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Students' Skills in Chess and Its Correlation to Their Performance in Mathematics

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Abstract

The study investigated the association of students' chess skills and their performance in mathematics among junior high school students of Dipolog City during the School Year 2024–2025. In this quantitative, descriptive-correlational research design, data were collected via a validated and pilot-tested questionnaire, modified from Progress With Chess (2020) [23] and Sala and Gobet (2017) [27] from 231 students among four public secondary schools. The results indicated that most of these respondents were male belonging to the 13–14 age bracket. Majority were from lower socio-economic backgrounds who had little experience in chess and only few had formal chess trainings. Despite this, students overall showed "Skilled" chess performance, excelling especially in cognitive and technical aspects while lacking in practical skills. Chess skills differed significantly by age, grade level, gender, and frequency of play, and mathematics performance differed significantly by grade level, frequency of play, and formal chess training. It was found that there was a weak positive correlation between chess skills and mathematics performance of the respondents, though this finding was still statistically significant. These showed that chess can be a beneficial tool to improve cognitive and academic achievement of learners, especially in mathematics. With these findings, the study proposes the advocation of chess among students and incorporating chess-oriented strategies into teaching methods and curriculum improvement to help further develop logical reasoning and problem-solving skills of learners which are the goals of teaching Mathematics.

Keywords: Chess skills, Mathematics performance, Junior high school, Cognitive development, Problem-solving skills, Descriptive-correlational design

1. Introduction

Chess is believed to be a game that requires a lot of critical thinking skills. It requires its players the ability to plan rigorously and creatively thus making it very challenging. Gobet (2018) [9] describes chess as a two-player strategy board game that is played on an 8 by 8 grid that consists of 64 alternating light and dark squares. The game is set up with each player controlling 16 pieces, which include a king, a queen, two rooks, two knights, two bishops, and eight pawns. The goal of the game is to checkmate the opposing King. This is only achieved when the King of the opponent is put to an immobile position which may seem almost impossible especially if you are against pros. Being able to win the game a very satisfying feat that is why it is very popular across all ages. Schools in all levels include the game in their annual sports feasts making it even more popular even to young learners.

In today's educational setting, a lot of efforts have been made to make learning appealing to students. The ever-changing educational curricula pose even greater challenges to educators alike especially in teaching Mathematics. Educators around the globe find it convincing that recreational games possess valuable assets that can improve and enhance learning. Mathematics teachers take advantage of these recreational games to further make learning more meaningful and enjoyable at the same time as Mathematics tends to be among the least favored subject by the majority of students.

Learning is a cognitive task. The same can be said on the game chess. Chess is one of these games that make it the most into the headlines as the game itself requires the most in terms of cognitive abilities of players. In a simple game of chess, a lot of things can happen. A lot of silence is common during chess games as players carefully plan each move they make. Players use a lot of their time to predict their opponent's move and anticipate their course of action. Simple as the game may look, there is a lot of complexity that the game holds. An individual's involvement of the game could harbor great benefits. According to Stanborough (2020) [31], the habit of meticulous thought and planning is one of the many benefits of playing chess that improves cognitive health. This could then be translated to other aspects that require excessive use of cognitive skills such as Mathematical problem solving.

A research study found that children's cognitive skills and IQ test scores dramatically increase when chess is taught to them (Joseph, Veena Easvaradoss, & Solomon, 2016) [11]. Understanding the correlation of the skills in chess and the performance of students in mathematical problem solving could bring about various benefits such as strategies that could help enhance and improve the overall cognitive skills of learners.

The focus of this study centered on the junior high school students' skills in chess and mathematical performance in the form of grades. More specifically, the objective was to find out if there is a significant correlation between the skills in chess and performance in Mathematics. The study was targeted on the grade 7 to grade 10 students enrolled in schools located within Dipolog City proper.

2. Research Methodology

This study determined the correlation of the junior high schools' mathematics performance and chess skills during the School Year 2024-2025. The quantitative method with descriptive-correlational design was used, with the aid of a modified questionnaire from Progress With Chess (2020) [23] and Sala et al. (2017) [27] that has undergone validation and pilot testing to address and answer all research questions. The respondents of this study were the 231 sample of junior high school students from the four selected schools in Dipolog City namely Dipolog City National High School, Miputak National High School, Zamboanga del Norte National High School Estaka Campus, and Zamboanga del Norte National High School Turno Campus. A purposive sampling was utilized which identified students who have backgrounds in chess.

3. Research Findings

The detailed discussions on the study's findings are given below structured according to the respondents' profile (age, grade level, gender, socio-economic status, frequency of playing chess, and type of chess training received), mathematics performance, chess skills (cognitive skills, technical skills,

and practical skills) followed by the tests for significant differences on the variables of the study, and importantly, the test for significant correlation of the students' chess skills and mathematics performance.

- **Profile of the Respondents**

Table 1 presents the age profile of junior high school students from the four selected high schools in Dipolog City. As table 1 shows, there were 145 (62.77%) students who belong to the 13-14 age bracket; 83 (35.93%) belonged to the 15-16 age bracket, and 3 (1.30%) students who belonged to the 17-18 age bracket. With this, majority of the students were with the 13-14 age bracket. This age distribution aligns with the national educational structures of the Philippines where junior high school students comprise of students aging from 12 to 16 having the majority of which fall within the 13-14 age bracket.

In a recent report, approximately 28.61% of the Philippine population in 2023 were aged 0–14 years (O'Neill, 2025) [19]. This indicated that there was a high proportion of the population that were school-age individuals. Additionally, the Philippine Statistics Authority (2024) [21] reported that about 75% of individuals aged 5-24 attended school during the 2019-2020 academic year and of this 75%, 33.33% were from the 10-14 age group. This further supports the observed concentration of junior high school students aged 13-14 in the study.

Table 1 Profile of the Junior High School Students in terms of Age

Age	Frequency	Percentage
13-14	145	62.77
15-16	83	35.93
17-18	3	1.30
19 and above	0	0
Total	**231**	**100.00**

Table 2 shows the grade-level profile of junior high school students from the four selected high schools in Dipolog City. As table 2 showed, there were 70 (30.30%) grade 7 students among the respondents; 46 (19.91%) who were in grade 8; 63 (27.27%) who were in grade 9; and 52 (22.51%) who were grade 10 students. This showed that all grade levels from 7 to 10 were well represented and fairly balanced. By a small margin, the highest percentage of respondents was from grade 7.

The idea of having a fairly balanced sample in a research study is a necessity to capture the whole picture of the population under study. In the new K-12 curriculum of the Department of Education, they designed it with a progressive structure where competencies build upon one another. This supports the idea that in order to get a complete and accurate understanding of student learning, each grade level must be taken account equally. Similarly, Lipa, Llave, Nartea, Serrano, Gutierrez, Baccay, & Tigas (2017) [14] found that demographic factors, including year level, significantly influence academic performance. This further highlights the need for an equitable sampling in educational studies.

