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Does Playing Chess Improve Mathematics Scores? An Experimental Study Among Co-Curricular – Chess Students in Politeknik Kuching Sarawak

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Abstract: *The aim of this study is to determine the potential benefits of playing chess on mathematics improvement. There were two groups of respondents in this study, the experimental group were the students who taken chess as their co-curricular's course for a whole semester while the control group were the other regular-lessons students who not involved with any chess activities. A series of chess lessons and practices were planned and implemented to the experimental group during the weekly co-curricular class. The mathematics assessment consisted of items of The Engineering Mathematics 1 and conducted twice to the students for both groups, the pre-test at the beginning of the semester or before treatment process and the post-test at the end of the semester or after treatment process. The analysis used in this study were the descriptive statistics, the one-sample t-test and the independent sample t-test. This study showed the very encouraging result which playing chess mostly could benefit the students in their mathematics learning and improvement. The students in experimental group showed significantly higher mathematics improvement than the students from the control group. This finding may be useful for the institution to encourage students to learn and play chess during their free time or involve with any chess activities organised. The institution also can set up a chess club and open to all students to join. With these efforts in cultivating the chess playing in institution, it is hoped that even a short-time chess practice or chess playing among students can be a very useful tool to boost their mathematical abilities.*

Keywords: chess, mathematics, co-curricular

1. Introduction

The International Chess (hereafter denoted as "chess") game was originated in northern India in the 6th century AD and spread to Persia and later widespread in Europe (Murray, as cited in Simple English Wikipedia, 2021). Nowadays, chess has become one of the world's most popular indoor games, played by millions of people worldwide (Wikipedia, 2021). According to WooChess (2018), the benefits of playing chess which more contributed to studying such as the benefit in raising the IQ as well as the increasing in the problem-solving skills, spatial skills, memorisation, creativity, and concentration. Hence, the author had conducted this experimental study to evaluate if any significant effect of playing chess on mathematics learning and improvement between the experimental group (co-curricular – chess students with their regular-lessons as well) and the control group (regular-lessons students only without participating in chess course). This finding may be useful for the institution to encourage students to learn and play chess or involve with any chess activities organised, as a very useful tool for them to boost their mathematical abilities.

2. Literature Review

There are a lot of prior works to identify how playing chess can promote the academic performance especially the mathematics scores. However, the author summarized only some here. Subia et. al. (2019) had conducted a study among 31 college players who came from the four colleges and universities in Cabanatuan City, Philippines regarding the performance of chess and mathematics. They used the descriptive correlational research design in this study. Besides, they obtained the respondents data of mathematics grades from their school transcript of records. The open-ended questions also had been used to gather remarks or comments from the respondents. The results shown that the respondents' general weighted average (GWA) in mathematics was above the average. Furthermore, they also found that the respondents' performance in chess competition was directly proportional to their mathematics achievement. The respondents also believed that a chess player could also be a good mathematician if they trained, played, and performed well in chess.

According to Sala et. al. (2016) in their experimental study, they designed three-group respondents namely the experimental, placebo, and control groups in the study merely to control for possible placebo effects. They measured the mathematical ability and metacognitive skills twice, before and after the treatment. The finding showed that the mathematics performance of the experimental group was better than the placebo group but then almost equally with the control group. For metacognition, there was no difference found among the three groups. These results suggested that some chess-related skills might generalize to the mathematical domain.

Kazemi et. al. (2012) had analysed the effect of playing chess on meta-cognitive development and mathematical problem-solving capability of students at various levels of schooling in Sanandaj, west of Iran. Those students had been divided into chess group with six months of chess course instructed and control group without any chess exposition. They assessed the students with meta-cognitive questionnaire and mathematics exams. This study indicated that the chess player students showed better achievement in the meta-cognitive abilities and mathematical problem-solving capabilities if compared to other non-chess player or control group students. Besides, they also found that there was a positive and significant relationship between the students' meta-cognitive ability and their mathematical problem-solving power. Therefore, Kazemi et. al. (2012) concluded that chess could be used as an effective tool for developing higher order thinking skills as well as improving their mathematical problem-solving ability.

