A Study of Impact of Learning to Play Online Chess on 7th Graders' Mathematics Achievement, Self-Regulated Learning, and Attitude toward Math

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Abstract

In this research study, 7^{th} grade students at Pewitt Junior High School who are taking technology applications will be learning and playing chess for 30 minutes each week, using an online chess program, to determine the effect of playing chess on mathematics attitude and basic skills. Both the experimental and control student groups will be tested on their skills in arithmetic reasoning, spatial ability, computational ability, and on their attitudes toward math before and after the study. It is hypothesized that students in the experimental group will have positive growth on some of these skills that contribute to achievement in math, which should, in turn, lead to an increase in students' self-confidence in math problem solving and in self-regulating learning after the study is over. Data sets from these pre- and post-tests will be analyzed according to mean, median, range, standard deviation, and will be compared using t-tests. If the project proves that chess is beneficial to mathematics achievement, chess will remain a part of the technology applications class during the 2011-2012 school year.

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Introduction

The purpose of this research is to find out whether having 7th grade students at Pewitt Junior High School learn and play chess online will positively influence their attitudes toward math and / or increase their aptitudes in arithmetic reasoning, spatial ability, and / or computational ability. Students will learn chess using ChessKid.com and will practice for at least 30 minutes per week.

Problem Statement

Students do not like math because they feel uncertain and nervous about math (Geist, 2010). Over the years 2003-2009, Texas 7th grade students have not performed as well on math TAKS tests as they have on reading TAKS tests ("Percent of Students," 2009). During that same period, from 2003-2009, Pewitt Junior High School 7th grade students performed better on reading TAKS tests than on math TAKS tests in all but two years ("TAKS Campus Aggregate," 2009). Researchers have suggested that there is a link between math and chess. Students who learn and play chess do better scholastically (Gobet & Campitelli, 2005). Math success depends on memory (Ashcraft & Krause, 2007). Learning and working to master chess improves memory, and success in chess encourages all kids to practice self-regulated learning (SRL) and peer-guided learning, no matter what their learning style, through the experience of having many problems to solve in a competitive environment in which they want to succeed (Ferguson, n.d.). Ho (2005) found that SRL has a positive connection with academic achievement. Samuelsson (2008) found that problem-solving increases students' SRL, which in turn, alleviates math anxiety. Cooperative groups and competition has also been shown to increase math scores (Reid, 1992). Therefore, learning chess should enhance students' success in math.

Significance of the study

With the increase in online classes and the probability that students will have to be able to be self-regulated learners to be successful, SRL is currently a popular topic of research. This study may contribute to understanding of the relationship between learners learning to play chess, memory, and mathematics ability. The result of the study may also help educators see how integration of chess playing into mathematics teaching can enhance students learning, self-regulation, and peer interaction.

Hypotheses

1. 7^{th} grade students who learn to play chess and play chess online at least 30 minutes per week will improve their performance on the arithmetic reasoning test of the Career Cruising Ability Profiler (CCAP) online test.
2. 7^{th} grade students who learn to play chess and play chess online at least 30 minutes per week will improve their performance on the spatial ability test of the CCAP online test.
3. 7^{th} grade students who learn to play chess and play chess online at least 30 minutes per week will improve their math performance on the computational ability test of the CCAP online test.
4. 7^{th} grade students who learn and play chess online will develop better attitudes toward math as measured by the MMAI (Sandman, 1980; Welch, 1976).

Review of Literature

Skills that contribute to achievement in mathematics

Research on mathematics education has suggested that certain skills are necessary for achievement in math. Successful math students tend to see differently, suggesting that these students have enhanced visual and spatial skills. Students gifted in math might not score as well on standard IQ tests that weigh verbal and mathematical skills because their gifts cannot be measured verbally. Some children are gifted in math but have verbal learning disabilities or even suffer from dyslexia because of their visual differences. Brain research even suggests that more boys than girls will be gifted in math because their brains are more spatially talented than are girls' brains. Usually mathematically gifted students can memorize numbers and visual information (Winner, 1996).

A strong working memory is also necessary for success in mathematical problem solving, which is strategy-based and / or process-based (Ashcraft & Krause, 2007). Problem solving is one important skill students need to achieve success in math. Marcou and Philippou (2005) studied 219 5^{th} and 6^{th} graders to judge their abilities mathematical problem solving. The authors administered motivational and self-regulated learning (SRL) questionnaires to participants. They found that motivation was related to SLR, and that students who believed in their ability to succeed had more success in mathematical problem solving. So both self-motivation and SLR contribute to success in mathematical problem solving.