Table 2 Profile of the Junior High School Respondents in terms of Grade Level

Grade Level	Frequency	Percentage
Grade 7	70	30.30
Grade 8	46	19.91
Grade 9	63	27.27
Grade 10	52	22.51
Total	**231**	**100.00**

Table 3 presents the gender profile of junior high school students from the four selected high schools in Dipolog City. As Table 3 shows, there were 154 (66.67%) male students, 68 (29.44%) female students, and 9 (3.90%) belonged to the LGBT gender spectrum. This shows that majority of the respondents are male having 66.67% of the total respondents of the study.

This finding adheres to many research studies where males dominate the game chess. Rothgerber and Wolsiefer (2013) [25] observed that female players tend to perform poorly in chess when facing male opponents which they found out was mainly due to stereotype threats where they feel anxious because of negative gender expectations. Additionally, Smerdon (2020) [30] also pointed out that males tend to participate more in chess than females resulting to generally being better in chess due to more experiences and confidence gained over time.

Table 3 Profile of the Junior High School Students in terms of Gender

Gender	Frequency	Percentage
Male	154	66.67
Female	68	29.44
LGBTQ+	9	3.90
Total	**231**	**100.00**

Table 4 reveals the socio-economic profile of the junior high school students from the four selected high schools in Dipolog City. As table 4 showed, there were 169 (73.16%) students who belonged to low-income families, 57 (24.68%) students belonged to middle income families, and only 5 (2.16%) of the students were from high income families. This shows that majority of the junior high school students belong to low-income families.

In a study from the Philippine Institute for Development Studies (PIDS) by Albert, Santos, and Vizmanos (2021) [2], it revealed that 59.3% Filipinos were categorized as low income in which they earn less than twice the official poverty line, while 39.8% fall within the middle-income bracket and only 0.9% belonged to the high-income families. This explains the trend of the low-income families that the students belonged to in this study. Moreover, Korous, Causadias, Bradley, Luthar, & Levy (2022) [12] found that children with lower socio-economic status generally exhibit lower cognitive abilities

which could negatively impact their academic performance. The findings from this study could infer a lower performance in math as majority of the respondents belonged to lower-income families.

Table 4 Profile of the Junior High School Student Respondents in terms of Socio-Economic Status

Socio-economic Status	Frequency	Percentage
Low Income (Less than ₱9,100 - ₱36,400 monthly family income)	169	73.16
Middle Income (₱36,401 - ₱109,200 monthly family income)	57	24.68
High income (₱109,201 to above ₱182,000 monthly family income)	5	2.16
Total	**231**	**100.00**

Table 5 shows how often the junior high school students from the four selected schools in Dipolog City play chess. Based on the data, 127 students (54.98%) said they rarely play, which means they play chess about once a week. Another 65 students (28.14%) mentioned they play chess sometimes, around 2 to 3 times a week. Meanwhile, 27 students (11.69%) reported playing often, roughly 5 times a week, and 12 students (5.19%) said they play chess every day. This suggests that most of the respondents don't play chess regularly, with the majority only playing about once a week.

Burgoyne, Sala, Gobet, Macnamara, Campitelli, & Hambrick (2016) [5] found that students who practice regularly in chess had better playing skills as well as better academic performance. Comparably, studies like the one by Trinchero and Sala (2016) [32], Sala et al. (2017) [27], and Sala and Gobet (2016) [28] questioned these beliefs. They claim that regular chess practice can improve students' skills in chess, but it does not guarantee better academic results.

Table 5 Profile of the Respondents in terms of their Frequency of Playing Chess

Frequency of Playing Chess	Frequency	Percentage
Rarely (once a week)	127	54.98
Sometimes (2-3 times a week)	65	28.14
Often (5 times a week)	27	11.69
Always (Daily)	12	5.19
Total	**231**	**100.00**

Table 6 shows the responses of the junior high school students on the question "Do you receive any formal chess training?". As Table 6 shows, only 55 (23.81%) students answered they had received formal chess training and 176 (76.19%) answered they did not receive any formal chess training. This reveals that majority of the respondents did not receive any formal chess training at all.

Research has shown that structured learning through chess can be significant in building cognitive and academic skills of individuals. According to Bart (2014) [3], chess training improves logical reasoning and systematic thinking, all of which might be transferable to mathematics. Likewise, Trinchero and Sala (2016) [32] have shown that playing chess makes a significant increase in mathematics performance which also reinforces executive brain functions such as memory, concentration and planning. Furthermore, Burgoyne et al. (2016) [5] in a meta-analysis covering the effect of formal chess training in students found out that students who underwent chess training showed improvements in their gameplay particularly in tactics, endgames and opening strategies. Moreover, since only few of the participants in this study had received formal chess training, it is likely that most did not realize the cognitive and academic benefits associated with systematic chess tutoring as the studies suggest.

Table 6 Response of the Junior High School Students on the Question "Do you receive any formal chess training?"

"Do you receive any formal chess training?"	**Frequency**	**Percentage**
Yes	55	23.81
No	176	76.19
Total	**64**	**100.00**

Table 7 shows the type chess of training received by the respondents who answered yes on the question presented in table 6. As Table 7 showed, 21 (36.21%) students attended school chess clubs, 7 (12.07%) students had private chess coaches, and 30 (51.72%) students answered they had online chess lessons. This reveals that majority of the respondents who had formal chess training engaged in online chess lessons. In addition, 3 students answered that they had more than one type of chess training received which adds 3 to the 55 students who answered yes in table 6.

The data indicates that online chess lessons are the most accessible platform for the respondents. With the increasing trend on the use of technology as alternative forms of learning, chess is falling right in line with such trend. Structured chess players, like the kind that are taught in schools, have been found to improve cognitive functions like concentration logic and planning according to Kramer and Filipp (2015) [13]. School chess clubs especially offer a social and supportive learning experience that helps solidify these skills through consistent practice. On the other hand, private chess coaching which provides a method that is tailored to individual students has shown to provide a great number of academic benefits. Additionally, Poston and Vandenkieboom (2019) [22] found that students playing chess in rated tournaments and those receiving formal chess instruction had a significant higher improvement in their mathematics exam scores. These findings indicate that various kinds of chess training may it be online, school-based, or private chess coaching, can add meaningfully to students' cognitive and intellectual development, provided that they are applied consistently and with appropriate structure.

Table 7 Profile of the Respondents in terms of Chess Training Received

Type of Chess Training	Frequency	Percentage
School Chess Club	21	36.21
Private Coach	7	12.07
Online Chess Lessons	30	51.72
Total	**58**	**100.00**

- **Students' Skills in Chess**

Table 8 presents the students' skills in chess in terms of cognitive skills, technical skills, and practical skills including the overall performance of the students across all three indicators. It is clear from the mean scores, as well as the standard deviations that skill levels differ and appear to vary between students as well.