According to Rosholm et. al. (2017), they analysed the effect of implementing a mathematics lesson based on chess instruction in replacing a regular weekly mathematics lesson in the primary school grades 1±3 from the City of Aarhus in Denmark. In this study, they found that the positive effects which the knowledge acquired through playing chess could be transferred to the domain of mathematics. They also found that the lecture based on chess instruction could increase the mathematics test scores as well as in reducing the students' boredom and increasing their happiness in learning. In conclusion, the study showed a very encouraging result that chess might eventually be suggested as an important tool for teaching and improving mathematical ability in young students.

Sala et. al. (2015) agreed that chess was a high cognitive-demanding game to be played well. In their research, they focused on investigating the potential benefits of playing chess on mathematical problem-solving ability in young students from schools of Northern Italy. These

students were divided into two groups, experimental (with chess course and online training) and control (with normal school activities only) and they had been tested on their mathematical and chess abilities as well. The research results presented a strong correlation between chess and mathematics scores. Besides, it also revealed that there was a higher improvement in mathematics for the experimental group than the control group. In conclusion, Sala et. al. (2015) believed that chess is a powerful tool to enhance students' mathematical abilities.

According to Mashuri (2015) in his experimental study on effect of playing chess to the academic performance of students of SD se-Kabupaten Trenggalek, Indonesia, he revealed that the students from the experimental group with chess practices showed the significant better academic performance rather than the students from the control group without any chess activities. There were differences found in the mean score of academic achievement between these two groups. Thus, Mashuri (2015) concluded that there was a significant effect of playing chess to the academic performance of students of SD se-Kabupaten Trenggalek, Indonesia.

Scholz et. al. (2008) focused a study in evaluating the benefit of chess in mathematics lessons for the learning-disabilities-children from the schools for children with learning disabilities in Saxony, Germany. These students were grouped into the chess group and the control group (without chess lessons). They had been assessed by using the standardised tests for their concentration and calculation abilities before and after the year of study. The results showed that the students' concentration and calculation abilities were developed equally well in both groups. However, the chess group showed more significant improvement in calculation abilities for simple addition and counting. Therefore, Scholz et. al. (2008) concluded that chess could be a valuable learning aid to improve the basic mathematics skills for children with learning disabilities.

Trinchero (2013) with his research on 568 pupils of the primary schools in the country of Asti and Bergamo (Italy) showed that a chess in-presence lessons and online training implemented to them could significantly improve the scores on the OECD-Pisa Mathematics Scale. According to the researcher, these pupils were subdivided in four groups namely the experimental, control, experimental without pre-test, and control without pre-test for the research purpose. The research results indicated that the experimental group presented a small but statistically significant increase in problem-solving skills on complex tasks. Thus, Trinchero (2013) concluded that the chess training could be a valuable learning aid that supports the acquisition of mathematical abilities, if used in couple to formal learning.

Işıkgöz (2016) focused his research on the contribution of chess in the success of mathematics lesson among the secondary school chess or non-chess playing students selected from the central districts of the Sakarya City in Turkey. According to the researcher, the relational screening model was used in this study. In addition, the student year-end mathematics score was used as the mathematics performance measurement. The research results showed that there was a significant difference between the mathematical scores of the chess playing students and non-chess playing students. However, the group of chess playing students showed relatively higher mathematics performance than non-chess playing students. Besides, there was no significant difference found between the mathematics scores of the chess playing students in relation to their genders and grades.

Trinchero and Sala (2016) conducted research among 931 primary school pupils, and they had been assigned into two treatment groups (group of chess instructors - chess problem-solving heuristics and group of school teachers – normal chess problem-solving) and a control group

with regular school activities as well. They had been assessed on their mathematical problem-solving abilities at the end of the treatment process. According to the researchers, the chess instructors' group was performed better than the other two groups in mathematical problem-solving ability. Besides, there was no difference found between the school teachers' group and the control group. As a conclusion, the researchers stressed that the heuristics chess problem-solving teaching method could be an effective way to promote mathematical problem-solving ability in primary school children.

