Sokikom Research Study With Navajo Elementary

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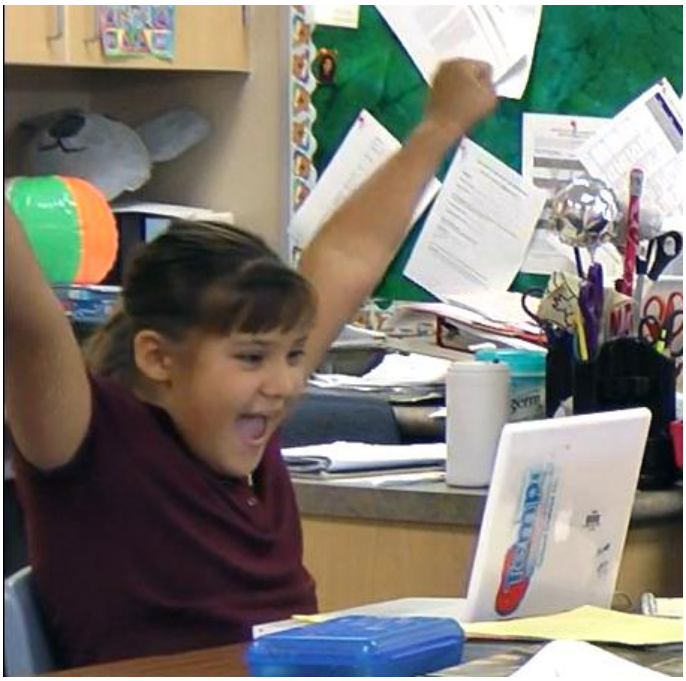
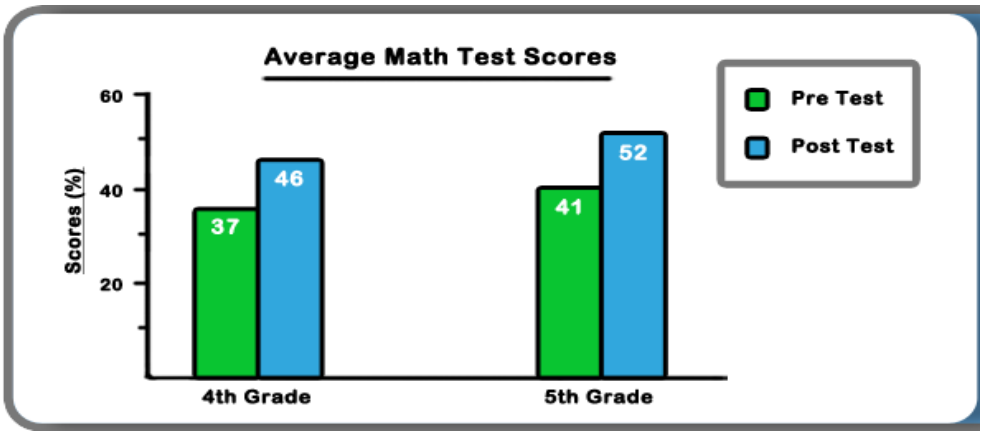
Introduction



Sokikom motivates elementary students in a math social learning game. Developed for grades 1-6, Sokikom emphasizes real-time cooperation and collaboration to engage students in developing math skills and in helping each other learn math. Massively multiplayer online game features combine with NCTM curriculum focal points and Common Core State Standards to provide intense engagement and higher math achievement. There is substantial research to support the hypothesis that games can improve math achievement (Eck, 2006; Prensky, 2001; Randel, 1992; Shaffer, 2005). This empirical research includes meta-analysis of the instructional effectiveness of games compared to conventional classroom instruction. This research has consistently found that games promote learning across multiple disciplines and ages. Research also shows that playing educational video games improves student motivation to learn mathematics (Rosas, 2002). Improved student motivation to learn math has been further shown to result in improved mathematical performance (Cordova, 1996; Gottfried, 1990; Schiefele, 1995; Viljaranta, 2008).