The cognitive skills domain got the highest mean score of 5.23 (SD = 1.79), which was categorized under "Much Skilled". It suggests that as a group, students correctly answered 6–7 out of 8 items of the cognitive skills test, which indicates a good command of chess rules, concepts, and position-based reasoning. The student respondents are capable of demonstrating logical reasoning and strategic foresight in hypothetical exam situations. A standard deviation of 1.79 indicates moderate variability in performance although many students performed at a high level, a proportion exhibited either lower or higher outcomes, indicating diversity in individual understanding and reasoning ability.

The mean score for the technical skills domain was 3.50 (SD = 1.53), interpreted as "Skilled." This shows that students scored an average of 4 out of 6 items correctly in the technical skills test, suggesting that many was capable of applying chess principles mostly in chess opening and endgame play. There were some strategic understandings but some flaws in the execution. The 1.53 standard deviation also indicated moderate spread, suggesting that while most students demonstrated a reasonable level of competence in terms of technical skills, some either had issues with consistencies or were above-average in terms of technical accuracy.

The practical skills component yielded the lowest mean score of 2.03 (SD = 1.79), which was classified under the "Less Skilled" category. This means that these students overall found time management and planning along with adapting moves within the gameplay simulation to be difficult correctly answering only 2–3 out of 6 items in the practical skills test. The standard deviation of 1.79 shows a big spread in practical ability which means that while some students may have developed practical game habits, many more have yet to be able to translate theory into actual gameplay strategy. This divergence might be due to differing exposure to chess games and/or differing levels of ability under pressure.

In terms of overall chess skills, the students had an overall mean score of 10.76 (SD = 4.33) which classified them towards the "Skilled" category correlating to correctly answering 45–64% on the chess skills test. This suggests moderate chess competence in which students can recognize and utilize basic

strategies but may have difficulty with the consistent and accurate application of strategies within the confines of the test's time limits. The relatively high standard deviation (4.33) indicates considerable variability across the group of students, and implies that although some students performed exceptionally well in all skill domains, others may require additional targeted support and practice to develop their overall performance.

This variability pattern is corroborated by Gaschler, Progscha, Smallbone, Ram, and Bilalić (2014) [8], that skill acquisition differs in chess and that evident variations can occur even when exposure and training times are equivalent across individuals. On the other end of the spectrum, other researchers have examined the effect of extended practice across multiple individuals, comparing developing talents with one another to continue to prove the Pygmalion Effect, that is, the better you practice the better you will be, or as the tale goes, the better you will perform. These findings suggest that there is a huge range of possible learning trajectories and that they are determined by more than just practice frequency or early aptitude. The differences found in this current sample of students are therefore in line with the broader findings concerning the accumulation of expertise in chess, emphasizing the need for individually tailored training and assessment.

Table 8 Students' Skills in Chess in terms of Cognitive, Technical, and Practical Skills

Chess Skills Indicators	Mean Score	SD	Description
Cognitive Skills Score	5.23	1.79	Much Skilled
Technical Skills	3.50	1.53	Skilled
Practical Skills	2.03	1.79	Less Skilled
Overall Score	**10.76**	**4.33**	**Skilled**

- **Students' Performance in Mathematics**

Table 9 presented the junior high school students' performance in Mathematics from their third quarter math grades. Of the 231 student respondents, 141 (61.04%) students have grades between 90–100 marked as "Outstanding", 55 students (23.81%) have grades ranging from 85–89 which is marked as "Very Good", 24 students (10.39%) have grades in the 80–84 range which marks them as "Good", and the "Fair" category only had 11 students (4.76%) whose grades were between the range of 75–79. These results reveal very good levels of Mathematics attainment, with a high percentage of students achieving a good level of mathematical achievement, with only a very small percentage of students requiring help. The mean grade of the 231 student respondents was 90.04 interpreted as "Outstanding" with a standard deviation of 5.66. This showed that the students demonstrated a good grasp of mathematical concepts, can transfer and use problem solving skills accurately, and can transfer these skills to both familiar and unfamiliar situations effectively. This indicates the students' performance in mathematics were consistent because the overall standard deviation of the grades is relatively low.

This finding is also true to some local studies on mathematics performance of junior high school students in the country. Abalde and Oco (2023) [1] identified a high performance among the Grade 10 stu-

dents of Agusan National High School in mathematics which they attributed to good study habits, as well as positive attitudes of the students that affected good performance. Similarly, study findings of Mengullo and Fuentes (2024) [16] also found that the students of Barobo National High School who obtained average grades of 90 to 94 which were categorized as "Outstanding", thus confirming the consistency of high performance in Mathematics among junior high school learners in the Philippines.

Table 9 Students' Performance in Mathematics

Variable	Grade Range	Frequency	Percentage	Mean Grade	SD	Description
Mathematics Grade	90-100	141	61.04	90.04	5.66	Outstanding
	85-89	55	23.81			
	80-84	24	10.39			
	75-79	11	4.76			
Total		**231**	**100.00**			

Test of Significant Difference on Students' Skills in Chess when Data are Grouped by Profile

Table 10 Kruskal Wallis H Test of Significant Difference on Students' Skills in Chess when Data are Grouped by Profile at 0.05 Significance

Chess Skills vs. Profile	H-value	P-value	Decision	Interpretation
Age	20.848	.000	Reject the null hypothesis	Significant
Grade Level	27.172	.000	Reject the null hypothesis	Significant
Gender	13.568	.001	Reject the null hypothesis	Significant
Socio-Economic Status	.510	.775	Fail to reject the null hypothesis	Not significant
Frequency of Playing Chess	11.870	.008	Reject the null hypothesis	Significant

Table 10 shows the summary of the Kruskal Wallis H test of significant difference on students' skills in chess when data are grouped by profile at 0.05 significance. Based on the results of the tests, the following values were obtained for each profile variable in relation to students' chess skills: for age, the H-value is 20.848 with a p-value of .000, indicating a highly significant difference; for grade level, the H-

value is 27.172 with a p-value of .000, also showing a highly significant difference; for gender, the H-value is 13.568 with a p-value of .001, which is likewise highly significant; for socio-economic status, the H-value is 0.510 with a p-value of .775, indicating a not significant result; and for frequency of playing chess, the H-value is 11.870 with a p-value of .008, which reflects a significant difference.

The results indicate that student's chess abilities vary greatly along the age, grade, gender and chess playing frequency. The variables such as age, grade level and gender have very low p-values, indicating a strong significance and thus rejecting the null hypothesis for these variables. This is consistent with studies showing age and practice are large contributors to performance in chess showing that younger players typically beat their older competition as they improve at faster rates where regular practice plays a key role to further enhances their capabilities (Blanch, Aluja, & Cornadó, 2015) [4]. In addition to this, the extremely small p-value associated with frequency of playing chess indicates that consistent practice is good for skill development. Macnamara, Hambrick, & Oswald (2014) [15] on deliberate practice found that deliberate practice explains a significant portion of the performance variance across domains, including chess, because it highlights the importance of engaging in dedicated practice to enhance performance.

