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EFFECTS OF CHESS PLAYING ON THE REFLECTIVE THINKING SKILL OF THE ADOLESCENT STUDENTS IN ANAMBRA STATE SECONDARY SCHOOLS

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ABSTRACT

This research studied the effect of chess playing on the reflective thinking skill of the adolescent students in SS 2 in Anambra State. The study was guided by two research questions and two hypotheses. It adopted non-randomized, pre-test, post-test control group quasi-experimental design. The population of the study comprise 12,277 (SS 2) students in the 204 co-educational secondary schools in Anambra State (Source: Post Primary Schools Services Commission, PPSSC, Awka Anambra State, 2022). Multi stage sampling procedure was adopted for this study. Four out of the six education zones in Anambra were used. A total of 200 students from the intact classes were used from the four sampled schools of the four zones. Verbal Cognitive Reflection Test (CRT-V) developed by Sirota, Dewberry, Juanchich, Valuš and Marshall (2011) was the instrument used for data collection. The instrument was adapted and revalidated by experts. The reliability of the instrument was established at .74 coefficient using Cronbach Alpha method. The researcher with the help of professional chess trainers and other research assistants carried out the 9 week experiment. Pretest and posttest were collected and analyzed with ANCOVA using SPSS version 2.0. The findings of the study showed that chess playing has a positive significant effect on the reflective thinking skill of the students. The study recommended that chess playing as a gamification in education should be adapted or adopted in secondary schools as a preferred learning style for the adolescents in the era of Forth Industrial Revolution (4IR).

Keywords: Chess Playing, Reflective Thinking Skill, Gender

Introduction

The era of fourth Industrial Revolution (4IR) characterized mainly by artificial intelligence has put much demands in every sphere of life which education is very much committed to responding accordingly. Educational psychologists, educators, policy makers, school managers, teachers and students grapple with this new reality by adjusting to a new method of teaching and learning that would provide a marching learning outcome to this effect. Hence, conventional method of teaching and learning in school curricula is being balanced and enhanced with new methods which cognitive/metacognitive education is foundational to it. The learner who is the most important subject in teaching and learning is of special interest to researchers in this method of teaching and learning. Despite this emerging reality, there is still paucity of researches that have been devoted to enhancing the metacognitive skills among the adolescent learner in Nigeria that takes cognizance of their specific

characteristics and preferred learning style in this era. Such metacognitive skills include but not limited to reasoning and planning on how to execute a learning task, self-assessment and evaluation of one's progress and learning outcome, and reflecting or thinking on a better process for a better learning outcome.

The metacognitive skill of reflective thinking is of special interest for consideration in this current research because of its prominent role in cognitive education curriculum (Çarkit, 2020). Reflective thinking is a sub-division of meta-cognitive skill under regulation of cognition. Reflection or reflective thinking deals with critically analyzing one's assumptions and how this may influence one's learning during and after learning. Charon and Hermann in Moniz, Melro, Warren, and Watling (2021) defined reflection as a cognitive, affective, imaginative, and creative means to perceive, represent in language, and thereby undergo one's lived experiences. These definitions presuppose that reflective thinking entails a mind activity that seeks to identifying problems and its solutions through a process of asking the appropriate questions.

Besides reflective thinking being an internal activity of the mind, students most commonly externalize reflective thinking as thinking aloud or as reflective writing. Thinking aloud is the verbalization of the metacognitive structure and strategy to a problem situation while reflective writing entails having those structures and strategies penned down. Reflective writing is conceptualized by Charon and Hermann (2012) as a representation of one's experiences in language, which is a forceful way by which one can render it visible and comprehensible. For the sake of this study, reflective writing aspect of reflective thinking and how it could be acquired, enhanced and applied by adolescent students is what the researcher has in view.