3. Methodology

This study was an experimental quantitative research. There were two groups of respondents in this study, the experimental group were the students who taken chess as their co-curricular's course for a whole semester (with their regular-lessons as well) while the control group were the other regular-lessons students who not involved with any chess activities (just attending their regular-lessons only). These two groups of students (session of June 2019) were taught by author (as chess instructor and lecturer) for easy control and observation. A series of chess lessons and practices were planned and implemented to the experimental group only during their weekly co-curricular class. The planned contents of this chess course were listed briefly as below:

Part 1: Introduction
- a. The history of chess playing
- b. The objectives and benefits of playing chess
- c. The attractive video of chess playing

Part 2: Level 1 Course
- a. The chessboard and chess pieces
- b. The chess's trade value
- c. The chess basic movement and capturing
- d. The chess special move
- e. Activities such as playing chess games, solving related puzzles and so on.

Part 3: Level 2 Course
- a. The five elements in chess
- b. The general principle in chess
- c. The exchange and principles
- d. The FIDE chess rules
- e. Activities such as playing chess games, solving related puzzles and so on.

Part 4: Level 3 Course
- a. The checkmate and types
- b. The draw and types
- c. The chess tactics
- d. Activities such as playing chess games, solving related puzzles and so on.

Part 5: Level 4 Course
- a. The chess openings
- b. The middle game
- c. The end game
- d. Activities such as playing chess games, solving related puzzles and so on.

The Figure 1 below shows some of the chess contents instructed to the experimental group during the co-curricular class.

