International Journal of Innovative Social & Science Education Research 12(2):83-90, April-June, 2024

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Relationship Between Reasoning Ability And Academic Performance In Chemistry Among NCE Students Of Isa Kaita College Of Education Dutsinma, Katsina State

Bello Isa Karofi[1] & Ismai'l Hassan[2]

[1]Department of Adult And Non-Formal Education
Isa Kaita College of Education Dutsinma, Katsina State, Nigeria

[2]Department Of Special Needs Education
Isa Kaita College of Education, Dutsinma, Katsina State, Nigeria

ABSTRACT
Science Education is very important to the development of any nation that is why every nation must take it very serious in all institution of learning because it served as an instrumental through which a lots of problems can be solve insecurity inclusive. This paper examine the place of Science Education and National Development, Security and National Development, the factor responsibility for security challenges, solutions to the challenges. It further examine the roles of science education for sustainable development and peaceful co-existence. The conclusion were made by stressing of some of the problems. The paper also offers some recommendation with the view of enhancing the teaching of science education for national security.
Keywords: Reasoning Ability, Academic Performance in Chemistry

INTRODUCTION

In today's complex world, the ability to think and reason logically is essential for everybody. Recommendations have been made in the National Policy on Education section 4 on the need to lay a good and sound foundation for scientific and reflective thinking at the primary school level so as to equip individuals to live effectively in the modern age of science and technology (FME, 2013).

Mari (2001) observed that, for students to have deeper understanding of the key concepts and fundamental principles of science, the process involved in generating these concepts and principles must be learnt. He went further to state that formal reasoning ability is highly relevant to science education as it is involved in the acquisition of the science process skills. According to Ellis (1996) science teachers concentrate on imparting knowledge to the students but fails to focus attention on the student's ability to analyze, synthesize and enumerate the knowledge acquired through critical thinking and deep reasoning ability.

Reasoning ability is a variable tool which is to be related with performance in school more especially in the areas of science education. Piaget, (1972) stated that children pass through various developmental stages throughout their lives. They do not undergo physical changes, but also development with respect to cognitive abilities. The Piagetian model describes a number of stages in which each stage represents a new method for information acquisition and management. Piaget (1972) summarized the changes in reasoning pattern into four successive categories;

i. Sensory motor period; 0-2years;

ii. Preoperational period; 2-7years;
iii. Concrete operational period; 7-12years;
iv. Formal operational period; 12years and above.

In sensory motor period, children get to know their environment by observing every object using their sense organs. Omrode (2006) stated that an understanding of cause-effect relationship begins to develop at this stage. Later in the preoperational period, children develop language skills so that they can engage in social relationship since they can express themselves using words, but they do not have the ability to understand that other people may have different opinions, and they concentrate more on their own need and feelings. They begin to develop logical thinking ability but still not able to explain their reasoning. The concrete operational stage is characterized by the ability to use hypothetic-deductive reasoning to test descriptive hypothesis, categorize objects and events in higher order classes (Lawson, 2004). They are able to reach logical conclusions and understand other people may have different opinions.

Gender barrier within the educational system is also an existing issue, and science classrooms are not exceptions. Scientific discourses are perceived to be more suitable for boys; while girls separate themselves from sciences, particularly physical sciences and engineering as they mature, although they do well in early grades (Brickhouse, 2001). Brickhouse states that girls have difficulty in constructing scientific identities. Research shows that high school males like science courses more than females (Miller et al., 2006).

Scope and Delimitation of the Study

This study was limited to 20/2021 NCE chemistry students of Isa Kaita College of Education, Dutsin-ma. The reason for choosing NCE students for this study was that, at this level of post-secondary Education, it supposed that the students had attained the age of transition from concrete reasoning ability to formal reasoning ability. The study therefore, shall correlate student's reasoning ability and performance in chemistry.