The non-significant p-value for socio-economic status on the other hand showed that socio-economic status does not have a significant effect on the games one play. This is corroborated by the findings from Forrest, Tena, & Varela-Quintana (2022) [6] whose empirics showed that although; economic resources may play a role in access to chess training, they have no direct bearing on performance outcomes. Overall, the findings of the study suggest that, apart from socio-economic status, the factors that are tested affect the variations in students' chess skills, in particular age and grade level, sex, and frequency of playing chess.

Table 11 Mann-Whitney U Test of Significant Difference on Students' Skills in Chess when Data are Grouped by Profile at 0.05 Significance

Chess Skills vs. Profile	U-value	P-value	Interpretation	Decision
Chess Training	4736.500	.810	Not significant	Fail to reject the null hypothesis

Table 11 shows the Mann-Whitney U Test of significant difference on students' skills in chess when data are grouped by profile at 0.05 significance. The test yielded a U-value of 4736.500 with p value of .810, meaning that, as the p-value is more than the level of significance (0.05), the result will be considered as not statistically significant, thus, failing to reject the null hypothesis. This means that the students grouped based on if they received chess training or not, did not show a statistically significant difference in their chess skill. This likely means that formal training in chess, at least as delivered in this context, was not intensive or effective enough to yield measurable improvement in students' performance at chess. There could be other variables like informal practice, interest, motivation and personal cognitive ability that play a vital role in one's improvement in chess. Some studies have suggested that though structured chess instruction may carry certain benefits, unless mastery of the game is accompanied by routine, deliberate practice, the advantages are not always significant (Sala & Gobet, 2017)

[29]. Therefore, providing formal chess training does not appear to considerably affect students' overall performance in chess, demonstrating that participation, for example, in training programs may not be enough to ensure improvement without additional factors, such as regular practice and personal commitment.

Test of Significant Difference on Students' Performance in Mathematics when Data are Grouped by Profile

Table 12 Kruskal Wallis H Test of Significant Difference on Students' Performance in Mathematics when Data are Grouped by Profile at 0.05 Significance

Mathematics Performance vs. Profile	H-value	P-value	Decision	Interpretation
Age	4.091	.129	Fail to reject the null hypothesis	Not significant
Grade Level	7.828	.050	Reject the null hypothesis	Significant
Gender	5.930	.052	Fail to reject the null hypothesis	Not significant
Socio-Economic Status	.020	.990	Fail to reject the null hypothesis	Not significant
Frequency of Playing Chess	12.316	.006	Reject the null hypothesis	Significant

Table 12 presented the Kruskal Wallis H test of significant difference on students' performance in mathematics when data are grouped by profile at 0.05 significance. The H-value for age was 4.091 with a p-value of .129, which translate to not being statistically significant, and therefore a decision to fail to reject the null hypothesis. This is different from the findings of Navarro, García-Rubio and Olivares (2015) [18], which noted that relatively older students of the same grade perform better than their younger counterparts in academic activities including mathematics, even when controlling for variables like socioeconomic background. As for gender, the H-value was 5.930 and the p-value was .052 which is slightly above threshold so it is also not statistical significance hence it failed to reject the null hypothesis. These results are similar to what was found in Rusli (2019) [26] that showed little gender difference in mathematics performance. Socio-economic status produced an H-value of 0.020, and a p-value of .990, which is well above the 0.05 threshold level meaning it is not statistically significant, and again null hypothesis is not rejected. This is consistent with the findings of Munir, Faiza, Jamal, Daud, & Iqbal (2023) [17] who found that SES affects achievement but mediating factors such as school climate and family involvement play a larger role while contextual factors often mediate SES effects which provide a possible explanation for the current study's findings.

In contrast, grade level yields an H-value of 7.828 and a p-value of .050 that is right on the 0.05 significance level, and is therefore slightly statistically significant and the null hypothesis is rejected. Zakariya (2022) [33] emphasized the importance of grade-specific interventions to build students' math self-efficacy, potentially explaining this variation. The strongest association is between frequency of playing chess in which gave an H-value of 12.316 and a p-value of .006, which is less than 0.05 significance level, so this variable is also statistically significant and therefore the null hypothesis will be rejected. This supports Sala and Gobet's (2017) [29] findings that chess instruction enhances mathematical problem-solving. In conclusion, there were significant differences in Mathematics performance of the students in the grade level and frequency of playing chess variables, but age, gender, and socio-economic status did not reveal any statistically significant effects.

Table 13 Mann-Whitney U Test of Significant Difference on Students' Performance in Mathematics when Data are Grouped by Profile at 0.05 Significance

Mathematics Performance vs. Profile	H-value	P-value	Decision	Interpretation
Chess Training	3412.000	.001	Reject the null hypothesis	Significant

Table 13 shows the Mann-Whitney U Test of significant difference on students' performance in mathematics when data are grouped by profile at 0.05 significance. It showed the statistical significance in students' Mathematics performance categorized by the students who have chess training and students who do not have chess training yielding a U-value of 3412.000 and less than the 0.05 significance level of a p-value of 0.001. This proves that chess training plays a role in boosting the performance of students in Mathematics. Hence, the null hypothesis "students without chess training do not perform better in Mathematics" is rejected. A similar finding was noted in a study conducted by Rosholm, Mikkelsen, and Gumede (2017) [24] which investigated the influence of adding chess to mathematics instruction with primary school children in Denmark. Their study revealed that replacing one weekly math lesson for chess-based activities has yielded a significantly higher mathematics performance in terms of test scores of students which has a standard deviation of between 0.10 and 0.18 of learning gain. These results serve to underscore the cognitive benefits of chess instruction, one that transfers positively into mathematical performance.

Test of Significant Correlation of the Students' Performance in Mathematics and their Chess Skills

Table 14 Spearman rho Test of Significant Relationship of Spearman rho Correlation of the Students' Performance in Mathematics and their Chess Skills at 0.05 Significance Level (Two-tailed)

Variables Correlated	Spearman rho	P-value	Decision	Interpretation
Mathematics Performance and Chess	.167	.011	Reject the null hypothesis	Weak positive correlation; significant

Skills				

Table 14 presented the test of significant relationship of spearman rho correlation of the students' performance in mathematics and their chess skills at 0.05 significance level (two-tailed). The results confirm that students' chess skills significantly correlate with their performance in Mathematics. The table showed a correlation value of 0.167 which suggests a weak positive correlation of the two variables being tested. The p-value of 0.011 which is less than that of the 0.05 level of significance, means that this correlation is statistically significant, although the value of the correlation coefficient is still relatively low. As a result, the null hypothesis is rejected. This indicates that chess skills might have a real but small correlation with better performance in Mathematics.