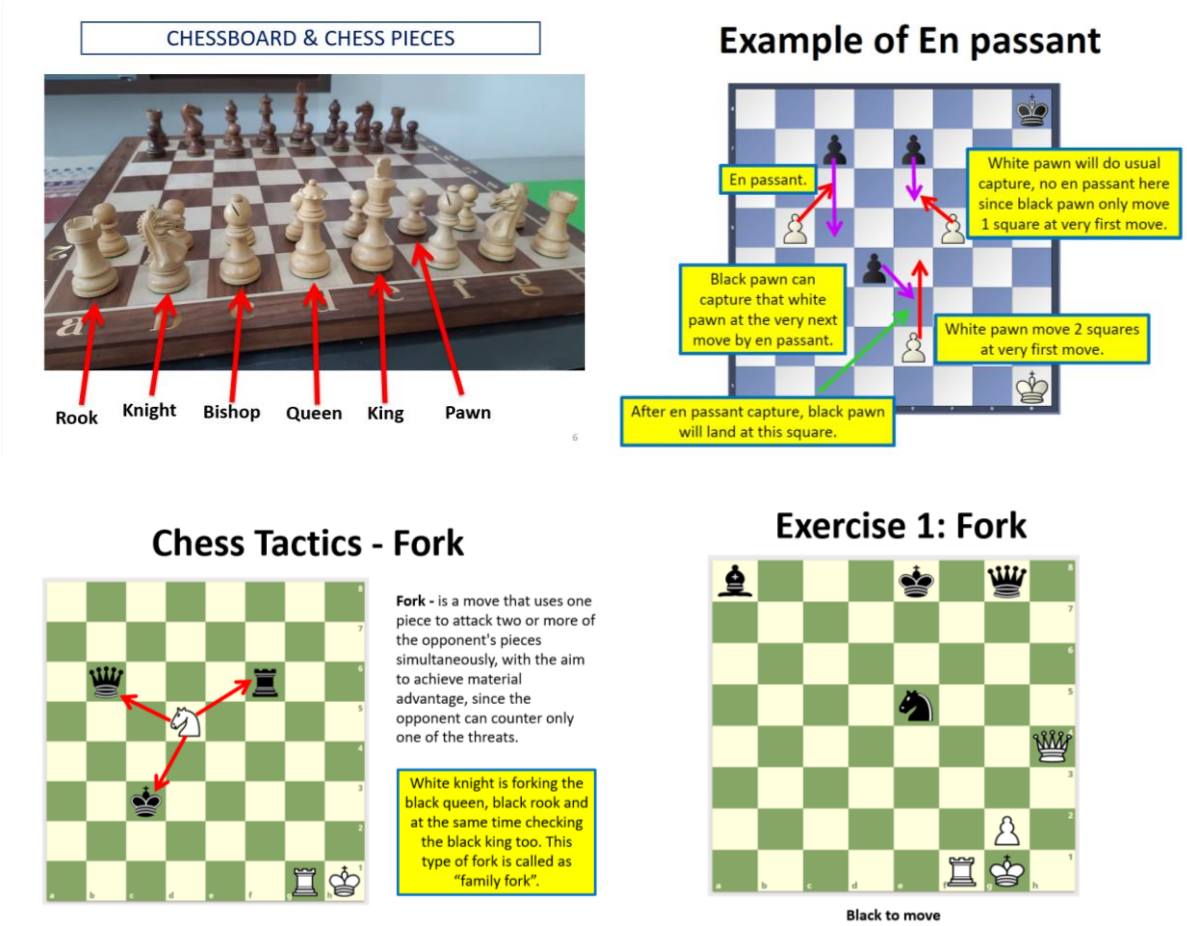

Figure 1: Some chess contents instructed to the experimental group.

The 20-items mathematics assessment was consisted of The Engineering Mathematics 1 and conducted twice to the students for both groups, the pre-test at the beginning of the semester or before treatment process and the post-test at the end of the semester or after treatment process. The purpose of this assessment used in this study was to measure the students' mathematics achievement.

The main objective of this study was to evaluate if any significant effect of playing chess on mathematics learning and improvement between the experimental group (co-curricular – chess students with their regular-lessons as well) and the control group (regular-lessons students only without participating in chess course). The analysis used in this study was the descriptive statistics, the one-sample t-test and the independent sample t-test.

The hypothesis for testing in this study were as below:

(a) Null hypothesis, Ho: There is no significant mathematics improvement (for the experimental group or control group which is applicable).
(b) Alternative hypothesis, Ha: There is a significant mathematics improvement (for the experimental group or control group which is applicable).

4. Discussion and Conclusion

Table 1 shows the descriptive data of respondents according to their assigned group with the pre-test and post-test mean scores in this study. From this table, there was a class of 29 co-curricular's chess students assigned in the experimental group while the control group consisted of a class of 24 other academic students who just attending their regular lessons only. As could be seen, the mean score of pre-test and post-test for the experimental group were 9.86 and 13.28 respectively with the percentage increase of 34.69%. At the same time, the mean score of pre-test and post-test for the control group were 9.83 and 10.67 respectively with the percentage increase of 8.55% only. This result also presented clearly in the Figure 2. Thus, it could be concluded here that there was a better improvement in the mathematics score achieved by the experimental group than the control group.

Table 1: Mean score for both groups of respondents in pre-test and post-test.

Group	Mean Scores			
	Pre-test	Post-test	Difference	Percentage Increase
Experimental (N=29)	9.86 (1.706)	13.28 (1.830)	3.42	34.69%
Control (N=24)	9.83 (2.615)	10.67 (2.014)	0.84	8.55%

Note: Standard deviations are shown in brackets.

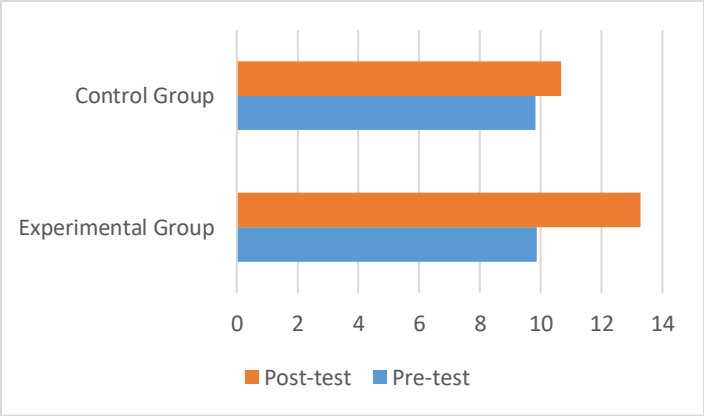

Figure 2: Mathematics mean scores for both groups of students measured before and after the treatment.

