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Educational impacts of chess instruction in Azerbaijan

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STATEMENT OF AUTHENTICITY

I have read ADA's policy on plagiarism and certify that, to the best of my knowledge, the content of this thesis, "Educational impacts of chess instruction in Azerbaijan", is all my own work and does not contain any unacknowledged work.

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Abstract

Does chess instruction improve mathematical and reading achievements of school students in Azerbaijan? The results in national and international examinations such as the Programme for International Students Assessment (PISA), and the Students State Admission Commission (SSAC), tests have shown that school students in Azerbaijan are performing at a lower level. This paper intends to propose chess instruction in schools as a new approach and possible solution to this problem. The study presented in this thesis explores the educational effects of chess instruction on academic achievement, especially mathematical and reading abilities among primary school students in Azerbaijan. T-tests have been conducted among first, second and third grade (chess and non chess groups) students from two schools in Baku. The results obtained from t- tests indicate that there is an improvement in reading outcomes among second and third grade chess group students. Nevertheless, there is inconsistency in the results of mathematical attainments of students in that only second graders show an improvement in their achievements. In addition, other t- test results indicate that changes in pretest performances in math and reading were not different from changes in the posttest performances in first and third grade students. However, these findings suggest that further research is needed to conduct and examine the educational impacts of chess instruction in more detail in the case of Azerbaijan.

Keywords: Chess instruction, PISA, SSAC tests, academic outcomes, mathematic and reading attainments.

Dedication

For my father who was the first person taught me

to play chess and to think outside of the box.

Acknowledgements

“If you write your thesis with gusto, you will be inspired to continue” says Umberto Eco. Since writing was not an easy journey, I had real challenges of this thesis writing. But the understanding and support of my mother and brother, my professors and my friends as well as the participants of this study encouraged me to focus on and finish my thesis. Many thanks to all those who contributed to this study.

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Preface

"Think of a virus so advanced, it infects not the blood but the thoughts of its human host. Liver and spleen are spared; instead, this bug infiltrates the frontal lobes of the brain, dominating such prime cognitive functions as problem-solving, abstract reasoning, fine motor skills, and most notably, agenda setting. It directs thoughts, actions, and even dreams. This virus comes to dominate not the body, but the mind"

("The Immortal game", David Schenk, 2011, p8)

The prologue of the book "*The Immortal Game*" penned by David Schenk reminded me of childhood memories and made me think again about that obsession. I still feel the positive educational effects of this virus that I called - "chess in my life"!

Having the chess-playing experience and being a policy student, mainly concentrated on the educational field, I can offer you an opinion upon one single idea - a chessboard in a classroom. This minor idea itself leaves great wonder to the power of 64 squared boards and the true nature of its educational effect on children's minds.

Since no research has been conducted, in the local context, on the effects of having chess in classes on students' academic achievements, specifically in math and reading this study is a first vivid glimpse of chess in schools in the case of Azerbaijan. My attempt to conduct a research on this issue grew and I became more curious after having challenges concerning the solutions to the problem of Azerbaijani school students' low performance in both national and international examinations. Therefore, in this thesis, the choice of the topic of chess as a non-traditional academic tool is not

random.

1. Introduction

1.1 Research problem

In the last few years, Azerbaijani school students have scored low at both national and international examinations such as the Programme for International Students Assessment (PISA), or the Students State Admission Commission (SSAC) tests. Azerbaijan participated in PISA in 2006 and 2009 tests. PISA, undertaken by the Organization for Economic Cooperation and Development, is the most comprehensive and large scale international triennial programme to assess fifteen year-old students' knowledge and skills across different countries. The assessment measures the capacity of 15-year-olds in the context to what extent they are capable of using the knowledge and skills to analyze and solve problems they have learned both in and outside of school. Starting in 2000, PISA surveys every three-year have been conducted with a focus on three domain specific cognitive fields - reading, mathematics and science, respectively (OECD, 2006). For each assessment, PISA focuses on one subject area in depth and gives a higher priority to that subject. For instance, in 2006, science was the major domain, while in 2009 greater emphasis was given to reading literacy. (Turner and Adams, 2007) According to PISA reports, in 2006, Azerbaijan ranked 54 among 57 countries and in 2009, 64 among 65 countries in science and reading, respectively. Moreover, PISA 2006 results demonstrate that Azerbaijan ranked 9th in math and 26th in science compared to 27 participating non-OECD countries (OECD, 2006, 2009).

As indicated in Table 1.1, in 2006, Azerbaijan ranked second to last both in reading (with a mean score of 353) and science (with a mean score of 382) among all the participating countries. It is disappointed to mention that the comparison of results

for two years' tests show a decline in performance of students and the mean score of Azerbaijani 15-year-olds is statistically significantly below the OECD average in all domains in both years. Regarding Table 1.1, on a reading scale Azerbaijan's score of 362 was the second lowest of the 65 participating countries. The average reading score was nine points lower in 2006 than in 2009, but the average science and math scores were higher compared to results of 2009.

Table 1.1 Comparison of average point scores of students from Azerbaijan in PISA, 2006 and 2009, with the OECD average

	Reading scale	Mathematics scale	Science scale
Azerbaijan (2006)	353	476	382
OECD average (2006)	492	498	500
Azerbaijan (2009)	362	431	373
OECD Average(2009)	494	496	501
Gain since 2006	(+)9	(-)45	(-) 9

In PISA 2009, high priority was given to reading literacy. According to Table 1.2, on reading sub-scales, the country's students scored higher (373) for their ability to integrate and interpret what they were reading; lower for reflecting on and evaluating what they had read (335) and for reading non-continuous texts (351); and about the same for accessing and retrieving information and for reading continuous texts (OECD Publishing, 2011)

Table 1.2. The average score of 15-year-old students' performance in reading through each subscale

	On the reading subscales				
On the overall reading scale	Access and retrieve	Integrate and interpret	Reflect and evaluate	Continuous texts	Non continuous texts
362	361	373	335	362	351

Moreover, PISA describes the performance of students either in six or seven levels from the lowest "Level 1 a" to the highest level. This system of evaluation allows countries to understand which tasks their students are successful or unsuccessful in completing. The highest proficiency level for math and science is six, while for reading it is five. According to the proficiency level claim, all modern knowledge society students should perform at least at Level 2 or above, which demonstrates the development level of students' problem solving and reading skills. According to PISA experts, only after Level 2 students start to demonstrate knowledge competencies that will allow them to participate actively in life situations related to science and technology.

However, the majority of students in Azerbaijan were able to cope with Level 1 tasks, which shows limited scientific, math and reading knowledge that can be applied to few, familiar situations in comparison with level 6 when students clearly demonstrate advanced thinking and reasoning and can apply their knowledge even to unfamiliar scientific and technological situations. In a nutshell, PISA results demonstrated a downturn in the educational landscape of Azerbaijan, which is not only associated

with the school curriculum, but also to the confrontation of knowledge and skills of students with unfamiliar real-life challenges. Not much has been written on the reasons for the results of PISA and its effect on school system performance in Azerbaijan. However, the publication of the OECD report on the PISA in 2006 and 2009 studies provided the broad picture of results of Azerbaijani school students' educational attainments.

Despite the fact that Azerbaijan left the PISA survey in 2009, the students' low results in national entrance examinations demonstrate that the problems are still continuing and becoming more aggravated. According to the annual report of SSAC, for the last years, overall school graduates do not assimilate 49-76 percent of the school program and have difficulties applying the lessons learned in practice. Azerbaijan is the first country in the former Soviet Union to initiate a university admission system, which reflects the outcomes of the acquired knowledge and skills over an eleven year period. The examinations are based on current school curriculum and all items consist of multiple choice and open-ended questions. Currently, the SSAC holds four types of University Entrance tests based on university programs, which include Science and Engineering (SE), Economy and Management (EM), Humanities (HU) and Medicine and Biology (MB). Reading (Azerbaijan language) and Math are contained in all group tests. Examination scores are calculated on the scale of 0-700 points and the minimum admission score has been decreased to 150 points in the recent years. As indicated in Table 1.3, the reasons for a significant decrease in admission scores to higher education institutions are linked to the percentage of students who scored very low in the exams.

Table 1.3. The percentage of school graduates who scored less than 200 points in SSAC in 2010-2014

Years	The percentage of students who scored less than 200 points
2010	61.60%
2011	62.44%
2012	64.65%
2013	64.97%
2014	64.65%

The results show that academically traditional methods fail to achieve the desired outcome, and require long-term perspectives to improve the academic performance of students. Numerous projects have been undertaken to fix the existing problems of Azerbaijani school students. For example, there were various joint projects undertaken by World Bank for introducing a new curriculum model, focusing on preparation of teachers and improving school qualifications. The curriculum reform was launched on the base of the first Credit agreement between the Republic of Azerbaijan and the World Bank, which was expected to cover the period of 1999-2013 (World Bank, 2003). According to this reform, the implementation stage of new curriculum started in 2008.There is no single trigger or reason – thus, an effort should be made to propose a solution to the issue of low academic performance of students, specifically in math and reading.