This supports earlier assertions that chess promotes problem-solving and cognitive skills transferable to mathematics. In a meta-analysis of Sala and Gobet (2016) [28], they found that students exposed to chess lessons significantly outperformed their peers in problems solving tasks, marking chess a valuable cognitive training tool. In addition, Bart (2014) [3] suggested that the cognitive demands of chess like reasoning, planning, and decision-making, among other skills, could improve general cognitive abilities that are applicable to fields such as Mathematics. These theoretical bases for the claims have set the stage for major experimental studies in the UK (Jerrim, Macmillan, Micklewright, Sawtell, & Wiggins 2016) [10], and public debate has supported this view of chess as a "cognitive enhancer" (Garner, 2012) [7]. However, a more nuanced and cautious approach is necessary, as demonstrated by differing findings such as those from the IoE Study (Jerrim et al., 2016) [10], which found no significant impact of primary-level chess instruction, provoking the question of when or under what conditions can chess deliver yields in educational payoffs (Pells, 2016) [20]. However, the findings from the current study provide statistical support for the modest yet significant association between chess skills and Mathematics performance, adding to the expansive discussion on the role of chess as a learning tool.

4. Summary of Findings

In summary, the study revealed the following:

1. Most of the respondents were within 13–14 years old, which is common age range for junior high school students in the Philippines. All grade levels were represented in the sample, with slightly more students in grade 7. Majority of the respondents were males. Majority of the students were from lower socio-economic status. For chess involvement, the results indicate that the majority of students play infrequently, often only once week, so chess is not necessarily a regular activity for most. They played less, a lot less, and few played every day. The respondents lacked formal chess training and most had no systematic instruction. Among people who did receive training, the most popular form was online chess lessons, followed by school chess clubs and outside coaching by private instructors.
2. Students showed at least "Much Skilled" cognitive ability which means that they could generally explain the rules of chess, think strategically and display positional reasoning to some extent. They were marked as "Skilled" in technical skills which indicates a decent understanding of opening principles and endgames, though some variances in execution were noted. For practical skills, the students were labeled as "Less Skilled" which suggests that they struggle with time

management, planning, and tactic adaptation during actual gameplay. In the overall chess skill performance, they were labeled as "Skilled".

3. There was a significant difference in students' chess skills when analyzed by age, grade level, gender, and frequency of playing chess. On the contrary, socio-economic status and formal chess training did not show significant differences. This suggests that regular play and individual characteristics have a greater effect on chess skills than structured training alone.
4. There was a significant difference in the students' mathematics performance when analyzed as to their grade level, frequency of playing chess, and formal chess training. In contrast, the variables such as age, gender, and socio-economic status showed no significant difference on their math performance.
5. There was a significant correlation between mathematics performance and chess skills of the respondents in the study, although the correlation was weak it was still statistically significant. This means that as their chess skills improve, their Mathematics performance also tends to improve slightly.

5. Conclusion

It can be concluded that these findings suggest chess could be a useful delivery mechanism for cognitive and academic development that could promote mathematical achievement to young learners. As educators find teaching math to be a challenge, chess could offer an indirect approach in enhancing cognitive functions such as problem solving and critical thinking which are necessary in Mathematics. The study adds to the vast studies supporting the idea of chess as a tool for improving academic excellence specially in Mathematics.

6. Appendices

Students' Skills in Chess and Its
Correlation to their Performance in Mathematics
QUESTIONNAIRE

I. Profile

Directions: Check (√) the box that corresponds to the information asked. Fill in the blanks with pertinent information.

Name: _____

Age: ☐ 13 – 14 years old
☐ 15 – 16 years old
☐ 17 – 18 years old
☐ 19 years old or above

Grade Level: ☐ Grade 7 ☐ Grade 8
☐ Grade 9 ☐ Grade 10

Gender: ☐ Male ☐ female ☐ LGBTQ+

Socio-economic Status: ☐ Low income (Less than ₱9,100 - ₱36,400 monthly family income)
☐ Middle Income (₱36,401 - ₱109,200 monthly family income)
☐ High income (₱109,201 to above ₱182,000 monthly family income)

Frequency of Playing Chess:

☐ Rarely (once a week) ☐
Sometimes (2-3 times a week)
☐ Often (5 times a week)
☐ Always (Daily)

Chess Training Background:

Do you receive formal chess training?
☐ Yes ☐ No

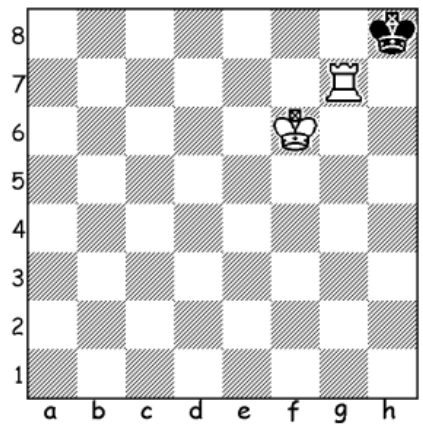
If yes, please specify the type of training:
☐ School Chess Club
☐ Private Coach
☐ Online Chess Classes

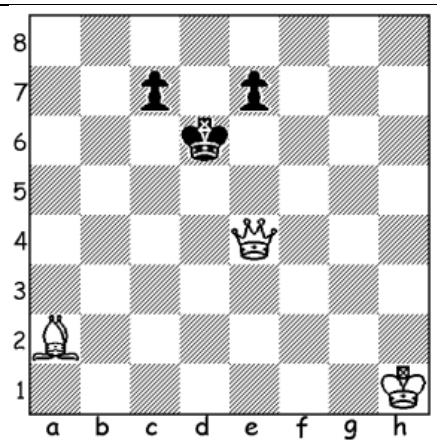
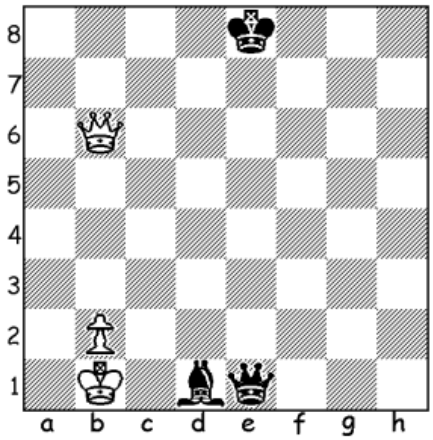
II. Chess Skills Test

Directions. This part intends to determine your skills in chess in terms of cognitive skills, technical skills, and practical skills. Read carefully each item and write your answer on the space provided. Your answer could be in a form of short essay or enumeration of what is asked. Each item is equivalent to 1 point having a total of 20 points.