Statement of the Problem

Over the years, researches in science education revealed that students generally perform poorly in science subjects (Usman, 2010). Factors responsible for poor performance include poor understanding of abstract concepts in science subjects (Ndioho, 2007), Lack of well equipped science laboratories and unqualified science teachers (Obomanu, 2011). Other factors are inability to exercise high formal reasoning ability (Astudilo and Naiz, 2012), among others.

This study has been prompted by the observation that most NCE Science students find it difficult to pass chemistry courses in my place of research which may be connected to some of the factors mentioned above. Thus, to investigate the relationship between reasoning ability and student's academic performance in chemistry, and to find out if reasoning ability and academic performance in chemistry are gender related among NCE students of Isa Kaita College of Education Dutsinma.

Objectives of the Study

The study has the following objectives:-

1. To investigate the relationship between students' reasoning ability and student's academic performance in chemistry
2. To determine if there is relationship between male and female students' reasoning ability.

Research Questions

This study will answer the following research questions:

1. Is there any relationship between students' reasoning ability and their academic performance in chemistry?
2. Is there any relationship between male and female students' reasoning ability?

Null Hypotheses

The following null hypotheses were formulated from the research questions and tested at $P<0.05$ level of significant.

Ho_1: There is no significant relationship between students' reasoning ability and their academic performance in chemistry.

Ho_2: There is no significant relationship between male and female students' reasoning ability.

Literature Review

This section reviews the summary of some related studies in reasoning ability, and performance in chemistry. Abdu, (2008) carried out a research on self-efficacy, reasoning ability and achievement in chemistry at School of Basic and Remedial Studies Funtua and the Remedial Students of Umaru Musa Yar'adua University, Katsina, the results revealed that:

a. Student's self-efficacy in chemistry is a predictor of their achievement in the subject. That students with high self-efficacy seems to perform better than those with low self-efficacy.
b. Students' reasoning ability in chemistry is a predictor of their achievements in the subject. That students with high reasoning ability seems to perform better than those with low reasoning ability.
c. Male student's self-efficacy and reasoning ability in the subject are predictors of their achievements. That male students with high self-efficacy and high reasoning ability seems to perform better than those with low self-efficacy and low reasoning ability.
d. The overall result revealed that there exist a positive relationship between students' reasoning ability and self-efficacy and achievement in chemistry and both can be used to predict academic achievement.

Sungur & Tekkaya, (2008) carried out a study to investigate the effect of reasoning ability and gender on the learning of human circulatory system concepts. The result revealed that there was no interaction between gender difference and reasoning ability. This finding indicated that the mean difference for one factor does not depend on the level of the other. Regarding gender difference, it was observed that there was no effect of this variable on the student's a performance. This result supported the findings of Young and Fraser, (1994) which shows that boys performed better than girls in physical sciences, while the difference is not very much in other subject areas. This study also revealed that reasoning ability had a significant influence on students 'performance. Therefore students' with high reasoning ability had more positive attitude toward the human circulatory system. There was no significant mean difference between transitional students and formal students and also between transitional students and concrete students. However, students at the formal level were the most successful in the test, while students at the concrete level were the least successful.

Hamide, (2000) carried out a study to investigate the relationship between formal reasoning ability, computer assisted instruction and chemistry achievement. One hundred and nineteenth (119) grade students from high school participated in the study. The results using applicable instrument revealed that, formal reasoning ability is a strong predictor of achievement in chemistry. This means that, reasoning ability is an underlying intellectual factor associated with science concepts achievement. Many. Heron, (1978) suggested that chemistry courses are generally taught at a level of abstraction requiring formal thought, even though most students have not yet attained a formal operation level of cognitive development. Also, the role of treatment in the performance in chemistry was significant in the study. The positive correlation coefficient of the treatment and higher mean score of the computer aided instruction (CAI) group showed that CAI had more positive effect on performance in chemistry.