Table 2 illustrates the mathematics improvement for both groups of students in this study. From the Table 2, as could be seen, the experimental group had achieved higher mathematics' post-test performance ($M = 13.28$, $SD = 1.830$) than found in the population as a whole, $t(28) = 9.639$, $p = .000 < .05$. Thus, the null hypothesis in this study would be rejected. Hence, for the conclusion, there was a significant mathematics improvement for the experimental group after chess playing treatment. Meanwhile, for the control group, they had achieved the mathematics' post-test performance ($M = 10.67$, $SD = 2.014$) with $t(23) = 1.621$, $p = .119 > .05$. This result indicated that the null hypothesis in this study would be accepted. Thus, for the conclusion, there was no significant mathematics improvement found for the control group.

Table 2: Hypothesis testing for mathematics score in post-test, with One-Sample Test.

	Test Value = 10					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Experimental (N=29)	9.639	28	.000	3.28	2.58	3.97
Control (N=24)	1.621	23	.119	.67	-.18	1.52

Table 3 presents the mathematics improvement for both groups of students in this study analysed by method of the independent sample t-test. From the Table 3, as could be seen, there was no statistically significant difference in the mathematics score of the pre-test for control group (M=9.83, SD=2.615) and experimental group (M=9.86, SD=1.706) with t (38.155) = .046, p = .963. This indicated that before the treatment process had been implemented, both the control and the experimental group showed no statistically significant difference in mathematics learning and achievement. Meanwhile, there was a statistically significant difference in the mathematics score of the post-test for control group (M = 10.67, SD = 2.014) and experimental group (M = 13.28, SD = 1.830) with t (51) = 4.936, p = .000. This indicated that after the chess treatment process had been implemented for the experimental group, then it was found that the experimental group showed statistically significant difference in mathematics learning and achievement than the control group. Therefore, the alternative hypothesis with the statement of "There is a significant mathematics improvement for the experimental group." was accepted.

Table 3: Hypothesis testing for mathematics improvement, with Independent Sample t-Test.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Maths Pre-test	Equal variances assumed	7.172	.010	.048	51	.962	.03	.597	-1.170	1.227
	Equal variances not assumed			.046	38.155	.963	.03	.621	-1.228	1.285
Maths Post-test	Equal variances assumed	.411	.524	4.936	51	.000	2.61	.529	1.548	3.670
	Equal variances not assumed			4.891	47.102	.000	2.61	.533	1.536	3.682

As a conclusion, the above results showed that there was a significant mathematics improvement for the experimental group (co-curricular – chess students with their regular-lessons as well) than the control group (regular-lessons students only without participating in chess course). This result was supported by the previous studies of Subia et. al. (2019), Rosholm et. al. (2017), Sala et. al. (2016), Trinchero and Sala (2016), Işıkgöz (2016), Sala et. al. (2015), Mashuri (2015), Trinchero (2013), Kazemi et. al. (2012) and Scholz et. al. (2008) that the experimental group in the study achieved better scores and improvements in mathematics learning than the control group. The author also agreed with all the above researchers that chess could be a very valuable tool to enhance students' mathematics abilities if implemented properly and accordingly in education.

It is recommended that the institution may encourages students to learn and play chess during their free time or involve with any chess activities organised. The institution also can set up a chess club and open to all students to join. With these efforts in cultivating the chess playing in institution, it is hoped that even a short-time chess practice or chess playing among students

can be a very useful tool to boost their mathematical abilities, especially in critical and problem-solving skills.

Furthermore, it is suggested that this study can be extended by favourable to enlarge its sample size and scope to determine the effect of playing chess on the other lessons such as engineering calculation-oriented subjects or subjects that need more memorisation. Other suggestion is that this similar study can be repeated but, in the future, all the respondents whether from the experimental or control groups will be tested by the Engineering Mathematics 2 or even higher level to see how great their mathematics performance, especially for the experimental group with chess treatment process.

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