Cognitive Skills (Critical thinking, Problem Solving, Pattern Recognition, Knowledge in Chess Principles)

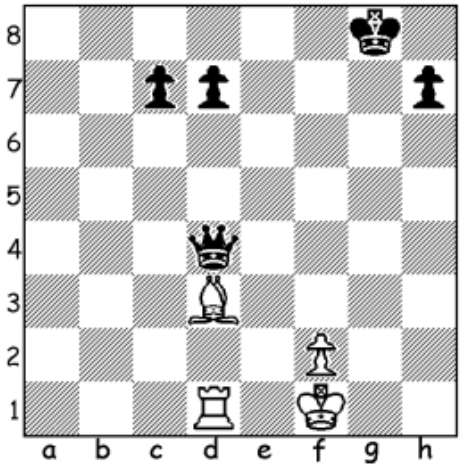
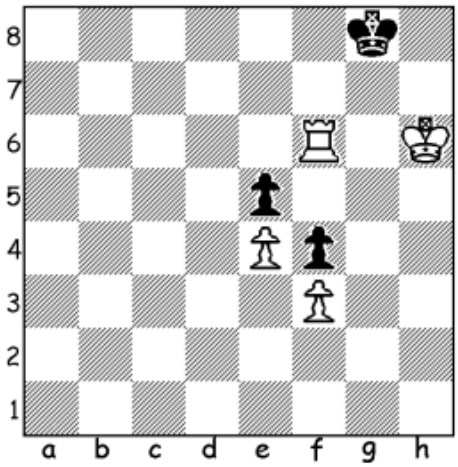
No.	Question	Your Answer
1.	Name the chess piece that is limited to diagonal movements only.	

2.	Name the special move that a King and a Rook can do if they are on their initial place (you haven't moved them since the beginning of the game) and there is no other piece between them.	
3.	When your opponent's pawn moves two squares forward from its starting position and passes your pawn, what should you do in response?	
4.	Generally, what is your main goal at the opening phase of a chess game?	
5.	What advantage can you get if your opponent has double pawns?	
6.	It is black's turn to move. What chess terminology describes the black king's situation below? 	
7.	You are white and it is your turn to move. Analyze this position and determine the one move to checkmate the black King. Write your answer in chess notation.	

		
8.	It is black's turn to move. Determine the one move that would checkmate the white's king. Write your answer in chess notation. 	

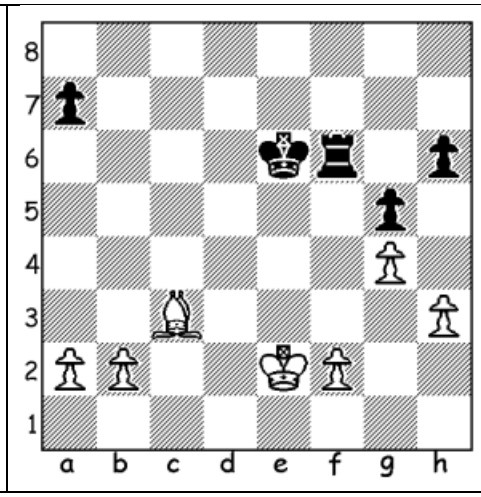
Technical Skills (Opening Principles, Endgame Techniques)

No.	Question	Your Answer
9.	At the beginning of the game, name the ONLY two chess pieces that can move.	
10.	What three basic principles should a player focus on at the beginning of a chess game?	1. 2. 3.

11.	It is the white's turn to move. Determine the two moves that would make you advantageous (like having more chess pieces with higher values). Write your answer in chess notation. 	White's 1st move: Black's possible response move: White's 2nd move:
12.	What is the name of the famous chess opening move that begins with Black playing c5 after White plays e4?	
13.	It is White's turn to move. Determine the two moves that will checkmate the Black's king. Use chess notation to write your answer. 	White's 1st move: Black's possible response move: White's second move to checkmate black:
14.	What is the advantage of having more pawns at endgames?	

Practical Skills (Strategic Planning, Time Management)

No.	Question	Your Answer
15.	When playing chess with a timer (standard time-control of 90 minutes), how would you divide your time into the three stages of the game (opening game, middle game, endgame)? Which stage should you give more time to and why?	
16.	What should a player focus on at the middle game of a chess match?	
17.	Give one reason why controlling the center of the board is an important strategy?	
18.	What is the best strategy if you are low on time during a chess game?	
19.	In the middle of a chess match, you notice that your opponent has less time than you. What would be the best strategy to keep this advantage?	
20.	It is White's turn to move. What is the best move to do in this position? Explain why it is the best move. Write the move in chess notation.	



Thank you for participating in the study!

Chess Skills Test Answer Key:

1. Bishop
2. Castling/Castle
3. When your opponent's pawn moves two squares forward from its starting position and passes your pawn, you have the opportunity to capture it 'en passant' in which you move your pawn forward diagonally to the square directly behind the opponent's pawn.
4. The main goal at the opening of the game is to control the center of the chess board by developing your chess pieces.
5. Answers could be: reduced mobility of the opponent's doubled pawn, weak pawn structure of the opponent which you can easily target, the opponent could have difficulty at endgames if he/she has doubled pawns.
6. The black King is in stalemate.
7. Qd5 or Queen to d5.
8. Bb3 or Bishop to b3.
9. Pawns and Knights are the only chess pieces that you can move at the very start of a chess game.
10. The three basic principles that a player should generally focus at the beginning of a chess game include: control the center, develop your pieces, and protect your King.
11. White's 1st move: Bxh7
    Black's possible responses: Kxh7, Kh8, Kg7, Kf7, or Kf8
    White's 2nd move: Rxd4
12. Sicilian Defense
13. White's 1st move: Kg6
    Black's response move: Kh8
    White's winning move: Rf8
14. Possible answers: easier pawn promotion, more controlled squares making it easy to corner the opponent, creation of passed pawns, pressuring the opponent to making defensive mistakes during the endgame.
15. When the game involves the use of chess clock, you may want to allocate more time in the middle and endgame as this is the most crucial part of the game. The opening part of the game main-

ly focuses on the general principle such as controlling the center, developing your pieces, and protecting your king.

16. Possible answers: ensure safety of your king, control squares to maximize your chance of winning and making your opponent more immobile, planning a strategy to capture the opponents key pieces, avoid rushing and stay vigilant on the opponent's possible attacks, put yourself in your enemies position predict and prevent possible attacks.
17. Possible answers include: greater mobility for your chess pieces that is vital to plan attacks and forge better defenses, enhances your king's safety, prepares for the middle and endgame.
18. Possible answers include: stay calm and play with a plan, avoid complicated calculations, focus on possible threats and plan simple countermeasures.
19. Possible answers may include: play fast but with practical move to maintain time advantage, complicate your opponent's position, play forcing moves (forcing your opponent to be at where you want him/her to be).
20. White's best move would be Bxf6 since a rook has a greater value than a bishop. Additionally, capturing the opponent's rook would eliminate future threats.

Sample Responses:

Republic of the Philippines
JOSE RIZAL MEMORIAL STATE UNIVERSITY
The Premier University in Zamboanga del Norte
Main Campus, Dapitan City

Assent Form for Minor Participants

Study Title: *Students' Skills in Chess and Its Correlation to Their Performance in Mathematics*

Researcher: Dave P. Lacquio
Institution: Jose Rizal Memorial State Univsity Main Campus
Contact Information: 09518533313

Study Overview:
This study looks at whether playing chess affects students' performance in math. You'll answer some questions about how often you play chess and take a short math test.

What You Will Do:

- Answer a few questions about your demographic profile.
- Take a brief chess test.