I have come to believe that this failure can be remedied by incorporating chess into classrooms, as do some 30 countries that implement chess in school curriculum as an academic subject to improve mathematical and reading/cognitive skills of

students. For example, the study conducted in Italy by Trinchero (2014) shows that chess significantly improves children's scores on the OECD-PISA Mathematics Scale, given certain conditions such as teachers' approach and the duration of chess lessons.

1.2 Methodology, Research Aim and Research Question

The purpose of this study is to reveal the educational impact of chess instruction in Azerbaijan.

Research Question - Does chess instruction in schools improve the math and reading achievements of students in Azerbaijan?

This research is aimed to determine the effects of 45 minutes of chess instruction on mathematics and reading achievements of Azerbaijani school students.

Table 1.4 Conceptualization and Operationalization

Variables	Conceptualization and Operationalization
Chess instruction	Study intervention consisted of 45 minutes of chess instruction delivered for 2nd and 3rd grade students by classroom teachers or chess instructors. The instruction included chess theories, chess basic rules and practice, which consists of games and chess puzzles. First and foremost, chess is a game, it is a clear fact. However, as multiple studies have been conducted and have shown, chess can be a part of school curriculum as an educational tool. Chess instruction has been practiced in public schools for many years in different countries such as Russia, Turkey, Venezuela, Iceland and others, as

	an academic instrument. This could enhance mathematical and reading skills of students through improving attention, memory, concentration and critical thinking. In this study chess is perceived as an academic activity, rather than a sport.
Reading and Math	In PISA 2009, the major domain was reading and the definition of reading literacy was as follows: "*Understanding, using, reflecting on and engaging with written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society."(PISA, 2009)* The words that are mentioned in this definition, such as "understanding, using, reflection" are linked to cognitive abilities, which require having good attention and concentration skills. The definition of math is given as follows according to the PISA 2009: *"An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen"(PISA, 2009)* This definition of mathematics is concerned with mathematical knowledge and skills such as coordination, and spatial reasoning, which would assist students to

	figure out and solve mathematical problems in unfamiliar situations. In this study, first, second and third class students' final academic grades are used as an outcome measure.

Limitations

Due to time constraints, I have not been able to carry out an experiment on chess myself and I have had to rely on quasi-experimental designs. Therefore, the external validity in this study could be weak. In addition, I did not have a big enough sample size and many variables to conduct statistical analysis for determining the causality between chess and students' math and reading abilities.

Summary and contribution of the research

This study is the first initiative that has been conducted to reveal the relationship between chess and education. It is an innovative research, which establishes a novel solution to the issue of school students' low performance on math and reading abilities in Azerbaijan. Since the traditional methods do not appear to achieve the desired outcome, the findings of this study could have a number of important implications for general education in Azerbaijan. In addition, the research may contribute to the understanding and perception of chess in schools as an educational tool, which can lead to incorporation of chess into the national curriculum with the proper

implementation.

This chapter provides an overview of the research problem, research question, methodology and limitations in this study. The second chapter of the thesis presents the literature review that consists of two parts – studies conducted to reveal the effects of chess instruction on math, cognitive and reading abilities of children and the background of “chess in schools” project. The third chapter deals with the methodology and the outcome of this study.

2. Literature Review

Introduction

The research about chess and its educational benefits has received much attention since the 1970s. However, it is necessary to mention that Benjamin Franklin's "The Morals of Chess", which was published in *The Columbian Magazine* in 1786, is considered one of the earliest texts on chess. This article demonstrates the link between chess and education and specifically, by writing 'several very valuable qualities of the mind, useful in the course of human life, are to be acquired or strengthened by chess, so as to become habits, ready on all occasions' author emphasizes the importance of learning through chess. In addition, he points out that playing chess teaches us foresight, circumspection and caution.

Questions such as whether chess can improve the academic attainments of students or whether it can really enhance math and reading skills are very difficult and inconclusive to answer and the main obstacle occurs because of the interpretation of the results of statistical analysis from chess studies. Approximately in thirty countries around the world, including Venezuela, Iceland, Russia, Canada and the USA, chess has been part of the curriculum, and it has been used as an educational tool to increase students' academic performance in schools since 1980's (Ferguson, 1995).

In Azerbaijan, in 2012, chess was integrated into school curriculum as a part of a chess pilot project in some schools, according to the joint memorandum signed by the Ministry of Education, The World Chess Federation and The Azerbaijan Chess Federation (edu.gov.az, 2012). Chess classes were designed to train second, third and fourth grade school children and recently more than 500 secondary schools use chess as a subject in Azerbaijan. There is a paucity of studies that have been conducted to identify the educational impacts of chess instruction in schools in the local context

of Azerbaijan. Therefore, it is not clear whether in Azerbaijan, chess instruction is a matter of tradition to promote the game or it could lead an improvement in math and reading outcomes of children. However, considerable amount of international studies have been written about the educational impacts of chess. Regarding the availability of international sources, this chapter will review, analyze and compare the existing published literature considering their relevance to the research question of this study. The main goal of this literature review is to identify the extent to which existing studies support the idea that chess instruction in schools enhances mathematical, cognitive and/or reading abilities of school students.

In a nutshell, this literature review has been designed in the following manner: the first part of literature review will establish the discussion on the relationship between chess and academic attainments of children. In this part of literature review, the studies that examine the impact of chess intervention on mathematical, reading/cognitive outcomes have been chosen and the results and the methodologies from these chess studies are presented. The second part of literature review will provide a background of the "Chess in Schools" initiative as a concept to provide its comprehensive understanding.

The impact of chess instruction on student's mathematical and reading/cognitive abilities.

Numerous studies have been conducted to demonstrate the impact of chess instruction on students' academic outcomes, specifically mathematical and reading/cognitive abilities (for example, Christiaen 1976; Frank, 1978; Liptrap, 1998; Ferguson, 1986 and 1995; Margulies, undated; Smith and Cage, 2000; Barret &Fish, 2011; Robert Boruch, 2011; Kazemi et al, 2012; Trinchero, 2013).

The results of these studies support the idea that chess instruction in schools leads to significant improvement in mathematical and reading/cognitive attainments of children. According to the studies, positive relations between chess and education is grounded by evidence, as regularly playing chess is associated with improvement in several abilities, including problem solving, analytical/critical reasoning, high level of attention and concentration on chessboard which is important to enhance mathematical and reading skills. One of the earliest studies, conducted by Christiaen, in 1976 in Belgium, revealed that chess teaching in schools, was effective as an educational tool for developing the cognitive abilities of students. The researcher of this study used only post-test by randomly selecting twenty-five students from Belgian boys' schools. Chess instruction was taken as an independent variable and Piagetian tasks and school results were considered as dependent variables of this study. In addition, the author used a seven round chess tournament with the Swiss system to determine the chess level of participants. According to the results of the research, after two years of chess instruction, chess group students showed significantly better results in Piagetian tasks and regular school testing than non-chess group students. The main strength of this study is the randomized selection of participants and variety of measures. However, this method of analysis also has a number of limitations regarding the lack of reliability of the results, taking into account that no pretest was conducted, as well as the fact that participants of the study were only males. Another similar study was conducted in Zaire by Frank (1979- 1981) who investigated the effectiveness of chess instruction to develop cognitive aptitudes, spatial ability and verbal ability in children. During the study, chess instruction included chess games theory, tests and practice and were taught to 92 students aged 16 years old. Compared to a Belgian study conducted by Johan Christiaen (1974-76), in this research both pre-tests and post-tests were given.

The results of this study revealed that the performance of the experimental group was better than the control group and chess led to an improvement in the children's numerical and verbal aptitude. The strength of this research is not only a random allocation of the participants, but also utilization of a variety of measures such as primary mental abilities test, differential aptitude tests, general aptitude tests battery and D2 test of Brieckenkamp (test for attention). It has been conclusively shown from these studies that the chess group showed better cognitive skills after chess instruction. However, findings in the study by Hong & Bart (2007) are not consistent with the findings of these studies. In Hong & Bart (2007), authors do not support the cognitive benefits of chess instruction, because the achievements of the experimental group in cognitive tests, who were students at risk for academic failure, were not different from the control group. The result of a lack of cognitive effects of chess instruction was explained by two interpretations in this study: a) the students at risk for academic failure could require more time for chess instruction; b) novice chess players at risk for academic failure need to develop their chess skills at a certain level to improve their cognitive abilities. Similarly, according to the articles of de Groot, academic benefits of chess are significantly different between those who are “highly skilled” and those who are new to the game of chess. Thus, “low level gains” from teaching chess such as improvements in concentration and attention are more expected than “high level gains” such as enhancements in intelligence and creativity (de Groot, 1977, 1978).