Marcou and Philippou suggest that the key to SRL, which is in itself an important characteristic successful math students use, is the students' belief in the task, the goal, and themselves. In fact, SRL has become more important in schools, with teachers attempting to empower their students to perform more independently, especially in math problem-solving. Marcou and Philippou claim that although SRL can help determine success, the element of student volition is also necessary. Volition is when the students feel as if they have control of their own consequences, positive or negative, and their environment, and also feel interested in their own learning and mastery.

Self-regulated learning and the learned skills that support independence

Students who are attuned to their own self-efficacy have been shown to have self-regulated learning (SRL). Ramdass and Zimmerman (2005) studied 42 5^{th}- and 6^{th}-graders to prove that students could learn to be more accurate in self-evaluation, which is one aspect of SRL. In the study, using self-correction strategies increased students' mathematical accuracy and helped them predict how successful they would be in math. The study suggests that students will do better in math if they not only receive mathematical training but also are taught skills to predict how they are going to perform in doing any mathematical task. Teachers can help encourage students to practice SRL by promoting their students' feelings that they will be successful. Students who understand that accurately gauging their self-efficiency will increase their success in math will feel more confident, and in turn, do better in math.

Teachers who teach students problem-solving strategies produced the greatest gains in a study carried out by Samuelsson (2008). When students used problem-solving skills together with their peers, they were more interested in math and more self-confident about themselves and their abilities to solve problems and be successful in math. In fact, Reid (1992) found that cooperative learners benefited from individual accountability, advancements in interpersonal skills and self-esteem, and achieved at a higher level in mathematics. Intergroup competition seemed to be one of the reasons that these students benefitted.

Math anxiety

Math anxiety is a major obstacle to math learning, mastery, and motivation, all of which are necessary to math achievement. Math anxiety also limits a person's working memory, which is important to successful mathematicians. Since math anxiety feeds upon itself by increasing students' avoidance of math, alleviating math anxiety will help math achievement (Ashcraft & Krause, 2007). Geist (2010) suggests that foundations for math success are set at home long before students start school. Math foundations are "order and sequence, seriation, comparisons, classifying, addition" and the abstraction that number symbols stand for values. Teachers' methods, especially timed math tests, undermine students' confidence that they can do math well. Girls and children of poverty are most at risk for math anxiety. Additionally, teachers who are math anxious tend to pass on their math anxiety to their students.

Some skills necessary for success in chess

According to Ferguson (n.d.), who agrees with many other chess researchers, chess might be the one of the answers to all problems in education, from discipline, to motivation, to math and science performance. Experts in teaching math using chess also promise leaps in math achievement (Root, 2008; Buky, 2007). These authors echo the claims of every online organized chess club and of every school that has included chess in its curriculum. Champion chess players are successful at visual tests (Frydman & Lynn, 1992). Chess requires high IQ (Gobet & Campitelli, 2005), or produces higher IQs (Ferguson, n.d.). Chess masters tend to have very good memories, especially in being able to memorize chunks of visual information. (Boettcher, Hahn, & Shaw, 1994). Learning chess can help special education students (Scholz, Niesch, Steffen, Ernst, Loeffler, Witruk, et al., 2008). The question of the true secrets of chess skill is still a fascinating study, and like many research questions, misconceptions and truths exist together.

Hong and Bart (2007) studied 38 elementary students in South Korea to see how learning chess influences cognition. They hypothesized that at-risk students need to develop cognitive skills, and that activities, especially chess, that help develop these skills are more valuable for at-risk students than learning basics by traditional educational practices like drills. To play chess requires learning sophisticated skills and successfully recalling how to apply those skills, which in turn helps heighten cognitive abilities. In the study, novice chess players or those without any background at all received 90-min instruction each week. Although famous studies by Christiaen and Frank suggest the positive tie between chess and achievement, the results of this study do not corroborate these results. The authors suggest that the students needed more time to develop chess expertise in order for the experiment to show those results, and that Christiaen's and Frank's studies did not have subjects that were at risk.

What chess *does* teach students

Some researchers have proven that learning and playing chess is beneficial to mathematical success. Frank (1979) proved that chess can increase students' math (and verbal) scores. Ferguson (n.d.) proved that chess can increase students' critical thinking skills. Buky (2007) and Buky and Ho (2008) proved that specific math skills can be improved when coupled with chess lessons. Margulies (1991) proved that the process of learning chess increases students' self-confidence in other problem solving situations, a conclusion reinforced by Unterrainer, Kaller, Halsband, and Rahm (2006). Chess aids math achievement because generally, students think it is fun; therefore, it creates student interest in small group competition, and helps students internalize problem solving, self-confidence, and self-regulated learning.