Despite the potential for positive academic result, Rogers (2001) reveals that the practical application of reflection or reflective thinking skill in learning remains a difficult task for educators. If this is so for the educators, then, one could hypothesize that it may be more difficult for the students who may not have had much experience about these metacognitive skills generally. Thus, the need to inculcate reflective thinking skill in students becomes imperative because of its positive correlation with lifelong learning (Colley, Billics and Lerch, 2012) and its indication to acquiring cognitive problem-solving skills (McCormick, Dimmitt and Sullivan, 2013). Therefore, it presupposes that adolescent students who are at critical stage of learning and faced by the challenges of 4th Industrial Revolution (4IR) should foundationally possess reflective thinking skill because its deficiency in their learning skills may not be unconnected to their poor academic achievement in schools. However, some authors (Botnaru, Wittenberg, Riggs, Mutchler, Syno, *et al.,* 2019) hold the view that its effect on academic performance of students has no much significance, and accordingly Cavilla (2017) opined that reflective thinking improves more of affective domain than cognitive domain.

Despite their findings, the researcher agrees with the opinion that the skill of reflective thinking has a significant relationship with academic success among adolescent students, as highlighted by the findings of Tsingos-Luca, Bosnich-Anticevich, Schneider, and Smith (2017). If so, then, this makes it compelling for the researcher to explore on the acquisition and enhancement of reflective thinking skill among adolescent students, which has attracted less attention among researchers in Anambra state of Nigeria in their search for the solution to better learning outcomes.

Given the importance of reflective thinking as a meta-cognitive skill in learning outcomes in the school subjects like English and mathematics, a simplified approach to meta-cognitive skills popularized as "Bloom Revised Edition" was devised to emphasize important cognitive/meta-cognitive behavioural skills which are critical to learning outcomes. Some of the behavioural skills include but not limited to: remembering, understanding, applying, analyzing, evaluating and creating (Anderson and Krathwohl, 2001). Accordingly, Garzon, Bustos and Lizarazo (2020) opine that meta-cognitive skills especially those of planning, organization, monitoring, control, assessment, evaluation, reflection, and self-regulation can lead to deeper learning and transfer of knowledge and skills in variety of tasks and contexts. Despite the fact that some recent studies (e.g. Cherrier *et al.*, 2021; Craig, *et al.*, 2020; Garzon *et al.*, 2020; Muawiyah, Yamtinah and Indriyanti, 2019; Hernandez and Camargo, 2017) consider meta-cognition as one of the most salient learning skills in the 21st century with strong relevance in the educational and psychological context and for improving academic and learning achievement, nonetheless, how to improve this metacognitive skill of reflective thinking in the context of adolescents' developmental characteristics and preferred learning style in this era of 4IR are rarely brought forward.

The adolescent is a teenager between the age of 12 and 17 years characterized by rapid growth into maturity which is genetically induced by puberty. Unachukwu, Ebenebe and Nwosu (2019) underscore this age as being very sensitive because it is characterized by rapidity in social, physical, emotional, moral, and cognitive development. More so, in the cognitive development of the adolescents, gender has played an important role in teaching and learning. To this effect, cognitive theory of gender development understands children as dynamic constructors of knowledge by seeking, interpreting, and acting on information with an intent to match their behavior to their understanding of gender (Miller, 2016). Hence, researchers have observed differently the effect of gender on learning outcomes. In their study on cognitive abilities using cognitive reflective test (CRT) which is mathematically inclined, Sirota, Dewberry, Juanchich, Valuš, and Marshall (2020) found that male participants out-performed their female counterparts. Accordingly, Adebule in Asikhia (2020) points out that this is in line with the traditional belief that male students do better in mathematics courses than female students. Also, Nagahi, Hossain and Jaradat (2019)

support this finding by observing that male practitioners have more systemic tendency in respect to systems worldview and change skills than female practitioners, though they observed no significant difference from each other in terms of System Thinking (ST) skills preferences such as interaction, independence, uncertainty, complexity, and flexibility.