Furthermore, findings from several studies have considered a positive relationship between chess instruction and students’ math and reading attainments. Liptrap in his study “Chess and Standard Test Scores" (1998) found out that in a large suburban school district near Houston, Texas teaching chess in schools increased the mathematical and reading abilities of elementary school children. The researcher explored the claim whether elementary school children increased their standardized test

scores by taking one hour chess classes per week and he compared the students' third and fifth-grade scores on Texas Assessment of academic skills. In the same way, in the methodology part of my study, T test was done comparing the first and third year grades of students who did not take chess class in their first year. According to the results of Liptrap's study, there was an improvement in the academic performance of students in math and reading. However, no data is provided on the statistical reliability of the results. In contradiction with previous studies, (e.g.Christiaen, 1976 or Frank 1979), this research does not take into account random allocation of participants which demonstrates that the participants of the study could be self-selected, as well as the number of male participants in the chess group (74.6%) exceeded the ones (50.8%) in the non-chess group. However, the study has a number of strengths such as large sampling, pretest and posttest and the duration of chess classes. Similar experimental design has been used by Margulies in his research. Both studies (Liptrap and Margulies) are quasi experimental, which makes results not valid and tentative.

Margulies's research "The effect of chess on reading scores" was carried out in 1991 in New York City's District Nine. He has concluded that there is a positive relationship between reading scores of students and chess instruction. In the first year, students were trained by chess masters and teachers, however, in the second year, chess instruction was enhanced through adding computers and software chess lessons to the experiment. After evaluation of two years chess program and using both pretest and posttest, it has been shown that the students in the chess group demonstrated reliably significant improvement in reading scores compared to the average student in the country and the average student in the school district. Despite the fact that chess group students showed an increase in their reading ability, the author does not provide a single explanation of this correlation. He points out that "Chess players combine high level processes - knowledge and information about the

position - and an interactive.

approach in which each “candidate move” is considered much like a word or phrase in reading. The cognition processes are very similar. Both chess and reading are decision-making activities and some transfer of training from one to the other may be expected” (Margulies, 1992, p 9). According to another article of “Chess in Modern Education” by Marcel Milat, it has been suggested that “Chess develops cognitive and attention skills. Furthermore, chess forces adolescents to visualize concepts and piece movement. This may allow for better visualization (interpretive) skills when reading” (Marcel Milat, p 94,).

In a quantitative research of 2011, Barret and Fish conducted a causal-comparative study to identify the effects of teaching chess to students’ math achievements in the sixth, seventh and eighth grades in a suburban middle school in southwestern United States. The study fails to claim causation and generalizability, but the results support the idea of using chess as an effective academic tool for students who receive special education services. In addition, this study detected that there was a significant relationship between chess instruction and end-of- year grades as well as the significant relationship between chess instruction and mathematics Texas Assessment of knowledge and Skills (TAKS) test scores. In another study, Smith and Cage (2000) point out that chess instruction affects positively mathematical achievements of rural, African-American secondary school students in Northern Louisiana. Specifically, the findings show that the scores of participants in mathematics achievement and non-verbal cognitive ability were significantly higher in the experimental group than in the control group. The study design encompassed 120 hours of chess instruction and involved treatment groups including 11 females and 10 males. The results were reported after controlling for differences among pretest scores (Smith and Cage, 2000).In a more recent study “Investigation of the impact of chess play on developing meta-cognitive ability and math problem-solving power of students

at different levels of education" Kazemi et.al(2012) investigate the effects of playing chess to the cognitive abilities. According to the study, after adjusting for post-test scoring the chess group participants that were composed of 86 randomly selected students from fifth, eighth and ninth grades from schools in Shanandaj in Western Iran performed higher in mathematics test scores. The study demonstrates that chess teaching improves significantly the mathematical abilities and the meta cognitive capacities of school aged children.

Nevertheless, there is inconsistency with these studies, in that it is difficult that to identify the reasons for the improvement is only chess instruction or some other variables have also an effect. Therefore, the findings are not enough to establish conclusions about the direction of causality between teaching chess and students' academic outcomes (Gobet & Campitelli, 2002). For instance, in the critical review on "Education and Chess" ,Gobet and Campitelli (2006) point out three possible views on that matter: a) the evidence presented about the educational impact of chess instruction is uncertain; b) several intervening factors such as motivational problems (lack of abilities to deal with practice of game in a short period of time) could appear among children in the learning process of chess; c) chess instruction may lead to an improvement specifically for novices, but not significantly for advanced players.

Recently, two Italian chess studies have been conducted during 2010-2014 to find out the relationship between chess and math learning. "Chess in school can improve math ability? Differences between instructor training and teacher training" (2014) and "Can Chess training improve PISA scores in mathematics?"(2013) by Roberto Trinchero emphasize that chess learning increases the mathematical abilities of primary school students, however, several precise conditions should be taken into account in chess instruction such as the duration of chess trainings and the teaching approach to chess classes. In the study of "Can chess training improve

PISA scores in mathematics" that involved 568 primary school children in Italy, the participants were subdivided in four groups: 1) experimental,2) control, 3) experimental without a pretest ,and 4) control without a pretest (Trinchero, 2013). In the study, the experimental group with chess instruction showed statistically significant increase in problem-solving skills on complex tasks and this improvement is greater in subgroups that have received more hours of chess in- presence lessons as well as have achieved higher level in online training. Trinchero offers an explanation for improved results that "the increased capacity of the pupils of reading and interpreting correctly the mathematic problems, apply their mathematic knowledge and reflect on their own actions and strategies, as effect of chess training" (Trinchero, 2013, p14). As shown in Table 3 the author has used the OECD-PISA items in the study to indicate math abilities of third grade students regarding the different levels of difficulty, through estimation by Oecd-Pisa.

TABLE 2.1.OECD-PISA items used in the study

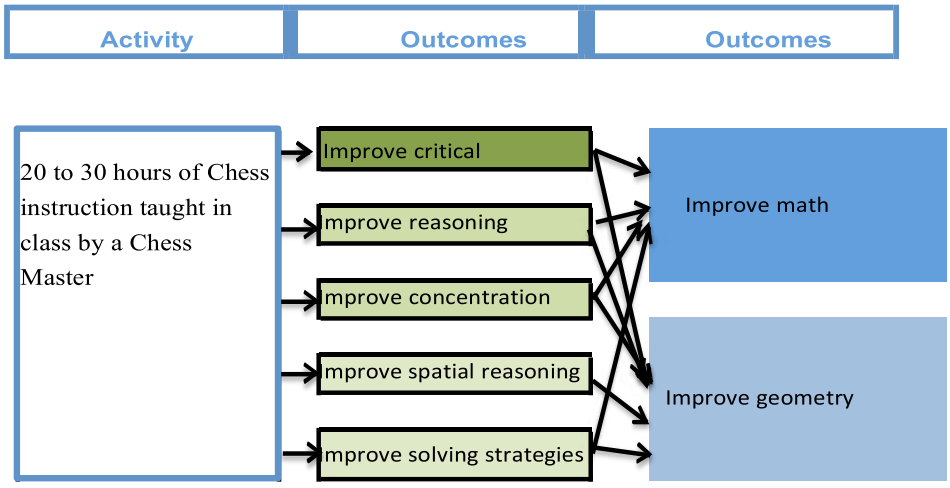
Item	Oecd-Pisa item code	Math abilities involved	Estimated difficulty (fromOecd-Pisa)	Score	Analogy with chess ability
10	M145Q01	Calculate The number of points on the opposite face of showed dice	478 (Level2)	0/1	Calculate material advantage
11	M806Q01	Extrapolate a rule from given patterns and complete the sequence	484 (Level4)	0/1	Extrapolate checkmate rule from chess situation

12	M510Q01T	Calculate the number of possible combination for pizza ingredients	559 (Level4)	0/1	Explore the possible combination of moves to checkmate
13	M520Q1A	Calculate the minimum price of the self-assembled skateboard	496 (Level3)	0/1	Calculate material advantage
14	M159Q05	Recognize the shape of the track on the basis of the speed graph of a racing car	655 (Level5)	0/1	Infer fact from a rule(e.g. possible moves to checkmate)
15	R040Q02	Establish the profundity of alake integrating the information derived from the text and from the graphics	478 (Level2)	0/1	Find relevant information on a chessboard
16	M266Q01	Estimate the perimeter of fence shapes, finding analogies in geometric figures	687 (Level6)	0/1	Find analogies in chessboard situations