Mari, (2001) carried out a study to determine the effect of process skills instruction on formal reasoning ability of students. 76 students selected from two schools in Zaria metropolis were used for the study. The result revealed that:

1. A high proportion of the students (74%) were operating at the concrete operational stage.
2. The experimental group performed significantly better than the control group in informal reasoning tasks after treatment.
3. Female students benefited from science based instruction more than their male counterparts.
4. The initial gap between the male and female students in formal reasoning ability was bridged in all schemata (conservation, control of variables, proportional reasoning, probabilistic reasoning, and combinatorial reasoning) except in correlation reasoning.

5. Science process skills instruction was found to be more effective in promoting the acquisition of science process skills in female than in their male counterparts.
6. Though the students showed an appreciable increase in their mean scores in the post test, the difference in the mean scores was however only significant in the schemas of combinatorial reasoning, proportional reasoning and control of variables.

One example for research in reasoning ability is a study carried out by Lawson and Marshal, (2006) concerning concrete and formal operational concept in secondary school biology, chemistry and physics classes. The researchers argued that a large portion of secondary schools students are concrete operational but the curriculum is mainly in appropriate for students since it is above their level of understanding. The aim of the study was to assess the understanding of concrete and formal operational subject by concrete and formal operational students. Researchers used four Piagetian styled task and determined the intellectual development of 134 students from suburban university town high school were selected from, biology, chemistry and physics classes, the students were classified into one of seven categories ranging from concrete to formal-operational thinkers. Percentage of students in each category was calculated for each discipline. About 64.8% of students in biology sample were categorized as concrete operational, one subject was categorized as transitional formal and no students were fully formal operational. Approximately 92% of chemistry students were fully formal operational. Physic students were mainly between concrete operational and formal operational, but the percentage of students in formal operational stage was higher in chemistry. Among the whole sample, 85% of students were above concrete operational and below formal operational, only 4.8% were formal operational thinkers. The researchers attributed this retarded development to in appropriate subject matter and teaching procedures. They further suggested that course content should be evaluated and modified to fit students, intellectual level, so that a progress from concrete to formal reasoning may be possible for them.

Another research concerned with the relationship between Piaget's theory of cognitive development and how children perform at school was carried out by Mwamwanda in (2008). This study investigated university student's cognitive development levels relation academic performance. This study revealed that students' with fully developed formal operations performed better than others. It was suggested that formal operational reasoning may be fostered by implementing problem solving and discussion activities that require students to think about conflicting situation and analyze their own thinking.

METHODOLOGY

Research Design

The study investigated the relationship between students' reasoning ability and academic performance in chemistry among NCE students of Isa Kaita College of Education Dutsinma Katsina State. The design used in this study was descriptive survey research of correlation type.

Population of the study

The population of the study consists of all 2021/2022 academic session NCE students with chemistry course combination at Isa Kaita College of Education, Dutsin-ma. The population of the students is four hundred and forty two (442) comprising of one hundred and twelve female (112) and three hundred and thirty male (330) male students.

Sample and Sampling Technique

Proportionate random sampling technique was used to select a sample of 205 subjects out of the population of 442 NCE chemistry students. The sample is made up of 55 female students and 150 male students of 2021/2022 academic session. The sample was chosen by using Krejcie and Morgan (1970) table for determining the sample size from a given population which says that if the population of research ranges from 440-459, a sample of 205 should be used. Proportionate random sampling was used because the subjects of the study comprise male and female students and it is discovered that the population of male students is much higher than that of females.

Research Instrument

The instruments used for the study were Group Assessment of Logical Reasoning Test (GALRT) and First Semester 2021/2022 NCE Chemistry results of Isa Kaita College of Education (IKCOE) Dutsin-ma. Group Assessment of Logical Reasoning Test (GALRT) was adapted from Road-Rangka Yeany and Padilla (1982).

The instrument was validated by five academicians. Two educational psychologists and three Science Educators. The ranks of those that validated the instruments were in the range of Senior Lectures' to Professor from Universities and Chief Lecturers from College of Education. The observations of the validators were used to make the instrument suit the environment of the researcher. The reliability of the GALRT was established using test-retest technique. The instrument was pilot tested at FCE, Katsina using 50 -NCE students of chemistry. The result was correlated using Pearson Product Moment Correlation. The index found was 0.79.