Contrarily, Ricker and Richert (2021) examined metacognitive abilities provided by digital games for children 6 to 10 years-old. It used fifteen different kinds of games with selected features of interactivity, including level-of-control, feedback, and adaptive ability to seek for the metacognitive awareness in children. The learning outcome indicates that there was no gender and age difference to game preference. Though children who were exposed to high interactive games gained more metacognitive awareness than those that were not. Also in another gender-related study on metacognitive skill of inquiry based learning, Nunaki, Damopolli, Kandowangko and Nusantri (2019) found that gender has no significant difference effect on the participants though the training helped to increase the metacognitive ability of the students. In summary, these findings presuppose that in this age and time, gender effect has become very topical in the standardization of any teaching and learning method in schools.

Based on these educational implications linked to adolescent developmental traits and their binary gender effect, the preferred learning style of the adolescent should always be of prominent consideration while adopting strategies for enhancing their skills. The learner's preferred learning styles adopted in teaching and learning predict to a great significance the students' acquisition of knowledge (Ikwuka, 2019). Hence, the researcher having taken cognizance of the developmental age, preferred learning style and the demands of the era of 4IR that is characterized by artificial intelligence and Internet of Things (IOT), considered gamification as a method for solving this academic problem. Gamification in education is the process of integrating and converting typical academic components into gaming elements or themes (Solanki and Airth, 2022). It presupposes that gamification is the building-in of games and games ideas/styles in teaching and learning with a viewing to enhancing interest, competition and cognitive activities. It is innovative to note that researchers have recently observed that gamification or game-based learning approach is more effective than the conventional learning approach (Chang, Kao, Hwang, and Lin, 2020; Wang and Zheng, 2021). Hence, this is making education as a desired learning outcome a culture of life for every age and time, in which learning becomes a fun.

To this end in this study, the researcher proposes the game of chess as a preferred learning style for the 4IR adolescents for acquiring and enhancing cognitive skill of reflective thinking. This view is conceived based on the outcome of some researches in which chess is investigated in psychology. Chess is theoretically investigated recently as a model for cognitive processes and

abilities such as perception, information management, attention, memory, logical thinking (Scholz, *et al.,* 2008); improvement of thinking skills, improvement of problem solving ability (Scholz *et al.*, 2008; Subia, Amaranto, Amaranto, Bustamante and Damaso, 2019); and better academic achievement (Subia, 2020). In their 9 month experimental study in Turkey, Sigirtmac (2016) found that chess training was statistically significant and effective in the development of creative thinking and theory of mind tests. Similarly in Indonesia, Citrasukmawati, Julianingsih and Trisnawaty (2020) observe in their study that chess game significantly increased understanding of Higher Order Thinking Skills (HOTS) for science subjects among the experimental group. These studies show evidence of transfer of learning acquired through chess game. Nonetheless, when chess was used to improve the poor academic conditions of 'students at risk of academic failure' and with learning disabilities by Hong and Bart (2007), the result indicated a lack of cognitive effects of chess instruction as changes in the experimental group performances were not different from changes in the control group performances.

Despite the efforts made by recent researchers to explore on the metacognitive skills linked to chess game, no such studies is known to the researcher that investigated on how to use chess game to enhance reflective thinking in Nigeria at large and Anambra State in particular. Therefore, to fill this lacuna in studies, the researcher hypothesizes that gamification as a teaching and learning strategy using chess may enhance students' reflective thinking skill among adolescents in Anambra State Secondary Schools. This hypothesis is based on the identical element of transfer of learning theory by Thorndike and Woodworth (1901). The theory states that training in one kind of activity would transfer to another only if the activities shared common stimulus-response elements.

Research Questions and Hypotheses

To achieve this purpose, the study is guided by two research questions and two hypotheses.

1. What is the difference between pretest and posttest mean reflective thinking scores of students with exposure to chess playing and those without exposure to chess playing?
2. What is the difference in the pretest and posttest mean reflective thinking scores of male and female students with exposure to chess playing?