Summary of Literature

Chess has long been honored as an intellectual game, whether by those who honor it as the pastime of the highly intelligent or by those who champion it as the salvation of struggling students in scholastic settings. Research has pinpointed some of the skills that success in both chess and mathematics require: visual-spatial insight, strong working memory, problem-solving, and self-motivation. Because chess is an independent, competitive, enjoyable pastime, students have fun learning and playing chess. As they learn to be more successful as chess players, those math / chess success skills get stronger and the chess player becomes a better math student who can cope with math anxiety and have confidence that they can be successful in math.

Research method

Overall approach and rationale for the study

The purpose of this research project is to determine whether having 7th grade technology applications students at Pewitt Junior High School learn chess and play chess online for at least 30 minutes per week will help them improve their attitudes about problem solving skills, their math attitudes, and increase their math achievement.

Site and sample selection

The program will be conducted through the 7th grade technology applications class at Pewitt Junior High School (PJHS). Peer groups, project managers, and some adult stakeholders will provide support for students as they learn and play chess. At PJHS almost all 7^{th} grade students are enrolled in technology applications class. Each Monday and Friday, technology applications students will be given time to learn chess strategies and play online chess with their fellow 7^{th} grade students as part of a chess club using www.ChessKid.com. A random set of 7^{th} graders will compose the experimental group and another random set of 7^{th} graders will compose the control group, which will not participate in learning and playing chess.

Researcher's role

I will be acting as project designer, coordinator, manager, and evaluator. In these roles, I will manage and evaluate all aspects of the project from inception to reporting. I will also be responsible for enrolling students in the program; finding and administering assessments; measuring, analyzing, and reporting data.

Instrumentation

Three assessment instruments will be used during this project:

- Career Cruising Ability Profiler: The Career Cruising program is a unified program which students use to discovery skills, aptitudes, and preferences that lend themselves toward careers. One of the assessment sets is the Ability Profiler, which is, in turn, made up of several assessments. For purposes of finding baseline and ending scores for both experimental and control groups in this project, the results of the following skills assessments will be collected and analyzed:

- Arithmetic Reasoning: According to the Ability Profiler Administrator Manual, this ability assessment tests students' abilities in problem solving using math and logic skills. The pre- and post-test data will be used to determine whether students who regularly play chess improve their problem-solving skills over those who do not play chess.

- Spatial Ability: This assessment tests students' skills in imagining how drawings are related to 3-dimensional reality. The pre- and post-test data will be used to determine whether students who regularly play chess improve their visio-spatial skills over those who do not play chess.

- Computation: This assessment tests students' skills in using basic mathematics skills—adding, subtracting, multiplying, dividing. The pre- and post-test data will be used to determine whether students who regularly play chess improve their computational skills over those who do not play chess.

- Minnesota Mathematics Attitude Inventory: This assessment measures students' attitudes toward mathematics in general. The pre- and post-test data will be used to determine whether students who regularly play chess improve their attitudes toward mathematics over those who do not play chess.

- Informal interviews: Interviews with both experimental group members and with control group members about their progress in mathematics as the year goes on.

Data management and data analysis strategies

Every assessment will be conducted online. All data collected will be archived. To judge participants' mathematics skills, both the experimental and control groups will take the CCAP pre-tests at the beginning of the project and post-tests at the end of the project. To judge participants' attitudes toward mathematics, we will conduct the MMAI pre-test at the beginning of the project and a post-test at the end of the project. For both the CCAP and the MMAI pre- and post-test we will summarize and describe results by calculating mean scores, median scores, ranges, and standard deviations of the data sets to compare pre- and post-~~project~~ treatment data. To evaluate project effectiveness, we will use t-tests for the experimental group and control group data sets to determine whether there is significant difference between the mean scores of the two groups. Both experimental groups and control groups will participate in informal interviews with project administrators throughout the year. Interview results will be summarized for use in final analysis of project effectiveness at the end of the year.

Ethical considerations

- I want all the students to be able to participate, because whether learning and playing chess regularly helps students' achievement in math or not, I think learning and playing chess will be overall beneficial to all students. To ensure fairness, opportunity will be given to the control students to learn to play chess at the end of the data collection period.