Source: “Can chess training improves PISA scores in mathematics?” Trinchero, 2013:

Furthermore, Trinchero has continued his research in another study - “Chess in school can improve math ability? Differences between instructor training and teacher training (2014).This study investigated two different teaching approaches (chess lessons performed by chess instructors and by a classroom teachers).The findings from the study demonstrated that the improvement is greater in problem solving ability in mathematics when chess instructors rather than classroom teachers teach the chess classes. Therefore, increasing the number of chess instructors is more necessary, which can assist to transfer chess skills such as problem solving, analytical reasoning and coordination to other domains such as mathematical ability. Similar results have been suggested in the study that was written by another Italian researcher, Barbara Romano in 2011. His study draws a conclusion that chess instruction in schools can improve math outcomes of 3rd grade students by a third of a standard deviation. Based on the approach used by author, the links between chess and mathematics is justified through the following logic model:

Figure1. The SAM (Chess and Math Learning) program Logic Model



Source: “Does playing chess improve math learning?” Barbara Romano, 2011, p7

As follows from the figures shown above, by playing chess students enhance

critical thinking, reasoning, concentration, spatial reasoning and solving strategies which are associated with an improvement in math and geometry abilities. In another study, “On the effect of chess training on scholastic achievement” the author writes that:

> In chess, one must engage in this sequence of (1) position comprehension, (2) pattern induction, and (3) move formulation and evaluation relatively quickly. This coordinated set of cognitive skills required in competent chess play likely transfers to the learning of mathematics and related fields that also often require comprehension, induction, analysis, and evaluation of complex phenomena (Bart, August 2014,Volume 5, Article 762 : page 2)

There are numerous mathematical problems associated with chessboards and by analyzing and evaluating chess positions and predicting the outcome of moves, children can transfer the knowledge and skills to other domains such as math abilities, because chess is not about pieces, but rather coordination, concentration, planning ahead and problem solving.

Background on "Chess in schools" projects

"Chess in schools" projects are supported by several international chess organizations such as European Chess Union, World Chess Federation as well as national educational organizations of countries. FIDE’s (World Chess Federation) Commission for Chess in Schools was founded in 1984 for the purpose of promoting the game of chess and increasing the potential of chess players in the countries around the world (The booklet of FIDE, 2014)

However, the implementation of Chess in Schools project indicates that there was a shift to interest in chess, that chess is not only used to prepare chess players but also to utilize this as an educational activity in schools. According to the written declaration on chess which was announced on 13 March 2012, by Martin Schulz, president of the EU Parliament, chess projects were launched in EU member states, however they were also incorporated into schools outside the EU. The primary purpose of this declaration is to encourage chess classes in schools for the purpose of not only promoting the game of chess, but also seeing the educational benefits of learning and teaching chess. Regarding this programme, several EU member states such as France, Italy, Spain, United Kingdom and others have promoted chess in their schools. For instance, in France the program for chess was launched in January 2011 but developed after the EU declaration on chess and the main purpose of adding chess into schools' curriculum was to improve pupils' competencies in sciences and technologies and to decrease the rate of innumeracy among them. Another example is Spain where an experimental programme for chess was launched in 2007 and the government supported the idea of incorporating chess in the school program. In the context of Spain, the chess programme was not only designed to focus on the improvement of concentration and logical thinking of kids, but also to prevent discrimination and eliminate racism among students. According to the estimation, in Spain teaching chess is spread in around 1000 schools and chess is considered as an effective part of academic program (Ragonnaud, 2011). Scientific research was conducted on the educational benefits of chess in Spain by the universities of Girona and Leida. The findings highlighted the positive impact of chess instruction on mathematical and reading scores among children. As a result, Spain has incorporated chess into school curriculum as a compulsory subject in 2015. (Malcolm Pein, 2015).

In Italy, the Italian Chess Federation supports chess lessons. In Piemonte 21,000 children have benefited from chess lessons as a part of a chess initiative in 2009-2010. Furthermore, in the last few years, Italian chess studies (Trinchero, 2012, 2013; Argentin, Romano, Martini, 2012) have received much attention in scholarly literature. Specifically, Trinchero has conducted a study to determine the effects of learning chess on children's math abilities based on the OECD-PISA mathematical scale (Trinchero, 2014). Starting from 2005, chess has been incorporated into classrooms in Turkey; 12,000 chess classrooms were opened within the framework of the chess initiative and it has been taught as an elective subject in schools. The objective of chess programme is to increase the intelligence of Turkish kids as well as to make the game of chess a main sport in the country. Moreover, chess serves as an instructional activity in many other countries around the world, including Hungary, Romania, Greece, Moldova, Slovenia and Algeria.

Chess is also very popular game in Azerbaijan and many programs have been implemented for the promotion of this game. The "State Program on development of chess in Azerbaijan in 2009-2014" was approved by the Decree of President Ilham Aliyev, and Azerbaijan is the only country among the members of FIDE which has established this development programme. The launch of this development programme aims to propagate the game of chess in Azerbaijani society and to increase the number of potential players. Although as a sport it has always been a popular activity in Azerbaijan, chess has not been perceived as an academic tool in the local context.

However, in 2012, the Azerbaijani government introduced chess into primary schools within the framework of pilot project for chess. This idea of incorporating chess into the national curriculum became real after the meeting of Ilham Aliyev, President of the Republic of Azerbaijan with FIDE President Kirsan Ilyumchinov in August 2012. As a

result of this meeting, the Ministry of Education of Azerbaijan, the World Chess Federation and the Azerbaijan Chess Federation signed an agreement on incorporating chess into schools' curriculum (edu.gov.az, 2012). In the beginning, the pilot project for chess was initiated and implemented within the framework of the "State programme for the Development of Chess". Chess is taught as an optional subject by chess trainers and classroom teachers. Bringing chess into the national curriculum aims to increase the number of chess players and to benefit from the educational effects of the game. In order to achieve this goal, in January 2012, for the first time chess was taught in several schools in the cities and regions of Azerbaijan (www.edu.gov.az, 2012). The first year of implementation of the project demonstrated that chess could be used as a non- traditional educational tool to improve academic outcomes and cognitive abilities of students. Therefore, the interest in this project grew and chess pilot project became popular in all parts of the country, which resulted in an increase of the number of chess classes in 2013 - 2014.

Conclusion

To sum up, some results from studies are quite convincing such as the Italian studies conducted by Trinchero. Reviewing the literature, it is clear that most studies have mainly focused on methodology design; however, in conducting a research about chess and education, some other questions need to be asked in the studies. For instance, if chess group students show an improvement/no improvement in their academic attainments, is it due only to chess instruction or could other factors also be reasons such as school qualification, effects of teachers' approaches and the duration of chess classes. In future studies, it is necessary to research these factors in order to provide convincing and a conclusive explanation of the educational impacts of chess instruction. Also, the findings from literature show that studies have a number of

possible limitations in their methodology that several factors should be better controlled, such as the selection of participants and utilizing both posttest and pretest.

3. Methodology

Introduction

The purpose of this study is to demonstrate the impact of chess instruction on school students' academic achievements, mainly on mathematics and reading outcomes, in Azerbaijan. This chapter provides an overview of the methods and research design used in this study. Specifically, in conducting this investigation, this part of the study will focus on (1) the sample presentation; (2) procedure of experiment; (3) the results of the experiment and (4) discussion. Quantitative approach is the main methodology used in this study, however, an interview with a chess teacher who works in a chess pilot school and the researcher's participant observation in a chess class, which will be used in the discussion part, serve as examples of qualitative methodology. Conducting accurate experiments to examine the use of chess instruction, as an intervention for increasing math and reading achievements of students, requires precise work on methodology. According to researchers - Gobet and Campitelli, a convincing experiment on the educational impact of chess instruction is difficult to conduct; however, the following requirements should be taken into consideration:

> "Random assignment of the participants to the various groups; presence of a pretest to insure that there is no initial difference between the groups; presence of a posttest to measure potential differences due to the treatment; presence of an experimental group and of two control groups, one for eliminating the possibility of placebo effect; provision of different people for carrying out the treatment, the pretest, and posttest; experimenter's and tester's ignorance of the nature of the group assignment; and participants' ignorance of the purpose of the experiment and even of the fact that they are participating in a study"

(Gobet&Campitelli, 2005, 8)