Hypotheses

3. There is no significant difference in the mean reflective thinking scores of students with exposure to chess playing and those without exposure to chess training.
4. There is no significant difference in the mean reflective thinking scores of male and female students with exposure to chess playing.

Research Method

The study adopted non-randomized, pre-test, post-test control group quasi-experimental

design. Specifically, it is 2 X 2 factorial design. The independent variables are exposure to chess playing and gender and the dependent variable is reflective thinking. The 2 X 2 factorial design means that there are two independent variables (exposure to chess playing and gender). Exposure to chess playing has two levels: those exposed to chess playing and those not exposed to chess playing. Gender equally has two levels: male and female students. The population of the study comprise 12,277 senior secondary two (SS 2) students in the 204 co-educational secondary schools in Anambra State (Source: Post Primary Schools Services Commission, PPSSC, Awka Anambra State, 2022). Using multi stage sampling techniques, four out of the six education zones in Anambra were used, which are Awka, Ogidi, and Aguata, Onitsha as the experimental and control groups respectively. An intact class of 200 students were used from the four sampled schools of the four zones. The instrument used for data collection was the Verbal Cognitive Reflection Test (CRT-V) developed by Sirota, Dewberry, Juanchich, Valuš and Marshall (2011). The CRT-V was a preferred instrument for this study because it was found to be test equivalent across gender, age groups and administration setting as well as being less associated with math anxiety, objective and subjective numeracy than the original CRT (Sirota *et al.*, 2020).

CRT-V is a 10-item test which was adapted for the sake of this study in item numbers 3, 4, 5, and 7. It was adapted because some of the concepts used in the test were not indigenous to the Nigerian students. For instance, JFK airport was replaced with Nnamdi Azikiwe airport in item 3, and electric train was replaced with bicycle in item 7. The instrument was revalidated by experts from measurement and evaluation, and educational psychology after adapting it for this study. To fill the questionnaire, the students were required to tick the correct answer from the two provided options in each question (one intuitive answer, and the other the reflective thinking answer) or to provide the accurate answer where none was provided. The intuitive answer is the incorrect answer that earns one point while the reflective answer is the correct answer that earns two points. Ticking both options or not ticking any, where it is provided earns zero point. The summation score ranges from 0 to 20, where higher scores indicate higher cognitive reflection ability. The reliability was obtained by administering a single test form to a group of sixty Enugu State secondary school students with homogenous traits. The coefficient reliability of .74 was obtained using Cronbach Alpha reliability coefficient.

Experimental Procedure

The duration of the experiment was nine weeks in the second term of the secondary school academic year. The research assistants who were three members of Anambra Chess Forum were trained by the researcher in the 1st week. The chess game syllabus for the experimental group was scrutinized by researcher and the chess trainers, and made essential modifications to suit the purpose of the research. Students who did not fall within the adolescent age range of 12-17 years as operationalized in the concept of adolescent in this study and those who have previously learnt chess game were not included in the

study. Through the principal, the consent of the participants' parents or guardians was obtained. In the 2nd week, the pretest for the two groups was administered and training began on the 3rd week. The chess trainers trained the intact classes of the experimental group on the beginner's package syllabus: basics moves, mates and tactics. The duration was 160 minutes every week during the periods mapped out in schools for extra-curricular activities on Thursdays and Fridays. The control group had no chess training but went on with their conventional schooling based on the termly syllabus. For optimum delivery of their assignment, the chess trainers were monitored with a Fidelity Test Inventory designed by the researcher in line with five main components of Fidelity Test in research by Mitchell (2021). After a six week training, posttest was administered; the items were reorganized so as to prevent pretest effect. Mean and standard deviation were used to answer the research questions based on the data from the pre-test and the post-test. Two-way analysis of covariance (ANCOVA) was used to test for significance difference at 0.05 alpha levels. The decision rule was to retain the null hypothesis (Ho) if the calculated p-value is greater than 0.05 ($p>.05$) while the null hypothesis (Ho) was rejected if the calculated p-value is less than or equals to the probability value of 0.05($p<.05$).

