameplay and highest game level reached by study group for each game.

Percentage of Students	Impulse		Quantum Spectre	
	Bridge (n=149)	Game Only (n=150)	Bridge (n=201)	Game Only (n=168)
<b>Duration of gameplay of</b>				
Less than 30 min	42%	65%	13%	22%
30–60 min	29%	16%	29%	38%
More than 60 min	30%	19%	37%	35%
<b>Highest game level reached</b>				
11–20	9%	11%	20%	17%
21–30	24%	19%	29%	44%
31–40	4%	1%	6%	12%
41–50	3%	2%	3%	5%
51–60+	20%	20%	23%	17%

There were significant differences in the duration of *Impulse* gameplay between students in Bridge and Game Only classrooms but not the highest level reached (Duration:  $X^2 [2, N=299]=16.2, p<0.01$ ; Highest Level:  $X^2 [5, N=299]=6.1, p=0.29$ ). Students in both groups were clustered at the tails of the distribution—lowest and highest levels of the game. Students played *Quantum Spectre* for greater durations than *Impulse*. Almost half of the students in *Quantum Spectre*

Bridge classes played for an hour or more while only a quarter of students in Game Only classes did so ( $X^2 [2, N=320]=20.2, p<0.01$ ). Like *Impulse*, students in Bridge classrooms were clustered at the lowest and highest levels of *Quantum Spectre*. This was less true of students in *Quantum Spectre* Game Only classes ( $X^2 [5, N=320]=23, p<0.01$ ).

Previous analyses showed Puzzle 21 to have a high dropout rate (Hicks, Eagle, Rowe, Asbell-Clarke, Edwards, & Barnes, 2016), so we included in the HLM analyses whether or not players who completed Puzzle 21 (1=yes, the player completed the level). There was a significant difference in the percentage of students in the Bridge and Game Only classrooms that reached Puzzle 22 ( $X^2 [1, N=320]=12.5, p<0.01$ ). A similar drop-off occurred in *Impulse* at Level 25, with significantly more students in Bridge classes (38%) than Game Only classes (25%) successfully completing Level 25 or higher ( $X^2 [1, N=299]=7.4, p<0.01$ ). We included a Level 25 completed (1=Yes, the player completed that level) covariate to examine the relationship between *Impulse* game performance and changes in pre/post assessments.