Method of Data Collection/ Analysis

The data collected from the field was used to answer the research questions and to test the hypotheses. The research questions were answered using descriptive statistics, while the hypotheses were analyzed using Pearson Product Moment Correlation formula, the reasoning ability test was correlated with the results of students' academic performance in chemistry and test hypothesis number 1. The data on reasoning ability was also correlated with respect to gender to test hypothesis 2

The GARLT was graded into three categories visa-a-viz; High reasoning ability coded 75%, Moderate reasoning ability coded 50% and Low reasoning ability coded 25%.

RESULTS

The result contains descriptive and inferential statistical tests. For the purpose of data collection, Group Assessment of logical Reasoning Test (GARLT) was used to measure students' reasoning ability. Students' first semester chemistry results 2021/2022 were used as their academic performance in chemistry. Two research questions were answered using descriptive statistics and two null hypotheses were tested using Pearson Product Moment Correlation at 0.05 level of significant. The results were presented as follows.

Research Question No. 1

Is there any relationship between students' reasoning ability and their academic performance in Chemistry?

To answer this research question, students' performance in GALRT and 1st semester 2021/2022 results were subjected to descriptive statistics and compared.

Table 1 Relationship between Students' Reasoning Ability and their Academic Performance.

Variables	N	Mean	Std. Deviation
Reasoning Ability	202	46.80	7.83
Academic Performance	202	43.95	16.84

In answering the above question, the mean reasoning ability of the students was compared with the mean academic performance of the students. It was found that the mean reasoning ability of the students was 46.80 and that of academic performance was 43.95. Therefore, there is relationship between students' reasoning and their academic performance in chemistry, because the reasoning ability score and that of their performance scores are almost the same.

Research Question No. 2

Is there any relationship between male and female students' reasoning ability?

To answer this research question, male and female students' performance in GALRT were subjected to descriptive statistics and compared. Summary of the analysis are shown in a Table 2

Table 2: Relationship between male and female students' reasoning ability

Variables	N	Mean	Std. Deviation
Male reasoning ability	147	45.82	8.29
Female reasoning ability	55	49.42	5.71

In answering the above question, the mean score of male and female students' reasoning ability were compared. It was found that the mean score of male students' reasoning ability was found to be 45.82 while that of the female was found to be 49.42. This showed that there is relationship between male and female students' reasoning ability

Hypotheses Testing

The researcher tested two null hypotheses. The Hypotheses were analyzed using Pearson product moment correlation.

Ho_1: There is no significant relationship between students' reasoning ability and academic performance in chemistry.

This hypothesis was tested by subjecting the students' reasoning ability scores and that of their academic performance to a Pearson analysis and was presented in table 3.

Table 3: Relationship between Students' Reasoning Ability and their Academic Performance.

Variables	N	Mean	Std. Deviation	r-Cal	*p*-Value	Decision
Reasoning Ability	202	46.80	7.83	.308	.000	H_0 Rejected
Academic Performance	202	43.95	16.84			

From the result of Table 3, students' reasoning ability and academic performance were positively related and significant, Pearson's $r(200) = .308$, $p = .000$. This indicates a significant relationship between students' reasoning ability and academic performance because the p-value is less than the .05 level of significance. Therefore, H_{01} which states that there is no significant relationship between students' reasoning ability and their academic performance in chemistry was rejected.

Ho_2: There is no significant relationship between male and female student's reasoning ability.

This hypothesis was tested by subjecting the male and female students' reasoning ability scores to a Pearson analysis and was presented in table 4.