Risks & Benefits:
There are no major risks. Your answers will be kept private, and the study will help us understand the relationship between chess and math performance.

Voluntary Participation:
Your participation is voluntary. You can stop at any time without penalty.

Confidentiality:
Your answers will remain confidential and used only for this study.

Agreement to Participate:
By signing, you agree to participate in the study. You can ask questions if you have any.

Participant's Signature over Printed Name: JOSH ASHLEY T. REGENCIA
Date: 3/19/25

Witness's Signature over Printed Name Name: Hecelyn Kent P. Manto
Date: 3/19/25

Researcher's Statement:
I've explained the study and answered any questions.

Researcher's Signature over Printed Name: DAVE P. LACQUIO
Date: 3/11/2025

Students' Skills in Chess and Its Correlation to their Performance in Mathematics
QUESTIONNAIRE

I. Profile

Directions: Check (√) the box that corresponds to the information asked. Fill in the blanks with pertinent information.

Name: Josh Ashton A. Regencia (93

Age:
- ☑ 13 – 14 years old
- ☐ 15 – 16 years old
- ☐ 17 – 18 years old
- ☐ 19 years old or above

Grade Level:
- ☑ Grade 7
- ☐ Grade 8
- ☐ Grade 9
- ☐ Grade 10

Gender:
- ☑ Male
- ☐ female
- ☐ LGBTQ+

Socio-economic Status:
- ☐ Low income (Less than ₱9,100 - ₱36,400 monthly income)
- ☑ Middle Income (₱36,401 - ₱109,200 monthly income)
- ☐ High income (₱109,201 to above ₱182,000 monthly income)

Frequency of Playing Chess:
- ☑ Rarely (once a week)
- ☐ Sometimes (2-3 times a week)
- ☐ Often (5 times a week)
- ☐ Always (Daily)

Chess Training Background:

Do you receive formal chess training?
- ☐ Yes
- ☑ No

If yes, please specify the type of training:
- ☐ School Chess Club
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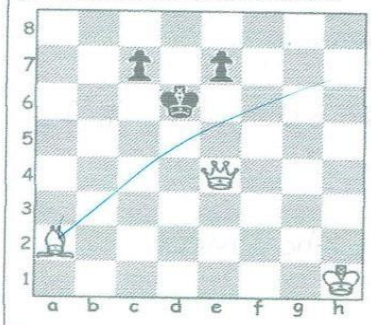
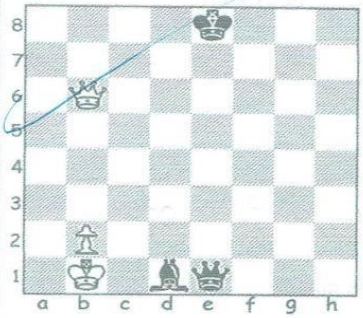
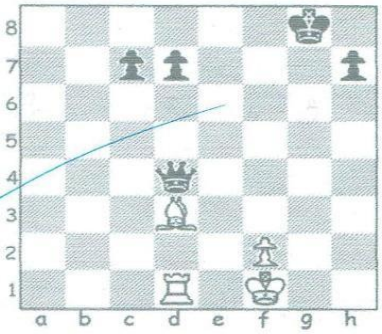
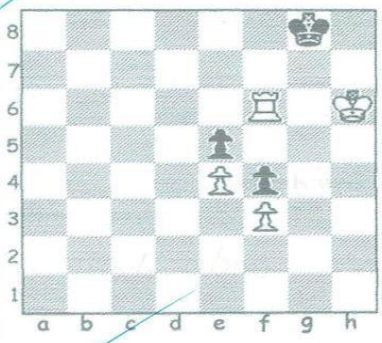
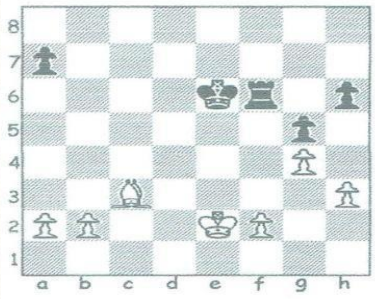
7.	You are white and it is your turn to move. Analyze this position and determine the one move to checkmate the black King. Write your answer in chess notation. 	queen e-4 to d-5
8.	It is black's turn to move. Determine the one move that would checkmate the white's king. Write your answer in chess notation. 	bishop d-1 to b-3

Technical Skills (Opening Principles, Endgame Techniques)

No.	Question	Your Answer
9.	At the beginning of the game, name the ONLY two chess pieces that can move.	The knight and the pawn.
10.	What three basic principles should a player focus on at the beginning of a chess game?	1. The opening 2. Time management 3. endgame

11.	It is the white's turn to move. Determine the two moves that would make you advantageous (like having more chess pieces with higher values). Write your answer in chess notation. 	White's 1st move: bishop to h-7 Black's possible response move: king takes bishop in h-7 White's 2nd move: Rook takes the queen
12.	What is the name of the famous chess opening move that begins with Black playing c5 after White plays e4?	the Scicilian Defense.
13.	It is White's turn to move. Determine the two moves that will checkmate the Black's king. Use chess notation to write your answer. 	White's 1st move: king moves to g-6 Black's possible response move: King moves to h-8 White's second move to checkmate black: rook to f-8
14.	What is the advantage of having more pawns at endgames?	having more pawns at the endgame allows you to control the game more because of the pawn's potential to become queen, rook, bishop and the knight.

Practical Skills (Strategic Planning, Time Management)

No.	Question	Your Answer
15.	When playing chess with a timer (standard time-control of 90 minutes), how would you divide your time into the three stages of the game (opening game, middle game, endgame)? Which stage should you give more time to and why?	I Divide the time like this, 40 minutes in the opening, 30 minutes in the mid game and 20 minutes in the end game, this is because the end game is where you checkmate and if you develop it well it is very easy to checkmate with queen and rook.
16.	What should a player focus on at the middle game of a chess match?	If a player is in the mid game i think he should focus on time management and his position.
17.	Give one reason why controlling the center of the board is an important strategy?	It is important so any pieces that will go to center will be in danger because it will be taken by my pawns.
18.	What is the best strategy if you are low on time during a chess game?	The best strategy is to get stalemate. Or focus on breaking the opponents defense to checkmate the king and control on how to use your time and dont think too long.
19.	In the middle of a chess match, you notice that your opponent has less time than you. What would be the best strategy to keep this advantage?	its best to pressure the opponent and trap him so his options are limited. Therefore taking more time to thik.
20.	It is White's turn to move. What is the best move to do in this position? Explain why it is the best move. Write the move in chess notation. 	bishop takes rook in f6 Explanation: It is the best move because losing a bishop to a rook makes the opponent at a disadvantage. Plus you have more pawns and you are likely to win because your pawns are more than ~~the~~ black.

Thank you for participating in the study!

Republic of the Philippines
JOSE RIZAL MEMORIAL STATE UNIVERSITY
The Premier University in Zamboanga del Norte
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Assent Form for Minor Participants

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Researcher: Dave P. Lacquio
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- Take a brief chess test.

