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Effect of Chess Training on Math Problem-Solving Ability of Elementary School Students

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ABSTRACT

In this paper, we present the background and the results of a research on the effect of chess training on math problem-solving ability of elementary school students. This paper is an empirical study and is designed with pretest-posttest control-group. The goal of this paper is to determine whether chess training affects the math problem-solving ability of fifth grade elementary school students. Thus, 25 male students were recruited as the experimental group from the fifth grade students of one of the southeast provinces of Iran using cluster random sampling; they were trained in chess for a period of six months. Another group consisting of 41 students was chosen as the control group. Both pretest and the posttest were based on the textbook content of fifth grade of the elementary school. Cronbach Alpha was used to determine the reliability; and for validity, the mean of the experts' opinion was used as the criteria. Fifty-two chess training sessions were held as the educational intervention. The results show that the students who were under chess training (the experimental group) were better at math problem-solving than the control group (non-chess players). These results suggest that chess can be applied as an effective training tool to improve math problem-solving ability of the students.

KEYWORDS: chess training, math problem-solving, elementary school period

INTRODUCTION

The National Council of Teachers of Mathematics (NCTM) always declares that students have to be challenged with unfamiliar and disputable problems (NCTM, 1989). The American dictionary of Oxford (Ehrlich & Flexner, 1980) offers the following definitions for the term "Problem".

1. What is difficult to deal with or to be perceived
2. An exercise in a textbook or in an exam

Another important aspect of the problem's definition is its relative nature. Something that is a problem for a student could be a mere exercise for another student.

Schoenfeld (1985) presents the relative nature of problem as follows: to be a problem is not an inherent property of a math exercise, but there are special relationships between people and exercises that invert tasks into problems for them.

Polya (1945), in his book "How to Solve it", offers a general framework for solving problems and hints on essential details for it. Polya's problem-solving model is a four-step description of problem-solving procedure:

1. Understanding the problem
2. Devising a plan
3. Carrying out the plan
4. Looking back

McIntosh and Jarrett (2000, coded by Stanic and Kilpatrick, 1989) identified three general themes that historically determine the role of problem-solving in school math. The themes are problem-solving as a context to carry out math, problem-solving as a skill, and problem-solving as an art. From the viewpoint of problem-solving as a context, the authors indicate the role of problem-solving in real life, motivating the students by presenting examples from the real life, the entertainment aspect of problem-solving as a fun activity, and its role as an exercise to improve skills and concepts.

Exponents of the viewpoint of problem-solving as a skill, consider problem-solving skills as a separate issue in the curriculum; and do not consider it as a tool to improve conceptual perception and basic skills; such as drawing a picture, looking back, preparing a list, and others.

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Polya (1945) introduced the idea that problem-solving can be taught as a practical art such as playing the piano or swimming. The purpose of teaching problem-solving as an art is to improve students' abilities and to make them professional and enthusiastic problem-solvers.

Although Polya (1945) presented a framework for problem-solving training more than 50 years ago, nevertheless the necessity for widespread use of his ideas is not sensed.

Today, chess is the number one sport in many countries (especially in Eastern Europe and the former Soviet Union); and it is an important mental sport for many of the world's youth. Chess has infatuated many philosophers, scientists, and politicians because of its entertaining power, as well as enthusiastic and rational attractions. People such as Jean-Jacques Rousseau, Benjamin Franklin, and Napoleon Bonaparte were chess players and chess lovers. Chess is a tool to increase intellectual focusing, strengthening memory, raising intelligence, improving designing skill, as well as learning the basics of strategies and tactics. Nowadays, the chess community is involved in designing computers and inventing intelligent systems using the chess elements (Maizelis, 1997).

In any position in chess games, we deal with a problem which has to be solved like a math problem and the steps of this solution is very similar to the four steps of Polya's problem-solving model.

Because no compiled activity is done in the math problem-solving educating area in the elementary schools in Iran, the educational system cannot specifically and effectively step to improve students' problem-solving ability. Therefore, individuals that are capable of solving problems have the skill inherently. Thus, any activity that can cause an improvement in problem-solving ability of the learners has a significant value. Therefore, it is worth to engage in this subject whether playing chess –according to its nature- can improve math problem-solving ability in the learners.

