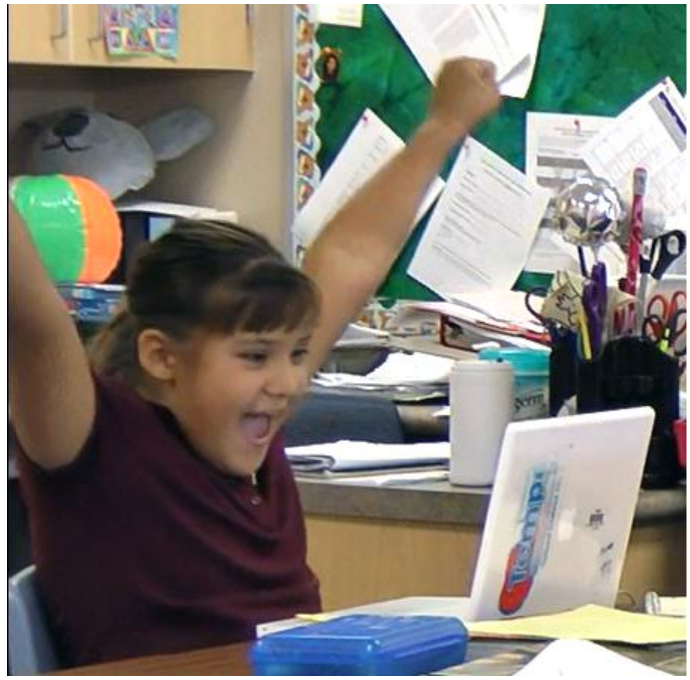
Sokikom Research Study

Navajo Elementary School, Scottsdale, AZ

Contents

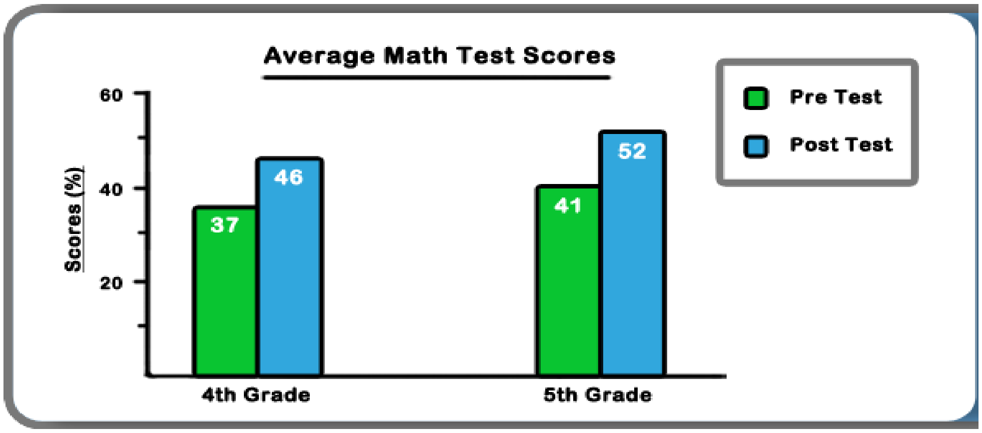
Introduction



Sokikom is the only online math program where elementary students can collaborate in a team-based game to help each other learn math; as well as learning on their own or with teacher assignments. Developed through funding from the U.S. Department of Education, Sokikom is designed for grades K-5. The program 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). The literature includes meta-analyses of empirical studies investigating the instructional effectiveness of games compared to conventional classroom instruction (Vogel, *et al.*, 2006; Ke, 2009). This research consistently finds 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 shown to result in improved mathematical performance (Cordova, 1996; Gottfried, 1990; Schiefele, 1995; Viljaranta, 2008).

The present study assesses the effectiveness of Frachine, a game within Sokikom which teaches fractions, wholes and parts, decimals, and percents. In the fall of 2009, Sokikom conducted a pilot study with fourth grade students. Students from two randomly selected fourth grade classrooms (n = 38) participated. Of the 38 participating students, Sokikom obtained valid data for 35 students. Both classrooms received a shortened math lecture from their teacher and then played *Frachine* for approximately fifteen minutes a day, for seven days. Five of the students played for thirty minutes a day, for seven days. All students were given a summative pre-test at the beginning of the study and a post-test at the end. During the experiment, Sokikom collected observational data from students and self-reported data from the teacher to determine the feasibility and usability of the prototype. The research questions investigated are: (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 pre-test to post-test. Scores improved by an average of 5.4%. The area where most gains were made was in fourth- and fifth-grade level fraction questions. In these questions there was a mean score improvement of 9.4%. Performance in sixth-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 increasing instructional support. The math instrument used during the pilot study included questions that students did not 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

Two randomly selected fourth grade classrooms from Navajo Elementary within the Scottsdale Unified School District in 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 identify as Hispanic or Latino, 1 identifies as African-America, 23 identify as 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.

Results & Analysis

We analyzed how well time spent playing Frachine (in minutes) was associated with 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 to 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.

Conclusion

The present study illustrates the potential for game-based supplemental math programs to improve student learning of fractions. Specifically, this study suggests students' use of Sokikom's Common Core Math Program holds moderate and positive effects on (1) math test scores for fraction skills, and (2) intrinsic motivation to learn math. Sokikom's impact on these two areas is important as the nation increases the rigorous of standards for student learning through the Common Core. This evidence demonstrating students' ability to improve their math learning through a game-based approach while also improving students' motivation towards learning math warrants further study to determine whether there is an interaction between the increases in motivation and the increases in student learning. Similar studies with larger sample sizes and should be conducted to validate and replicate these findings across various student populations. Future studies should also involve a research design that includes control groups to provide more credibility on the findings. It would also be useful to know whether there is differential impact on student learning across English Language Development levels, socioeconomic status, and other variables. Future studies should also investigate the impacts of Sokikom use on student performance in additional measures, like the Smarter Balanced Assessment and the Partnership for Assessment of Readiness for College and Career.

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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