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Voluntary Participation:
Your participation is voluntary. You can stop at any time without penalty.

Confidentiality:
Your answers will remain confidential and used only for this study.

Agreement to Participate:
By signing, you agree to participate in the study. You can ask questions if you have any.

Participant's Signature over Printed Name: Jhyrel Z. Dalumpines
Date: _____

Witness's Signature over Printed Name Name: _____
Date: _____

Researcher's Statement:
I've explained the study and answered any questions.

Researcher's Signature over Printed Name: DAVE P. LACQUIO
Date: 3/11/2025

Students' Skills in Chess and Its Correlation to their Performance in Mathematics
QUESTIONNAIRE

I. Profile

Directions: Check (√) the box that corresponds to the information asked. Fill in the blanks with pertinent information.

Name: JHYREL ZKYE Z. DALUMPINES

Age:
- ☑ 13 – 14 years old
- ☐ 15 – 16 years old
- ☐ 17 – 18 years old
- ☐ 19 years old or above

Grade Level:
- ☐ Grade 7
- ☑ Grade 8
- ☐ Grade 9
- ☐ Grade 10

Gender:
- ☑ Male
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- ☐

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Do you receive formal chess training?
- ☐ Yes
- ☑ No

If yes, please specify the type of training:
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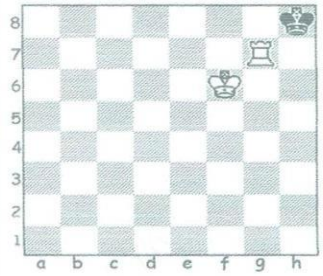
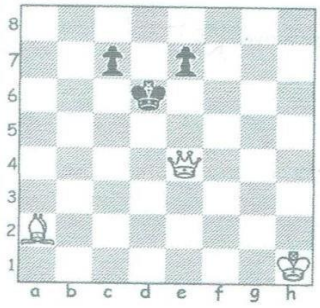
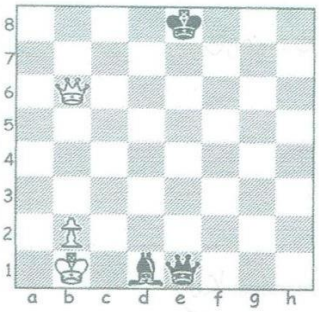
II. Chess Skills Test

Directions. This part intends to determine your skills in chess in terms of cognitive skills, technical skills, and practical skills. Read carefully each item and write your answer on the space provided. Your answer could be in a form of short essay or enumeration of what is asked. Each item is equivalent to 1 point having a total of 20 points.

Cognitive Skills (Critical thinking, Problem Solving, Pattern Recognition, Knowledge in Chess Principles)

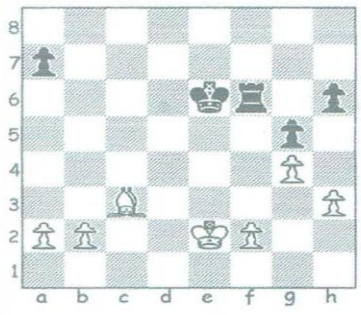
No.	*Question*	*Your Answer*
1.	Name the chess piece that is limited to diagonal movements only.	Bishop
2.	Name the special move that a King and a Rook can do if they are on their initial place (you haven't moved them since the beginning of the game) and there is no other piece between them.	Castling
3.	When your opponent's pawn moves two squares forward from its starting position and passes your pawn, what should you do in response?	You can capture the pawn as it had only moved one squate forward
4.	Generally, what is your main goal at the opening phase of a chess game?	Position the pieces, control the center, and ensure the King's safety
5.	What advantage can you get if your opponent has double pawns?	They are weaker because they cannot support eachother and can be easier to attack
6.	It is black's turn to move. What chess terminology describes the black king's situation below? 	Checkmate, the black king is trapped with no legal moves to escape

7.	You are white and it is your turn to move. Analyze this position and determine the one move to checkmate the black King. Write your answer in chess notation. 	Qf7#
8.	It is black's turn to move. Determine the one move that would checkmate the white's king. Write your answer in chess notation. 	Qb2#

Technical Skills (Opening Principles, Endgame Techniques)

No.	*Question*	*Your Answer*
9.	At the beginning of the game, name the ONLY two chess pieces that can move.	Pawns and knights
10.	What three basic principles should a player focus on at the beginning of a chess game?	1. Control the center 2. Position your pieces/Develop your pieces 3. Ensuring king's safety

Practical Skills (Strategic Planning, Time Management)

No.	Question	Your Answer
15.	When playing chess with a timer (standard time-control of 90 minutes), how would you divide your time into the three stages of the game (opening game, middle game, endgame)? Which stage should you give more time to and why?	Opening: 15–20 minutes (to develop pieces effiently) Middlegame: 45 minutes (since this stage involves complex strategies, and tactics Endgame: 20-25 minutes (requires precise calculations)
16.	What should a player focus on at the middle game of a chess match?	Plan an attack or weakening the opponent's position
17.	Give one reason why controlling the center of the board is an important strategy?	Controlling the center allows for greater mobility of pieces and restricts the opponent's options, leading to a stronger position
18.	What is the best strategy if you are low on time during a chess game?	Following general principles rather than over-analyzing each move
19.	In the middle of a chess match, you notice that your opponent has less time than you. What would be the best strategy to keep this advantage?	Play quickly and confidently to maintain time pressure
20.	It is White's turn to move. What is the best move to do in this position? Explain why it is the best move. Write the move in chess notation. 	Rxd7+: This move forces the Black king to move and may lead to decisive material gain or checkmate

Thank you for participating in the study!

7. Acknowledgement

The researcher would like to express his utmost gratitude to the following personalities who made immeasurable support and assistance to make this study a success.

Dr. Paterno S. Baguinat III, adviser of the researcher, who gave his unlimited support, guidance and expertise that paved way to the realization of the research study.

Dr. Edgar S. Balbuena, OIC-Dean of the Graduate School, whose patience and consideration made possible the completion of this study.

Prof. Harvey Dagpin, Prof. Troy Lasco, Prof. Rhidgel Ageas, and Prof. Luna Luz Racho, the panel for their valuable comments and suggestions.

To my family, who inspired me to strive hard and continue pursuing greater heights.

To my fellow faculty members, who pushed me to keep going no matter what.

Lastly, to our Heavenly Creator, for the gift of wisdom, perseverance, good health, determination, strength, love and everything that makes this thesis a success.

8. Authors' Biography

The author earned a Bachelor of Secondary Education degree with a specialization in Mathematics and is currently engaged in graduate studies at Jose Rizal Memorial State University. Serving as a part-time instructor at the same institution, the author is committed to advancing mathematics education through research and innovative teaching practices. With additional experience in the performing arts, the author brings a diverse and interdisciplinary perspective to scholarly work, contributing to a holistic approach in the field of mathematics education.

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