Table 4: Relationship between male and female students' reasoning ability

Variables	N	Mean	Std. Deviation	r-Cal	*p*-Value	Decision
Male	147	45.82	8.29	.121	.380	H_0 Accepted
Female	55	49.42	5.71			

From the result in Table 4, male and female students' reasoning ability though positively related were not significant, Pearson's $r(200) = .121$, $p = .380$. This indicates no significant relationship between male and

female students' reasoning ability because the p-value is more than the .05 level of significance. Therefore, H_{02} which states that there is no significant relationship between male and female students' reasoning ability was accepted.

DISCUSSION OF THE FINDINGS

The objective of this study was to examine the relationship between reasoning ability and academic performance in chemistry among NCE students of Isa Kaita College of Education, Dutsin-ma and to see if reasoning ability can be used to predict academic performance in chemistry. For this purpose the students' reasoning ability were measured using Group Assessment of Logical Reasoning Test (GALRT). Their first semester results 2021/2022 were used for their academic performance in chemistry. Based on these two variables, two null hypotheses were formulated for testing. The results are discussed as follows:

From the results in Table 3, it was found that students reasoning ability and their academic performance were positively related and significant. This finding agrees with that of Chadran et al. (1987), Michael and Lawson (1988), Cavallo (1996), Johnson and Lawson (1998), Abdu (2008) who also found a positive significant relationship between reasoning ability and academic performance. This finding can be based on the fact that the level of an individual reasoning ability can determine cognitive performance especially in natural sciences (Cavallo, 1996). The finding further revealed that formal reasoning ability and prior knowledge were the significant predictors of academic performance in Chemistry content (Chadrann et al., 1987). Heron (1998)

From the result in Table 4 male and female students' reasoning abilities were positively related but not significant. This indicates no significant relationship between male and female students' reasoning ability. These findings contradict with those reported by Young and Fraster (1994), Adesoji (2008), Sungur and Tekkaya (2008), Abdu (2008) they revealed that boys reasoning ability correlate well with that of female. Similarly for the students to perform better in natural sciences they must be able to transit from concrete reasoning ability to formal reasoning ability. This agrees with Heron (1975) who found that scientific concepts require formal reasoning ability in understanding them. It also agrees with Michael and Lawson (1988) and Cavallo (1996) who found that reasoning ability was the best predictor of students' achievement in solving genetic problems. It also rhymes with the work of Hamid (1995) who concludes that reasoning ability is a strong predictor for achievement in Chemistry.

RECOMMENDATIONS

Based on the findings of this study the following recommendations were made:

1. It was observed that reasoning ability correlate well with performance in chemistry for male students. Therefore science teachers should guide students more especially the female on the way and skills of improving reasoning.

Chemistry is one of the science subjects that requires rational thinking and high intellectual skills to collect, interpret and analyze data in order to solve problems. This process therefore requires high level of reasoning ability. It is hoped that the findings of this work would help curriculum planners, implementers (teachers), students, as well as the researchers in the following ways;

1. It would help the curriculum planners to be aware of the need to put into consideration student's reasoning ability when planning science curriculum.
2. It would create awareness among students and their teachers on the importance of attaining formal reasoning. This would help them to perform well in their scientific tasks that are abstract in nature.
3. It would help the chemistry teachers to always consider the cognitive level of their students before planning instruction so as to make it in conformity with their ability.

It would also help researchers, curriculum developers, educationist and members of several other disciplines to be able to research further, based on the findings of this research work

CONCLUSION

The study was concerned with whether or not there is a significant relationship among students' reasoning ability and academic performance in chemistry. The following conclusions were made:

1. Students' reasoning ability in chemistry is a predictor of their performance in the subject. That is students with high reasoning ability seems to perform better than those with low and moderate reasoning ability.
2. There is no significant relationship between male and female students' reasoning ability.
3. On a general note, reasoning ability is related to students' academic performance and can be used to predict the students' academic performance in chemistry.

ACKNOWLEDGEMENT

This research was conducted under the sponsorship of TETfund Institution Based Research (IBR) given to Isa Kaita College of Education Dutsinma Katsina State.

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