According to the rapid growth of the sport of chess, and many chess applications, using chess at all educational levels in order to improve Iran's math educational situation seems imperative. Nowadays, much research has been done at different characteristics of chess. In addition, because of the differences in culture, religion, geography, economy, and biology, it is possible to have different results in different countries. Therefore, according to the lack of studies related to different chess applications, especially in the educational progress of the students, we must fill the existing void using all interested trainers.

This research wants to answer the following question: "Is chess training effective in improving the math problem-solving ability of the elementary school students?"

LITERATURE REVIEW

Much research has been done on the advantages of learning chess in different areas. The results show that chess can advance capabilities including memory invigoration, concentration (Frank, 1973; Thompson, 2003; Dauvergne, 2000; Liptrap, 1998; Brenda, 2009), Intelligence quotient (IQ), and critical and creative thinking (Ferguson, 1995).

It can also strengthen the imagination (Kazemi, Yektayar, and Mohammadi, 2012); and increase pattern recognition ability (Ferreira, and Palhares, 2008).

Studying and recognizing patterns are important in both math and chess. By recognizing similarities and patterns, we can formulate a strategy in a creative procedure to solve problems; the strategy can also include different choices.

A professional chess player – like a skilled problem solver – considers many suitable patterns, and uses a calculating procedure to analyze and evaluate all of the possibilities in order to make the best decision.

Evidence shows that the game of chess can improve metacognition abilities and other important issues that are essential values for success in challenging activities, like math problem-solving (Kazemi, Yektayar, and Mohammadi, 2012).

Many educational advantages have been cited for chess. Meyers (2005) says, "We brought chess to schools because we believe that chess can participate directly in the educational activities". Chess makes children smarter; and this procedure is done by teaching focusing, visualizing, thinking ahead, weighing options, analyzing concretely, thinking abstractly, and planning.

This 25-member sample which participated in both chess training as well as mathematics course was also studied in a one-group pretest-posttest design. The tests were designed on the basis of the similarities between the chess strategies and mathematics problems solving strategies based on educational goals and textbooks of grade 5. In those tests besides the strategies of "solving simpler cases of problems" and "drawing figures", we have also used the three strategies, "solving subproblems", "pattern recognition" and "guess and check" taken from the textbook and resemble those used in "educational interventions". Finally, the research showed that chess training had a positive and meaningful effect on 5th grade students' mathematical problem solving' abilities(Rezvani, Fadaee and Gooya, 2014).

METHOD

This study is designed using an empirical research method with pretest-posttest control-group (Gall, Borg, and Gall, 1996) to specifically answer the question: "Is chess training effective on improving the math problem-solving ability of the fifth grade elementary school students?". The statistical population of this study is a set of male students of an elementary school's fifth-grade in one of the southeast provinces of Iran; the statistical sample of this study consists of 66 fifth-grade students of an elementary school in one of the cities in the southeast of Iran. The choice of the school is based on two-stage cluster random sampling method (Gall, Borg, and Gall, 1996). A zone from two educational zones was chosen randomly as the first step. As the second step, a school was chosen randomly from the existing schools in the zone. Twenty-five individuals were chosen randomly from 66 students of the fifth grade and were trained for the period of 6 months (the experimental group or the chess player students). The rest of the students that were 41 individuals formed the control group or the non-chess players.

Because the ages of the chosen students were under the 18, before the start of the research, their parents were asked to sign that they were willing their children to take part in the chess training course.

The pretest and post-test included 20 verbal problems that had multi-stage answers. The exams were based on the content of the math textbook of the fifth grade of elementary school, and were prepared by a group of fifth grade teachers of the school and were held under the supervision of the first author (Gall, Borg, and Gall, 1996).

According to the Cronbach's Alpha the reliability of the pretest was 0.821; and the reliability of the posttest was 0.818. To determine the validity, the mean of the opinions of the experts was the criterion. The validity was 0.915 for the pretest and 0.9275 for the posttest.

A group of math teachers of the fifth grade of the elementary school designed the questions, conducted the exams, and corrected the exam papers. The first author of this study fully supervised the procedure. The exam questions were determined based on the educational goals and the content of the fifth grade math textbook. The exams were held at the school's exam hall that had appropriate physical conditions. Before correcting the exams, a complete list of the answers was prepared and the teachers were asked to correct the first question in all the papers then the second question and so forth (Sharifi, 2008).

The research variable was the problem-solving ability of the students that was measured by a pretest and a posttest.