Presentation of Results

Research Question 1: What is the difference between pretest and post-test mean reflective thinking scores of students with exposure to chess playing and those without the exposure?

Table 1: Mean reflective scores of students with exposure to chess playing and those without the exposure

Group	N	Pre-test		Post-test		Mean gain
		$\overline{X}$	SD	$\overline{X}$	SD	
Chess players	95	18.61	1.88	50.03	4.16	31.42
Non chess players	105	12.52	2.25	30.95	5.79	18.43
Mean Difference		**6.09**		**19.08**		**12.99**

Table 1 shows that students with exposure to chess playing had 18.61 as the pre-test mean score and 50.03 as the post-test mean score with 1.88 and 4.16 respectively as their standard deviation with a gain in mean of 31.42. The students without exposure to chess playing had 12.52 as the pre-test mean score and 30.95 as their post-test mean with 2.25 and 5.79 respectively as their standard deviation, with a gain in mean of 18.43. The analysis reveals that the mean reflective thinking scores of students with exposure to chess playing is higher than those without exposure to chess playing because the mean gain of 31.42 for the experimental group is greater than 18.43 mean gain of the control

group. The mean difference is 12.99 in favour of experimental group. The standard deviation of 4.16 for the experimental group is smaller than the 5.79 for the control group. This implies that the posttest mean reflective thinking scores of the experimental group is more homogenous than that of the control group.

Research Question 2: What is the difference in the pretest and posttest mean reflective thinking scores of male and female students with exposure to chess playing?

Table 2: Mean Reflective Thinking Scores of Male and Female Students with Exposure to Chess Playing

Gender	N	Pre-test		Post-test		Mean gain
		$\bar{X}$	SD	$\bar{X}$	SD	
Male	44	35.45	2.89	71.07	2.66	35.62
Female	51	21.51	2.76	50.89	2.68	29.38
Mean Difference		**13.94**		**20.18**		**6.24**

Data analysis in Table 2 revealed that the male students had mean reflective thinking scores of 35.45 and 71.07 for their pre-test and post-test respectively with standard deviation scores of 2.89 and 2.66 for their pre-test and post-test scores. Also, female students had mean reflective thinking scores of 21.51 and 50.89 for their pre-test and post-test score with standard deviation scores of 2.76 and 2.68 for their pre-test and post-test respectively. The gain in mean of 35.62 for male students was higher than that of their female counterpart with 29.38 gain in mean. This means that the mean reflective scores of male students with exposure to chess playing is higher than their female counterparts with exposure to chess playing. The posttest standard deviation of 2.66 for the male students is lower than that of the female students (2.68) which shows a more uniform distribution of scores for the male students.

Hypothesis 1: There is no significant difference in the mean reflective thinking scores of students with exposure to chess playing and those without exposure.

Table 3: ANCOVA test of no significant difference in the mean reflective thinking scores of students with exposure to chess playing and those without exposure

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1847.805[a]	2	923.903	210.964	.000	.682
Intercept	635.825	1	635.825	145.184	.000	.424
Rethinking	.030	1	.030	.007	.934	.000
Group	257.402	1	257.402	58.775	.000	.230
Error	862.750	197	4.379			
Total	50235.000	200				
Corrected Total	2710.555	199				

a. R Squared = .682 (Adjusted R Squared = .678)

Table 3 revealed the significant difference in the mean reflective thinking scores of students with exposure to chess playing and those without exposure; F(1,197) = 58.775, P= 0.00 < 0.05. Therefore, the null hypothesis is rejected; this means that there is significant difference in the mean reflective thinking scores of students with exposure to chess playing and those without exposure.

Hypothesis 2: There is no significant difference in the mean reflective thinking scores of male and female students with exposure to chess playing.