- I am not only the program designer, but I will also be carrying out the program and collecting data and formulating results. The most obvious ethical issue of the entire study is, of course, my own personal biases. I think I can be objective, since I want to do what is best for my students, and this research seeks to find out whether using chess in my technology classroom to help students become better math students.
- Students in both the experimental group and in the control group will need to have their parents or guardians give permission. Students will be informed of their participation in the study.

Establishing reliability and validity

- Follow established guidelines of the project in order to be able to replicate the experiment in the 2011-2012 school year to compare results.
- Use standardized tests so that the data is repeatable.
- Ensure that the project has external validity (meaning to the outside world) by choosing the participants randomly from the 7th grade population at Pewitt Junior High.
- Ensure that the project has internal validity (that the project results are due to the experimental factors, not other random factors) by questioning members of both the experimental and control groups throughout the year.

Potential contributions of the study

This study will evaluate the effective of chess on mathematics attitudes and basic skills of the 7th grade students. Both formative evaluation and summative results will help the program manager decide whether to continue, reorganize, or discontinue the program for the 2011-2012 school year.

Limitations of the study

This study will address the impact of 7th grade students learning of mathematics concepts through chess. This may affect the outcomes in a different way than when playing chess in real life. In addition, impact of chess playing will be observed in only one subject, and implications of the study may not be drawn beyond the subject. Students' interest in playing chess and student absences during critical data collection period may affect the quality of data collected. The study will examine a limited number of 7th grade students in a small, rural school. The results of a study held here may not apply to different sized schools or different demographics of students. Therefore, the result of the study may be used with these limitations in mind. This study does not seek to measure the differences girls and boys in the results of the study.

Timeline

Time period	**Task**
August 2010	Administer pre-test MMAI
September 2010	Administer skills pre-test CCAP
Ongoing, 2010-2011 school year	Administer informal student interviews with both experimental and control group members
Ongoing, 2010-2011 school year	Experimental group students participate in online chess instruction and play; control group does not play or learn chess
April 2011	Administer post-test MMAI
April 2011	Administer skills post-test CCAP
End of 2010-2011 school year	Analyze assessment data, report evaluation findings

Budget

The only monetary cost of this project is $50 for a teacher account at the online chess program center, www.ChessKid.com. Student accounts are free. All other necessary equipment (i.e. computers) is present in classroom.

Conclusion

Researchers like Frank (1979), Ferguson (n.d.), Buky (2007), Buky and Ho (2008) have proven that learning and playing chess is beneficial to mathematical success. Some conclude that chess increases self-confidence in problem solving (Margulies, 1991; Unterrainer, et al., 2006). This research project tests the idea that chess might encourage math achievement. Throughout the 2010-2011 an experimental group of 7th graders will learn and play chess online using the website ChessKid.com. Analysis of their pre- and post-test data on mathematics skills tests and mathematics attitude inventories will be used to determine whether chess positively or negatively influenced, or did not influence mathematics achievement when compared to the data analysis result of the control group.

Participants will be a selection of 7th graders that are enrolled in technology applications class at Pewitt Junior High School; Martha Rice is the technology applications teacher and will also oversee the entire research project from inception to execution to evaluation and reporting. The 7th graders involved in the project will have student accounts on ChessKid.com and will spend 30 minutes each week playing and learning chess online. There will be a control group that will not participate in playing or learning chess in any way.

Research questions include whether the experiment group of students will improve their math performance on arithmetic reasoning, spatial ability, and / or the computational ability skills tests and whether the experiment group will develop better attitudes toward math.

Students, both in experimental and control groups, will take pre- and post- assessments using skills assessments on from Career Cruising and a mathematical attitude inventory. Data will be analyzed by examining mean and median scores, ranges, and comparisons between experimental and control data will be made using t-test.

If this research project suggests that incorporating chess into the technology applications class is in any way beneficial to 7^{th} grade math achievement, the chess project will be continued in the 2011-2012 school year with improvements suggested by this experiment.