Table 3.1 Methodological design of some studies

Study	Chess Intervention	Sampling	Dependent variables Outcome Measures	Random allocation
Christiaen (1976) Belgium	42 lessons, over Two years	Chess group 20 Non-chess group:17 Male 5^{tn} and 6^{tn} grades	Math& Reading (DGB)Piaget test, PMS(aptitude test for orientation purpose) and school results	√
Margulies	Two academic years	Chess group:22 Non-chess group:1118 Male&Female 7thgrade	Degree of reading Power test	
Liptrap (1998)	Weekly	Chess group: 23 Non-chess group: 269 Male&Female 5thgrade	TAAS	
Barret & Fish Texas	30 weeks	Chess group:15 Non-chess group:16 Male & Female 6th- 8th grades	Academic, Math (TAKS & End-of-Course Grades)	
Smith and Cage (2000)	120 hours of chess	11 female,10 male	Academic, mathematical and non-verbal abilities	
Frank (1979-1981) Zaire	Twice a week over a one year	92 teenagers for chess group and non-chess group	Cognitive abilities PMA,DAT,GATB D2 Test of Brieckenkamp (test of attention) Projective test	√

The table 3.1 contains summarized information including sampling, chess intervention, measures of outcomes and random allocation of several studies that explore the relationship between chess and students' mathematical, reading and cognitive abilities. In these studies, the study design mainly encompasses a comparison of academic outcomes between participants in the chess intervention and non-chess groups. Furthermore, researchers have used the experimental (e.g., random assignment) and quasi-experimental methodologies to examine the impact of chess instruction on students' academic outcomes (math and reading) and cognitive abilities. By utilizing different types of assessments such as standardized test scores and school year grades, the findings from these studies have demonstrated that the improvement of academic performance of students could be linked to chess instruction.

According to the quantitative methodology, a researcher must rely on numerical data. Taking into consideration time constraints and practical reasons, an experimental study could not be conducted by the researcher of this study. However, putting more emphasis on the quantitative methodology, the numerical data (final grades of students) collected from two schools in Baku was used to test the research hypothesis. Selected schools were included in the list of the pilot project for chess. For this study, I chose a chess school from the list that the Ministry of Education of Azerbaijan Republic has provided on its webpage. The year of teaching chess is highly important for this study. Therefore, special attention should be drawn to the year when chess instruction started in the selected school. The treatment school had chess instruction from 2012, which provided me with sufficient data, including grades of second and third classes on math and reading. This school implements chess instruction once a week throughout the academic year as a part of the curriculum, and

chess classes consist of games, theories and practice. Chess lessons are not graded; however, it is a compulsory class for all students. A control group school is located near the pilot school and both are public schools. The second school has not been included in the pilot project for chess; therefore, no chess instruction is provided there. Students regularly attend classes and they are in the same year with the students of chess pilot school. The data collection consists of final academic year grades of second and third class students on math and reading from both schools, as well as first year grades of students from the chess pilot school.

Based on the collected data, t-tests are carried out: a) firstly, a t-test of output that is obtained from two different groups of students from the two (chess and non-chess group) schools; b) secondly, a t-test is conducted only for the same students from the chess pilot school to compare their first and third class (the two year differences) grades. Overall, the chess class serves as an intervention in this research. According to the statement of the Ministry of Education, chess classes start to be taught to 2nd grade students and the classes continue in 3rd and 4th grades. In the article by Wendi Fischer from the John Hopkins School of Education, it has been suggested that chess is more beneficial as an educational activity for the age group of 2nd and 3rd grade students. The author explains that “eight and nine year-old minds and thinking skills are developing rapidly, and chess teaches higher level thinking skills such as the ability to visualize, analyze and think critically” (Fischer,2006,p1). First grade students do not have any chess instruction in the curriculum, therefore, both pretest and posttest has been conducted to compare the math and reading achievements of the same students from the chess pilot school. By analyzing the outputs of the t tests of each grade students in math and reading, a comparative picture of the results was provided.

Furthermore, it is necessary to note that according to the pilot project, in

Azerbaijani schools chess teachers and classroom teachers carry out chess instruction. In the school selected for the study, a classroom teacher carries out the chess trainings. This teacher is a history instructor, but has basic knowledge about the game of chess. An interview, which was conducted with a chess teacher of selected grades, as well as participant observation, was used to get an impression of the chess instruction in this school.

To sum up, using the combination of both methods that complement each other has provided a more complete analysis. In the first phase, conducting t-test, the goal of the quantitative analysis is to identify the relationship between chess and the academic performance of the first, second and third grade school students on math and reading in schools of Azerbaijan. In the second phase, a qualitative approach is used to arrive at conclusion through an individual interview, as well as the researcher's participant observation. The rationale for using this mixed approach is to provide an in-depth answer to the research question of this study.

Sample presentation (participants)

The target group of this study was composed of 140 students from a school of the chess pilot project and 87 students who participated as non-chess group students aged 9-10 from two schools in Baku. Despite the fact that these students are currently studying in the last year (4^{th}) of elementary school, I used the academic grades of these students from previous years (2^{nd} and 3^{rd} year) to conduct T- test. For conducting the other t -test between the first year and third year grades of the students of the chess pilot school the data was collected in the same way and the target group was composed of 114 students from the chess pilot school. In addition, neither newcomer students nor students who drop out were included in this study. In the chess pilot school the number of classes are seven, while in the non-chess school the number is four. I do not

differentiate male and female students, because this is not a significant enough indicator to change the study design. All schools keep copies of school journals of classes from the previous years that provided easy access to the data of first, second and third class grades on math and reading. However, the grades of students are not in electronic version, and for both schools, permission must be sought from the principal. As a researcher I preserve the anonymity of the schools and participants involved in this study.

Study Design

For the purposes of this study, chess instruction has been chosen as an independent variable, which is taught once a week in school hours. The dependent variables are first, second and third year mathematics and reading grades of Azerbaijani school students for the end of academic year. In the schools of Azerbaijan, academic evaluation is done twice a year and consists of two semiannual gradings. I have collected final academic grading of the second and third academic years' grades. Schools use a numeric system of grades from 2 to 5. Highest grade is 5 and failing grade is 2. Following this design, my aim in conducting this study was to examine the alternative hypothesis that chess instruction in schools in Azerbaijan improves academic performances of students in mathematics and reading, which was tested at the alpha that is 0.05 levels of significance. Null hypothesis is defined as "there is no difference" in output from t-test, which means the chess group's students do not show any improvement in their academic attainments. Chess has been included in the curriculum as a part of the pilot project in schools of Azerbaijan since 2012. The data collected for the study covers the academic years of 2012/2013 and 2013/2014. The students involved in this study have been part of chess classes starting from 2012, which means these students, who are studying in

the fourth year of primary school are trained over two years. The students have received one hour a week of chess instruction as a part of the curriculum. The classes last for 45 minutes and students have a chance of learning the theory of the game of chess and the practice by playing it and solving puzzles. The syllabus of chess instruction encompasses both practical and theoretical learning such as chess pieces, the movement of pieces, checkmates with different pieces, elementary openings and endings. These are included in the syllabus of chess classes that has been approved by the Ministry of Education of the Azerbaijan Republic.

According to the order of the Ministry of Education of the Azerbaijan Republic, the instructors of chess classes are classroom teachers and chess trainers who have been involved in this project. In the treatment school, chess lessons were delivered by school teachers who did not have sufficient knowledge of chess to be helpful for the improvement of problem solving and mathematical abilities of students and this lack of qualified instructors could become a limitation for the research.

For data processing, I have used R studio software to obtain the outputs of t- test in order to compare the results and draw conclusions about the relationship between chess and students' academic performance in math and reading.

Results

Table 3.2: The results obtained from t test based on students' academic achievement in math and reading

Measures	T test	P value	Mean (control group)	Mean (experimental group)	Gain
Math 2nd grade	-2.1935	0.01482	4.18	4.39	0.21
Math 3rd grade	-0.4063	0.3425	4.39	4.42	0.03
Reading 2nd grade	-1.9042	0.02933	4.39	4.56	0.17
Reading 3rdgrade	-2.059	0.02057	4.40	4.59	0.19

In order to test the hypotheses, the output obtained from t test provides a comparison of two groups (chess and non-chess) students from different schools. A numerical example is given in the Table 3.2 with p value and the level of significance that is used to compare the differences between chess and non-chess group of students. According to these results, an alternative hypothesis shows that the independent variable, which is chess intervention, can lead to improved academic outcomes, specifically in reading attainments of students. It is apparent from Table 3.2 that in the second grade, the chess group students performed better in math compared to the non-chess group. So, the output of T test of second graders on math demonstrates that p value is 0.01482, which is lower than 0.05 the level of significance.