Table 4: ANCOVA test of significant difference in the mean reflective thinking scores of male and female students with exposure to chess playing

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1621.184[a]	2	810.592	146.586	.000	.598
Intercept	709.615	1	709.615	128.326	.000	.394
Post_CRT	1621.118	1	1621.118	293.160	.000	.598
Gender	30.781	1	30.781	5.566	.019	.027
Error	1089.371	93	5.530			
Total	50235.000	95				
Corrected Total	2710.555	94				

a. R Squared = .598 (Adjusted R Squared = .594)

Table 4 reveals the significance in the mean reflective scores of male and female with exposure to chess playing; F(1,93) = 0.019, P= 0.019< 0.05. Therefore, the null hypothesis is rejected, thus, there is a significant difference in the mean reflective scores of male and female students with exposure to chess playing.

Discussion of Findings

The findings based on research question one as seen in Table 1 analysis revealed that chess playing had a positive effect in enhancing the reflective thinking skills of the secondary school students in Anambra State. The result equally showed a more homogeneous effect than those who did not have the training. More still, comparing

research question one with hypothesis one in table 3, the null hypothesis was rejected. This means that chess playing had significant positive transfer of learning effect on reflective thinking skill of the students with exposure to chess playing than those without exposure to it. Support for this finding is seen in the findings of Sigirtmac (2016) who found that children who were taught chess game out-performed their counterparts who did not undergo chess game training in both creative thinking and theory of mind tests. Similarly, the findings of Citrasukmawati, *et al.* (2020) supported this current finding. Hence, the finding of this current study is in line with the result that chess playing helps in the improvement of thinking skills, improvement of problem solving ability (Scholz *et al.*, 2008; Subia, Amaranto, Amaranto, Bustamante and Damaso, 2019) and better academic achievement (Subia, 2020). Thus, the study affirmed that there is transfer of learning in metacognitve skill of reflective thinking using chess.

However, the study of Hong and Bart (2007) who found no improvement by using chess for 'students at risk of academic failure' and learning disabilities in Korea did not support this current finding on chess. The reason for the difference in the finding could be that this current study was experimented on healthy students unlike that of Hong and Bart whose subjects were children at risk of academic failure and learning disabilities. Thus, they may basically lack the schema for the identical element of transfer of learning to easily occur.

In table 2, it was revealed that male students responded better to chess treatment for enhancing reflective thinking skill than their female counterparts. In table 4, it was confirmed to be significant. This current finding is supported by the study of Sirota, *et al.* (2020) who found that male participants out-performed their female counterparts in cognitive reflective abilities. Adebule in Asikhia (2020) observed that this is in line with the traditional belief that male students have better learning outcomes than female students especially when it is of mathematical subjects. More so, the study of Nagahi, *et al.* (2019) supported this current finding though there study observed no significant difference between the genders in their systemic thinking skill preferences.

However, there are similar studies on metacognitive skills that were not supported by the findings of this current study. Nunaki, et *al.* (2019), and Ricker and Richert (2021) studies indicate that there was no gender preference to learning outcomes though students exposed to metacognitive awareness training performed better than those that were not exposed to it.

Conclusion

Based on the findings of this current study, chess game playing has been found to be of great help in developing and enhancing metacognitive skill of reflective thinking among adolescent students. With the challenges put up by the advent of 4IR that demands skills in metacognition, chess game playing was certified by this study as a

preferred learning style for effecting identical element of transfer of learning skills among students.

Recommendations

1. Based on the findings of this study, the researcher recommends that education policy makers and school managers should adopt or adapt to gamification in education as one of the recent and reliable method of enhancing cognitive education.
2. Based on the demands of the 4IR, educators should improve on conventional method of teaching that could be boring for some students, by assimilating modern teaching techniques like gamification. Gamification, like chess game is a recreational game which has the capacity to transfer metacognitive (reflective thinking) skills in students. Hence, this game should also be learnt by teachers who should encourage students to learn it for their cognitive development and recreation. Chess clubs should be established in schools.

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