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Appendix A:

Links to assessment tools

Career Cruising Ability Profiler (CCAP) Manual...
http://www.careercruising.com/newmedia/docs/American/AP_AdminManual_US.pdf

Minnesota Mathematical Attitudes Inventory (MMAI)..
....http://www.crosspulseconsultants.com/MMAI.pdf

Appendix B:

Screenshots of Career Cruising Ability Profiler

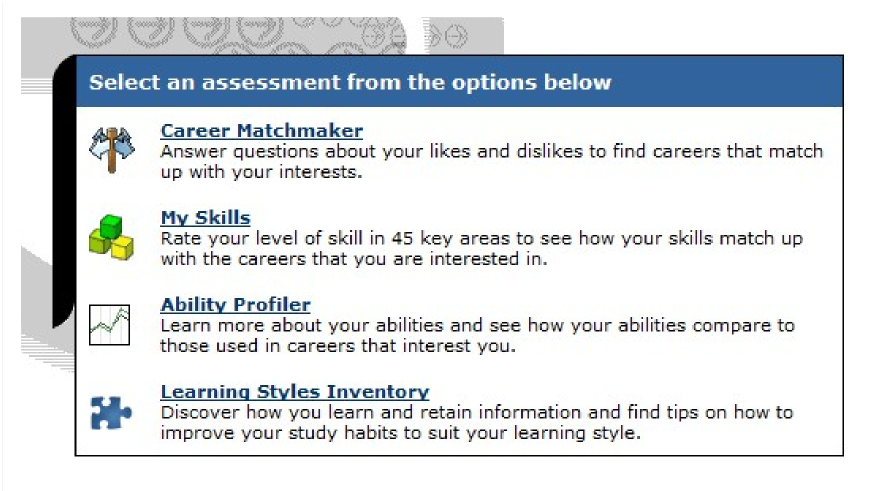

Figure 1. Assessment selection box. This figure illustrates a students' opening page in the CareerCruising.com assessments section.

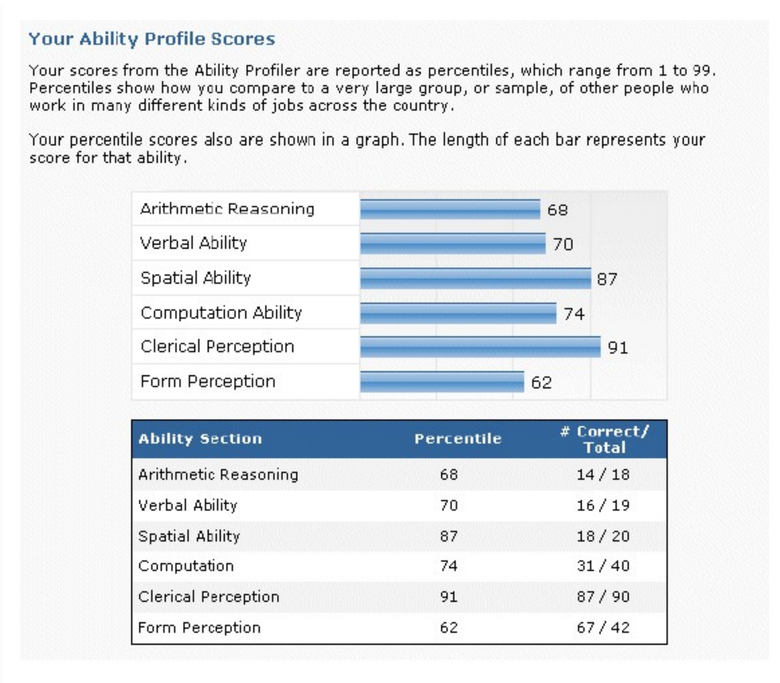

Figure 2. Sample Ability Profile Excerpt. This figure represents a sample of a student's results in all skills ability profile assessments from CareerCruising.com

Appendix C:

Sample questions from MMAI

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Mathematics is useful for the problems of every day life.	①	②	③	④
2. Mathematics is something which I enjoy very much.	①	②	③	④
3. I like the easy mathematics problems the best.	①	②	③	④
4. I don't do very well in mathematics.	①	②	③	④
5. My mathematics teacher shows little interest in the students.	①	②	③	④
6. Working mathematics problems is fun.	①	②	③	④
7. I feel at ease in a mathematics class.	①	②	③	④
8. I would like to do some outside reading in mathematics.	①	②	③	④
9. There is little need for mathematics in most jobs.	①	②	③	④

Figure 3. First questions in MMAI. The entire inventory contains 48 questions.

Appendix D:

Informal interview sample questions

1. What do you dislike about math?
2. What do you like about math?
3. What has been your favorite topic in math this year? Why?
4. What has been your least favorite topic in math this year? Why?
5. What could you do in math to make it easier?
6. What do you do best in math classes?
7. If you could change math class in any way, what would it be?
8. Describe a time you felt frustrated in math.
9. Describe a time you felt really good about math.
10. Who was your favorite math teacher prior to this year? What made her or him your favorite?