After holding the pretest, 52 chess training sessions for the period of 26 weeks were held based on the lesson plan of the chess federation of Iran; the sessions were held by the chess federation authorized trainers and under the supervision of the first author of this article.

Data Analysis: to determine the normality of the data, Kolmogorov-Smirnov test was used (Conover, 1980). The p-value of the Kolmogorov-Smirnov test determined that the pretest and the posttest scores had normal distributions. Hence, the paired t-test was used for statistical comparison (Gall, Borg, and Gall, 1996).

Research Limitations: A chess-training program limited this research; and the participants were elementary school fifth grade male students. Moreover, the designed training was not directly related to the curriculum of the students. In addition, the time to conduct the training sessions was after the official school hours and the training course was an extracurricular activity; and the results did not have any effect on the educational situation of the students.

RESULTS

In this section, the obtained results of the research data analysis are presented.

According to the statistical tests, it was determined that the chess-player students (the experimental group) showed more progress in the final math exam (posttest) than the non-chess-player students (the control group). The statistical comparison of the pretest and posttest scores of the experimental group is shown in the Table 1 and the statistical comparison of the pretest and posttest scores of the control group is shown in the Table 2.

Table 1: Results of the t-test for comparing the math score means of the pretest and the posttest of the experimental group

	N	Mean	Std.Deviation	t	df	Significance. (2-tailed)
pretest math	25	10.3000	3.58018	-4.289	24	.0001
post-test math	25	12.2100	3.23045			

Paired t-test – for comparing the means of the pretest and post-test scores – shows that the meaningful amount of 0.0001 is achieved, and the assumption of the means' equality is rejected. Comparing the achieved mean from the experimental group's scores shows that the mean of post-test score (12.21) have grown more in relation to the mean of pretest score (10.30).

Table 2: Results of the t-test for comparing the math score means of the pretest and the posttest of the control group

	N	Mean	Std.Deviation	t	df	Significance. (2-tailed)
pretest math	41	9.5366	4.51821	-3.342	40	.002
post-test math	41	10.3902	4.68076			

Paired t-test – for comparing the means of the pretest and post-test scores – shows that the meaningful amount of 0.002 is achieved, and the assumption of the means' equality is rejected. Comparing the achieved means with the control group scores shows that the mean of post-test score (10.39) have grown more in relation to the mean of pretest scores (9.53).

Because the math posttest scores are grown in both of the experimental and control groups in relation to the pretest scores, the t-test for dependent groups is used in order to show the non-equality of the mean of the difference of the pretest and posttest scores of the experimental and control groups. Statistical comparison of the mean of the difference of the pretest and posttest scores of the experimental and control groups is shown in table 3 (Gall, Borg, and Gall, 1996).

Table 3: Results of independent t-test for comparing the mean of the difference of the scores of the experimental group and the control group

	N	Mean	Std. Deviation	Significance of Variances Equality	t	df	Significance. (2-tailed)
Difference of pretest and post-test of the control group	41	0.8537	1.63552	0.160	-2.215	64	0.030
Difference of pretest and post-test of the experimental group	25	1.9100	2.22659				

T-test results for independent groups in order to compare the mean of difference of the pretest and post-test scores of the experimental group and the control group show that the p-value for equality of variances is 0.160; so, the assumption of the variance equality is not rejected. The t-test p-value would be 0.03. We reject the hypothesis that the means of the difference of the pretest and post-test scores are the same in the two groups.

The statistical results show that the chess-player students (the experimental group) showed greater progress in relation to the non-chess-player students (the control group) in the math problem-solving final exam (posttest). Therefore, we make a conclusion that "participation in chess training class is effective on improving the math problem-solving ability of the elementary school fifth grade students".

Conclusion

According to the results of the present research, it can be concluded that:

Chess training can be used as a tool to improve math problem-solving ability. Consequently, it is appropriate that teachers plan to teach chess so that their students become better chess players with the intention to achieve the educational goals of the curriculum.

Moreover, it seems useful that chess be considered as an independent course unit or a part of schools' math scheduling; or, at least it be considered as a part of schools' extracurricular activities, according to the existing nature of chess; in this way, it can increase the happy mood of the students (Maizelis, 1997).

Why chess training improves the students' math problem-solving ability? The answer to this question and other related questions can be the goal of new researches.

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