The results from t- test indicates that null hypothesis is rejected in favor of alternative hypothesis and it shows that there is an improvement in the math grades of second year chess group students. However, surprisingly, a comparison of third grade math results reveals that there is no improvement in the grades of third year students. The p-value output from grades of second year students in reading are 0.02933 that is lower than 0.05 the level of significance, which indicates that the alternative hypothesis is true. Also, these results appear in the third grade students' academic performance on reading (p-value =0.02057). According to the output of the t- test on reading, the improvements were revealed in the second and third year grades of students. Both grade students enhanced their performance over a year. Nevertheless, only second grade chess group students improved their mathematical achievements.

Table 3.3. T test output of students according to the first and third classes' grades

Welch Two sample t – test	Welch Two sample t – test
Data: control$math1and treat$math3 T=1.2587, df=224.704, p value=0.1047 Alternative hypothesis: true difference in means is greater than 0 95 percent confidence interval: Inf -0.03285876 Sample estimates: Mean of x mean of y 4.587719 4.482456	Data: control$reading1 and treat$reading3 t = -0.6858, df = 223.889, p-value = 0.2468 alternative hypothesis: true difference in means is less than 0 95 percent confidence interval: -Inf 0.07413127 Sample estimates: Mean of x mean of y 4.587719 4.640351

The results of T tests that is obtained from the first year and third year grades of students in mathematics and reading from the pilot school indicate that there is not an improvement in academic achievement of students. As p-value is greater than 0.05, we fail to reject null hypothesis, which means that third grade students have not improved their academic achievement compared to the first year in reading and mathematics.

Discussion

The purpose of this study was to explore the influence of chess instruction on students' academic outcomes in mathematics and reading in the case of Azerbaijan. Although there has been no local literature published on this matter, the findings of this study are consistent with the results of previous researches done by international researchers. According to the results of the study, there is an improvement in the academic achievements of chess group and non-chess group students in 2nd and 3rd grades. Specifically, contrary to the results of t- test in mathematics, the pupils in a chess pilot school showed much improvement in reading in both years (2nd and 3rd) compared to the non-chess group. While interviewing a chess instructor, he pointed out that chess lessons are beneficial for students, because, students in his class may spend much time engaged with chessboard, which led to an improvement in their behavioral abilities and concentration. According to the view of de Groot (1977) educational benefits of chess instruction may have two types of gain: low-level gains and high- level gains. Low-level gains are an improvement in concentration, attention and high level gains are an enhancement in intelligence, creativity and school performance. The findings of my study indicate that low level gains are greater than high level gains.

T-test results indicate that chess may lead to an improved math achievement of 2nd grade students; however, third grade students of the treatment school still did not outperform control third grade students on math grades. Secondly, in the analysis of other t-tests involving the grades of the same students, changes in pretest performances in math and reading were not different from changes in the posttest performances. Math abilities such as critical thinking, problem solving, and calculation skills could be enhanced by learning chess and solving chess puzzles.

Not having much improvement in math in chess groups could be explained by the fact that a classroom teacher who lacked sophisticated knowledge of chess theories performed the chess lessons. “Most times chess puzzles and some chess theories from textbooks are difficult to understand and this is a challenge in my chess teaching” expressed a chess teacher in his interview. Participant observation in a chess class provided me an opportunity to look at chess textbooks, which were designed for this instruction. These textbooks had multiple chess exercises for each topic that require systematically practicing chess. Therefore, the lower level of chess experience of the teachers could be a challenge for these students to get more advantage in their learning.

As it has been conclusively shown in the research on “Chess in school can improve math ability: differences between instructor training and teacher training from an experiment in Italian primary schools”, chess lessons trained by a chess instructor can lead to increased math outcomes compared to ones conducted by classroom instructors. Conversely, the improvement is much smaller if a classroom teacher performs chess training. (Trinchero, 2014)

Moreover, based on the results of the interview with a chess teacher, it also became clear that the chess instruction is perceived differently in this school. For instance, the answer by a teacher to the question about the introduction of chess into the curriculum as a compulsory academic subject was that “it is not necessary to have chess as a required subject in classes, because this does not guarantee to prepare chess players and once a week chess class cannot increase the number of chess players”. It is apparent that chess is not perceived as an academic subject in school, and this could create a discouragement in the teaching approach for non- chess player instructors.

To sum up, the study encourages and suggests further researches to examine the educational effects of chess instruction to student's mathematical and reading achievement. More research should be conducted in order to examine this impact in depth, to understand why chess instruction has had a positive impact on reading achievements, and what other factors could lead to an increase in students' academic attainments in mathematics.

4. Conclusion

As it has been highlighted throughout the first chapter of this thesis, the research problem in this study is the low performance of Azerbaijani school students in national and international evaluations such as PISA and SSAC tests. Chess instruction could be proposed as a novel solution to the existing issue. Therefore, this study was conducted to find out whether chess instruction in the schools of Azerbaijan could have a positive impact on students' academic achievements in mathematics and reading abilities.

A quantitative approach was chosen as the main methodology, and the study involved two groups of first, second and third year school children in Baku as a treatment and control group. In order to conduct t-tests to compare the academic attainment of chess and non-chess groups in reading and math, final academic grades of first, second and third year students from two schools were collected. Firstly, t-test was conducted to compare the academic attainment in math and reading grades of second and third year students from two schools. Secondly, t- test was conducted by utilizing the first and third year grades of the same students in math and reading from the school which has chess instruction. Furthermore, an interview with a chess teacher and participant observation was used in the research.

The results obtained from first t-test indicated that students in the school with chess instruction showed much improvement in reading and math attainments compared to non-chess group students, however, math grading of third year students is taken as an exception. The output obtained from other t- test showed that third year chess group students did not indicate a difference in reading and math achievements.

The study finds it necessary to conduct further research in order to explore the educational benefits of chess instruction in more detail. Because of time constraints and

practical reasons, this research had some limitations, as the researcher could not conduct experimental study; therefore the study is weak on validity. For future research, it is recommended to take into consideration several features such as experimental design, random selection of participants, the presence of pretest and posttest, as well as additional variables to examine the causality relationship between chess and students' academic attainments. In addition, it is necessary to investigate the differences between chess training run by a chess instructor and a classroom teacher.

Meanwhile, it is difficult to come to a precise conclusion based on the findings of this study. The first recommendation is that chess needs to perceive and deserve as an academic subject in schools in Azerbaijan. It seems that the benefits of chess have not been realized as an educational tool in the schools in Azerbaijan. This could make a challenge both for students and teachers to understand the place of chess in the classroom. Moreover, since the Ministry of Education implements a pilot project for chess, there is a lack of systematic data about the results of implementation of this project. More studies on these issues are required. For this purpose, the Ministry of Education and educational leaders should enhance and stimulate the research on chess and education.

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Appendix 1 The final academic grading of the second and third year students (both chess and non chess students)

Math 2	Reading 2	Math 3	Reading 3	Gender	Chess	Class
4	4	4	4	MALE	YES	A
5	5	5	5	MALE	YES	A
3	3	3	3	MALE	YES	A
4	4	4	4	FEMALE	YES	A
3	3	4	4	MALE	YES	A
5	5	4	5	FEMALE	YES	A
4	4	5	5	FEMALE	YES	A
4	4	4	4	FEMALE	YES	A
5	5	5	5	FEMALE	YES	A
4	5	5	5	MALE	YES	A
5	5	5	5	FEMALE	YES	A
3	3	3	4	MALE	YES	A
4	5	5	5	MALE	YES	A
3	4	4	4	MALE	YES	A
3	4	3	4	FEMALE	YES	A
4	4	4	4	FEMALE	YES	A
4	4	5	4	MALE	YES	A
4	5	4	5	MALE	YES	A
4	4	4	4	FEMALE	NO	A
4	4	4	4	MALE	NO	A
5	5	5	5	MALE	NO	A
4	5	5	5	MALE	NO	A
4	5	5	5	MALE	NO	A
4	4	4	4	MALE	NO	A
4	5	4	5	MALE	NO	A
4	4	4	4	MALE	NO	A
5	5	5	5	MALE	NO	A
5	5	5	5	MALE	NO	A
4	4	4	4	FEMALE	NO	A
3	3	3	3	MALE	NO	A
4	4	4	5	FEMALE	NO	A
3	4	4	4	MALE	NO	A
5	5	5	5	FEMALE	NO	A
4	5	4	4	MALE	NO	A
4	5	5	5	MALE	NO	A
5	5	5	5	MALE	NO	A
4	4	4	4	FEMALE	NO	A
4	5	4	5	FEMALE	NO	A
5	5	5	5	FEMALE	NO	A
5	5	5	5	FEMALE	NO	A
5	5	5	5	FEMALE	NO	A
4	5	4	5	FEMALE	NO	A