This study will assess the effectiveness of Frachine, a game within Sokikom which teaches fractions, wholes and parts, decimals, and percents. Frachine. In the fall of 2009 Sokikom conducted a pilot study with fourth grade students. Two randomly selected fourth grade classrooms participated, n = 38. Of the 38 students that participated, Sokikom obtained valid data for 35 students. Both classrooms received a shortened math lecture from their teacher and then played *Frachine* for approximately 15 minutes a day, for 7 days. Five of the students played for 30 minutes a day, for 7 days. All students were given a summative pretest at the beginning of the study and a posttest at the end. During the experiment, Sokikom collected observational data from students and self-report data from the teacher to determine the feasibility and usability of the prototype. The research questions being answered were: (1) What effect does playing *Frachine* have on student performance to math standards? And, (2) What effect does does playing *Frachine* have on student intrinsic motivation level to learn math?

Results from the post assessments showed a statistically significant improvement in performance to math standards as determined by mean scores from pretest to post test. Scores improved by an average of 5.4%. The area where most gains were made was in 4th and 5th grade level fraction questions. In these questions there was a mean score improvement of 9.4%. Performance in 6th grade level questions stayed the same from pretest to posttest. The Sokikom team believes that the overall improvement rate, although positive, could be much higher by addressing the following area: (1) the lack of instructional support. The math instrument used during the pilot study included questions that students didn't encounter through game-play. A more appropriate instrument should have greater focus on concepts that are covered during normal game-play. The graph below shows the performance increases for the most impacted grades—four and five.



The Children's Academic Intrinsic Motivation inventory (CAIMI) (Gottfried, 1990) showed a slight improvement from pretest to post test in intrinsic motivation, but not to the extent where it can be considered a real difference. This is likely due to the need for a much longer study required for proper CAIMI usage. This pilot study was significantly shorter than other studies which used the CAIMI. As such, student surveys were also used to determine motivation improvements. Surveys along with observations indicated that students improved their attitude about fractions, enjoyed learning fractions, and were highly engaged.

Sample

2 randomly selected fourth grade classrooms from Navajo Elementary within the Scottsdale Unified School District (Scottsdale, AZ). N = 38. Of the 38 students, valid data was collected from 35 students. The demographic profile for these 36 students is: 18 girls, 20 boys; 4 special education, 4 English language learners, 9 receive other intervention support; 12 Hispanics, 1 black, 23 Caucasian

Settings

Students went to a computer lab in the school where each student had access to his/her own PC. This was done each time game-play was required.

Measures:

Student outcomes were measured by using the following instruments: (1) a mathematics standards test; (2) The Children's Academic Intrinsic Motivation Inventory (CAIMI) , and (3) a student survey. These instruments were part of a pre and post summative assessment. In addition, qualitative data was collected to assess implementation fidelity for student engagement.

The Children's Academic Intrinsic Motivation Inventory (CAIMI):

The CAIMI was developed by Gottfried in 1985. CAIMI has been used in several related studies due to its validity, applicability, and reliability—including a study that revealed that intrinsic math motivation was found to be related to initial and later levels of math achievement (Gottfried, 1990).

Mathematics standards test

Student performance in the fraction specific math standards were tested using a math standards test. There were 17 questions in this test, which ranged in difficulty from grade 3 through 6. The questions were similar to the model questions used to assess fraction understanding in the Arizona Instrument to Measure Standards (AIMS) test.

Student Questionnaire

Students were given a questionnaire to further determine their interest in math, and the benefits/drawbacks of learning math through a game.

Data analysis and descriptive statistics used

A multiple regression analysis was conducted to evaluate how well time spent playing Frachine (in minutes) predicted the posttest score on a math assessment consisting of questions related to fractions. The means, standard deviations, and correlation measures for each of these predictors are presented in Table 1. The posttest scores were positively correlated with the time spent playing Frachine. Both of these correlations were small and were not significant.