5	5	5	5	MALE	NO	A
4	5	5	5	FEMALE	NO	A
5	5	5	5	FEMALE	NO	A
5	5	5	5	FEMALE	NO	A
5	5	5	5	MALE	NO	A
5	5	5	5	MALE	NO	A
4	5	5	5	FEMALE	YES	B
4	5	4	5	FEMALE	YES	B
4	5	4	5	MALE	YES	B
5	5	5	5	MALE	YES	B
5	5	5	5	FEMALE	YES	B
4	4	4	4	FEMALE	YES	B
5	5	5	5	MALE	YES	B
3	5	4	4	MALE	YES	B
4	5	4	5	MALE	YES	B
4	5	4	4	FEMALE	YES	B
5	5	4	5	MALE	YES	B
5	5	5	5	FEMALE	YES	B
5	5	5	5	MALE	YES	B
5	5	5	5	MALE	YES	B
5	5	5	5	MALE	YES	B
4	5	4	4	MALE	YES	B
4	5	5	5	MALE	YES	B
5	5	5	5	FEMALE	YES	B
5	5	5	5	FEMALE	NO	B
5	5	5	5	MALE	NO	B
5	5	5	5	FEMALE	NO	B
5	5	5	5	FEMALE	NO	B
4	4	3	4	FEMALE	NO	B
3	3	3	3	MALE	NO	B
3	4	4	3	MALE	NO	B
5	5	5	5	MALE	NO	B
4	5	5	5	MALE	NO	B
3	4	4	3	MALE	NO	B
3	3	3	3	FEMALE	NO	B
4	5	4	4	MALE	NO	B
4	5	5	4	MALE	NO	B
4	5	5	5	FEMALE	NO	B
3	3	3	3	MALE	NO	B
5	5	5	5	FEMALE	YES	C
4	3	4	3	FEMALE	YES	C
4	4	4	4	MALE	YES	C
4	4	4	4	MALE	YES	C
5	4	5	5	FEMALE	YES	C
5	4	5	5	MALE	YES	C
5	5	5	5	FEMALE	YES	C

5	5	5	5	MALE	YES	C
5	5	5	4	MALE	YES	C
4	4	4	4	MALE	YES	C
5	4	5	4	MALE	YES	C
5	4	5	4	MALE	YES	C
5	4	5	4	FEMALE	YES	C
5	4	5	5	MALE	YES	C
5	5	5	5	FEMALE	YES	C
5	5	5	5	MALE	YES	C
5	4	5	5	FEMALE	YES	C
5	5	4	4	MALE	YES	C
5	5	5	4	MALE	YES	C
4	4	4	4	MALE	YES	C
5	5	5	5	MALE	YES	C
5	5	5	5	FEMALE	NO	C
4	4	4	4	FEMALE	NO	C
4	4	4	4	FEMALE	NO	C
4	4	5	5	FEMALE	NO	C
5	5	5	5	FEMALE	NO	C
4	4	5	5	FEMALE	NO	C
4	4	4	4	MALE	NO	C
5	5	5	5	FEMALE	NO	C
4	4	4	5	MALE	NO	C
3	3	4	4	FEMALE	NO	C
4	4	3	3	MALE	NO	C
4	5	5	5	FEMALE	NO	C
3	4	3	3	MALE	NO	C
4	4	4	4	MALE	NO	C
3	3	3	3	MALE	NO	C
5	5	5	5	MALE	NO	C
4	4	5	5	FEMALE	NO	C
5	5	5	5	FEMALE	NO	C
4	5	5	5	FEMALE	NO	C
5	5	4	4	MALE	NO	C
3	3	3	4	MALE	NO	C
3	3	5	4	MALE	NO	C
4	4	4	5	FEMALE	NO	C
3	4	4	4	MALE	NO	C
5	4	5	5	FEMALE	YES	C2
4	5	5	5	MALE	YES	C2
5	5	5	5	MALE	YES	C2
4	4	4	4	MALE	YES	C2
4	4	3	3	FEMALE	YES	C2
5	5	5	5	FEMALE	YES	C2
5	5	5	5	MALE	YES	C2
4	4	3	3	MALE	YES	C2

4	4	3	3	FEMALE	YES	C2
5	5	5	5	MALE	YES	C2
5	5	5	5	FEMALE	YES	C2
3	4	3	3	FEMALE	YES	C2
4	5	5	5	FEMALE	YES	C2
5	5	5	5	MALE	YES	C2
4	4	3	3	FEMALE	YES	C2
5	5	5	5	MALE	YES	C2
4	4	4	4	FEMALE	NO	C2
4	4	4	4	MALE	NO	C2
4	4	4	4	FEMALE	NO	C2
4	4	4	4	MALE	NO	C2
5	5	5	5	MALE	NO	C2
5	5	5	5	FEMALE	NO	C2
3	3	4	3	FEMALE	NO	C2
3	4	3	3	FEMALE	NO	C2
3	4	4	4	MALE	NO	C2
5	5	5	5	FEMALE	NO	C2
5	5	5	5	MALE	NO	C2
4	3	4	3	FEMALE	NO	C2
4	3	4	3	FEMALE	NO	C2
5	5	5	5	MALE	NO	C2
4	4	4	4	MALE	NO	C2
5	5	5	5	FEMALE	NO	C2
5	4	5	5	MALE	NO	C2
5	5	5	5	FEMALE	NO	C2
5	5	5	5	FEMALE	YES	D
5	5	5	5	FEMALE	YES	D
5	5	5	5	FEMALE	YES	D
4	5	4	5	FEMALE	YES	D
5	5	5	5	FEMALE	YES	D
4	5	4	5	FEMALE	YES	D
3	3	4	4	MALE	YES	D
4	4	4	4	MALE	YES	D
3	3	3	4	MALE	YES	D
4	5	4	5	FEMALE	YES	D
5	5	5	5	MALE	YES	D
5	5	5	5	FEMALE	YES	D
4	5	5	5	MALE	YES	D
5	5	5	5	MALE	YES	D
5	5	5	5	FEMALE	YES	D
4	5	4	5	FEMALE	YES	D
4	4	4	5	MALE	YES	D
5	5	5	5	FEMALE	YES	D
5	5	4	5	FEMALE	YES	D
3	3	3	3	MALE	YES	D

4	5	5	5	FEMALE	YES	D
4	5	4	5	MALE	YES	D
4	5	4	5	FEMALE	YES	D
4	5	4	5	FEMALE	YES	D
4	5	4	4	MALE	YES	E
3	3	3	3	MALE	YES	E
5	5	5	5	FEMALE	YES	E
4	5	4	4	MALE	YES	E
5	5	4	4	MALE	YES	E
4	4	4		MALE	YES	E
5	5	5	5	FEMALE	YES	E
4	4	4	4	MALE	YES	E
5	5	5	5	FEMALE	YES	E
4	4	4	4	FEMALE	YES	E
5	5	5	5	FEMALE	YES	E
5	5	5	5	MALE	YES	E
3	4	4	4	MALE	YES	E
4	5	4	4	FEMALE	YES	E
5	5	5	5	FEMALE	YES	E
5	5	5	5	MALE	YES	E
5	5	5	5	MALE	YES	E
5	5	5	5	MALE	YES	E
4	4	3	4	MALE	YES	E
5	5	5	5	FEMALE	YES	E
4	4	3	4	FEMALE	YES	E
4	4	4	5	FEMALE	YES	E
4	4	4	5	MALE	YES	E2
4	5	5	5	MALE	YES	E2
4	4	4	5	MALE	YES	E2
4	4	4	5	MALE	YES	E2
5	5	5	5	FEMALE	YES	E2
4	5	4	5	MALE	YES	E2
5	5	5	5	FEMALE	YES	E2
5	5	5	5	FEMALE	YES	E2
5	5	5	5	FEMALE	YES	E2
5	5	5	5	MALE	YES	E2
5	5	5	5	MALE	YES	E2
3	4	4	4	MALE	YES	E2
5	5	5	5	FEMALE	YES	E2
4	4	4	5	MALE	YES	E2
5	5	5	5	FEMALE	YES	E2
4	4	3	4	MALE	YES	E2
4	4	4	5	FEMALE	YES	E2
4	4	4	5	MALE	YES	E2
5	5	5	5	FEMALE	YES	E2
5	5	5	5	FEMALE	YES	E2

4	4	4	5	FEMALE	YES	E2

1. T test results of the second and third grade students in math and reading

a)t.test(control$math2,treat$math2,alternative="less",var.equal = FALSE)

```
        Welch Two Sample t-test

data:  control$math2 and treat$math2
t = -2.1935, df = 168.485, p-value = 0.01482
alternative hypothesis: true difference in means is less than 0
95 percent confidence interval:
     -Inf -0.05139666
sample
estimates:
mean      of      x
mean of y
 4.183908  4.392857
```

b)t.test(control$math3,treat$math3,alternative="less",var.equal= FALSE)

```
        Welch Two Sample t-test

data:  control$math3 and treat$math3
t = -0.4063, df = 178.679, p-value = 0.3425
alternative hypothesis: true difference in means
is less than 0 95 percent confidence interval:
    -Inf
    0.1159406
sample
estimates:
mean      of      x
mean of y
 4.390805  4.428571
```

c) t.test(control$reading2,treat$reading2,alternative= "less",var.equal= FALSE)

```
        Welch Two Sample t-test

data:  control$reading2 and treat$reading2
t = -1.9042, df = 161.232, p-value = 0.02933
alternative hypothesis: true difference in means
is less than 0 95 percent confidence interval:
     -Inf -0.02276409
sample
estimates:
mean     of     x
mean of y
 4.390805  4.564286
```

d) t.test(control$reading3,treat$reading3,alternative="less",var.equal= FALSE)

```
        Welch Two Sample t-test

data:     control$reading3   and
treat$reading3  t  =  -2.059,  df  =
157.347, p-value = 0.02057
alternative hypothesis: true difference in means
is less than 0 95 percent confidence interval:
     -Inf -0.03826856
sample
estimates:
mean     of     x
mean of y
 4.402299  4.597122
```

Appendix 2 The first and third year academic grades of chess groups students in mathematics and reading

reading1	math1	gender	chess	class	reading3	math3	chess3
3	3	FEMALE	NO	A	3	3	YES
4	3	FEMALE	NO	A	4	4	YES
3	3	FEMALE	NO	A	4	4	YES
5	4	MALE	NO	A	4	4	YES
5	5	FEMALE	NO	A	5	5	YES
5	5	FEMALE	NO	A	5	5	YES
3	4	FEMALE	NO	A	4	3	YES
5	5	MALE	NO	A	5	5	YES
5	4	FEMALE	NO	A	5	5	YES
4	5	MALE	NO	A	4	4	YES
3	4	FEMALE	NO	A	4	5	YES
4	4	MALE	NO	A	5	4	YES
4	5	MALE	NO	A	5	5	YES
5	5	FEMALE	NO	B	5	4	YES
5	5	FEMALE	NO	B	5	4	YES
3	3	FEMALE	NO	B	5	5	YES
5	5	MALE	NO	B	5	5	YES
5	5	FEMALE	NO	B	4	4	YES
5	4	FEMALE	NO	B	5	5	YES
5	5	MALE	NO	B	4	4	YES
4	5	MALE	NO	B	5	4	YES
4	4	MALE	NO	B	4	4	YES
4	5	FEMALE	NO	B	5	4	YES
5	5	MALE	NO	B	5	5	YES
5	5	FEMALE	NO	B	5	5	YES
4	5	MALE	NO	B	5	5	YES
4	4	MALE	NO	B	5	5	YES
3	3	FEMALE	NO	B	4	4	YES
4	5	MALE	NO	B	5	5	YES
4	5	MALE	NO	B	5	5	YES
5	5	FEMALE	NO	B	5	5	YES
5	5	FEMALE	NO	C	4	3	YES
4	4	FEMALE	NO	C	4	4	YES
4	4	MALE	NO	C	4	4	YES
4	4	MALE	NO	C	5	5	YES
5	5	FEMALE	NO	C	5	5	YES
5	5	MALE	NO	C	5	5	YES
4	4	FEMALE	NO	C	4	5	YES

5	5	MALE	NO	C	4	4	YES
4	4	MALE	NO	C	4	5	YES
5	5	MALE	NO	C	5	5	YES
5	5	FEMALE	NO	C	4	5	YES
5	4	FEMALE	NO	C	5	5	YES
5	5	MALE	NO	C	5	5	YES
5	5	MALE	NO	C	4	4	YES
5	5	FEMALE	NO	C	5	5	YES
5	5	FEMALE	NO	C	4	5	YES
5	5	MALE	NO	C	4	4	YES
5	5	MALE	NO	C	5	5	YES
5	5	MALE	NO	C	4	5	YES
5	5	MALE	NO	C	5	5	YES
5	5	FEMALE	NO	C2	5	5	YES
5	5	MALE	NO	C2	5	5	YES
5	5	MALE	NO	C2	4	4	YES
4	3	MALE	NO	C2	5	5	YES
5	5	FEMALE	NO	C2	5	5	YES
5	5	MALE	NO	C2	3	3	YES
4	4	FEMALE	NO	C2	5	5	YES
5	5	MALE	NO	C2	5	5	YES
5	5	FEMALE	NO	C2	5	5	YES
5	5	MALE	NO	C2	3	3	YES
4	4	FEMALE	NO	C2	5	5	YES
4	5	MALE	NO	C2	5	5	YES
5	4	FEMALE	NO	D	5	5	YES
5	5	FEMALE	NO	D	4	4	YES
4	4	MALE	NO	D	4	4	YES
4	4	MALE	NO	D	4	3	YES
4	4	MALE	NO	D	5	4	YES
5	4	FEMALE	NO	D	5	5	YES
5	5	MALE	NO	D	5	5	YES
5	5	FEMALE	NO	D	5	5	YES
5	5	MALE	NO	D	5	5	YES
5	5	FEMALE	NO	D	5	4	YES
5	5	MALE	NO	D	5	4	YES
4	5	MALE	NO	D	5	5	YES
5	5	FEMALE	NO	D	5	4	YES
5	5	FEMALE	NO	D	3	3	YES
3	3	MALE	NO	D	5	4	YES
5	5	FEMALE	NO	D	5	4	YES
5	5	MALE	NO	D	5	4	YES
4	4	MALE	NO	E	5	5	YES
5	5	FEMALE	NO	E	4	4	YES
5	5	MALE	NO	E	5	5	YES
5	5	FEMALE	NO	E	5	5	YES

5	5	FEMALE	NO	E	5	5	YES
5	5	MALE	NO	E	4	4	YES
4	4	MALE	NO	E	4	4	YES
5	5	FEMALE	NO	E	5	5	YES
5	5	FEMALE	NO	E	4	3	YES
4	4	MALE	NO	E	5	5	YES
5	5	MALE	NO	E	5	5	YES
5	5	MALE	NO	E	5	5	YES
5	5	MALE	NO	E	5	5	YES
5	5	FEMALE	NO	E	4	3	YES
4	4	FEMALE	NO	E	5	4	YES
5	5	FEMALE	NO	E	5	4	YES
5	4	MALE	NO	E2	5	5	YES
5	4	MALE	NO	E2	5	4	YES
5	4	MALE	NO	E2	5	4	YES
5	5	MALE	NO	E2	5	5	YES
5	5	FEMALE	NO	E2	5	4	YES
5	4	MALE	NO	E2	5	5	YES
5	5	FEMALE	NO	E2	5	5	YES
5	5	FEMALE	NO	E2	5	5	YES
5	5	FEMALE	NO	E2	5	5	YES
5	5	MALE	NO	E2	5	5	YES
5	5	FEMALE	NO	E2	4	4	YES
5	4	MALE	NO	E2	5	5	YES
5	5	FEMALE	NO	E2	4	5	YES
4	4	MALE	NO	E2	4	3	YES
4	4	MALE	NO	E2	5	4	YES
5	5	FEMALE	NO	E2	5	4	YES
5	4	MALE	NO	E2	5	5	YES
5	5	FEMALE	NO	E2	5	5	YES

2. T –test results of chess group students in first and third grade

a)t.test(control$reading1,treat$reading3,alternative= "less",var.equal= FALSE)

Welch Two Sample t-test

data: control$reading1 and treat$reading3

t = -0.6858, df = 223.889, p-value = 0.2468

alternative hypothesis: true difference in means is less than 0

95 percent confidence interval:

-Inf 0.07413127

sample estimates:

mean of x mean of y

4.587719 4.640351

b) t.test(control$math1,treat$math3,alternative="greater",var.equal = FALSE)

Welch Two Sample t-test

data: control$math1 and treat$math3
t = 1.2587, df = 224.704, p-value = 0.1047
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
-0.03285876 Inf
sample estimates:
mean of x mean of y
4.587719 4.482456

Interview questionnaire:

1. Are there any academic, cognitive behavioral improvements in students after chess instruction during two years?
2. Does teaching approach play the important role for learning chess? How chess training performed by a chess instructor can is different from chess lessons run by classroom teacher?
3. Why offer chess as a subject in national curriculum ?