To answer the first research question of how game-play affects the performance to fraction math standards, a paired samples t-test was conducted to compare the mean scores of students prior to spending time in Frachine and after spending time in Frachine. The results indicated that the post test mean (M= 8.44, SD = 2.87) was significantly greater than the pretest mean, (M= 7.59, SD = 1.89), $t(35)$= 2.05, $p < .05$. The standardized effect size, d, was .35, with the 95% confidence interval for the mean difference between the two scores being .01 to 1.7.

A paired samples t-test was also conducted to compare the participants mean scores on questions related to grade fractional concepts and skills introduced in the 4th and 5th grades prior to and after spending time in Frachine. The results indicated that the posttest mean scores on 4th and 5th grade questions (M= 3.81, SD = 1.80) was significantly greater than the pretest mean scores on the same measure, (M= 3.08, SD = 1.48), $t(35)$= 2.96, $p < .01$. The standardized effect size, d, was .50, with the 95% confidence interval for the mean difference between the two scores being .23 to 1.22. An identical approach was used to test the understanding of 6th grade level fractional concepts. The results for this segment of questions indicated that the posttest mean score was nearly identical—insignificantly greater than—the pretest mean score. This was likely due to the lack of instructional support and the design of the math instrument. A more appropriate instrument should have greater focus on concepts that are covered during normal game-play.

The final research question to be answered was whether or not time spent in Frachine would result in an increase in intrinsic motivation related to mathematics. The participants completed the Children's Academic Intrinsic Motivation Inventory, (CAIMI) prior too and after the pilot testing session. These results are presented in Table 3. In looking at the averages there was an increase in all of the measures related to the CAIMI from pre to post measures. There was a significant increase in the percentile rank in math from pre to post, 27% to 41%. The percentile rank allows comparison to the normative group. For instance, a student with a percentile rank of 40% means that the student is at a rank where 40% of the students score at or below the student's score. It is difficult to say whether or not this increase is a definitive actual increase because of the reliability measures that are inherent to the CAIMI. The pretest scores have a built in confidence interval of + or - 3 units on the standard error of measurement scale from the initial measure. For scores on each of the scales (percentile, T-score) the standards error of measurement indicates that on a retest the child's score would lie within the provided range (+ or - 3). The posttest T-scores fall within that range. We can conclude then that for the entire sample population there was a slight improvement in intrinsic motivation but not to the extent where it can be considered a real difference. It is likely that this is the result of the small amount of time spent in Frachine per session (approximately 13 minutes) and the small average number of sessions per participant (approximately 7 sessions). All of the other case studies that used the CAIMI instrument were conducted over a period greater than or equal to 12 weeks. Of note, 12 participants had substantial gains in their T –scores which would lie well outside the standard error of measurement. The average increase in these T-scores was 12.5. These students displayed a real difference in intrinsic motivation.

Table 1

Descriptive Statistics for Frachine Math Posttest from Time Spent Playing Frachine, and the number of Sessions of Frachine (N=36)

Measures	Mean	SD	Correlations		
			Posttest	Time	Number of Sessions
Posttest	8.44	2.87			
Time	92.68	29.15	.08		
Number of Sessions	7.28	2.57	.11	.980	

*$p < .05$;

Table 2

Descriptive Statistics for all Measures (N=36)

Measure	**Means**	**SD**
Pretest	7.59	1.89
Posttest	8.44	2.87
Time	92.68	29.15
Number of Sessions	7.28	2.57
Pretest 3rd Grade Questions	3.74	.90
Posttest 3rd Grade Questions	3.85	1.15
Pretest 4th Grade Questions	1.82	1.11
Posttest 4th Grade Questions	2.35	1.35
Pretest 5th Grade Questions	1.29	.80
Posttest 5th Grade Questions	1.59	.86
Pretest 6th Grade Questions	1.29	.80
Posttest 6th Grade Questions	1.00	1.07

Table 3

CAIMI Results (n = 36)

Measures	Mean	Percentile	T-Score
Pre CAIMI Math	92.45	27	44
Post CAIMI Math Total	98.79	41	48
Total Change	6.34	14	4

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