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ASSESSMENT OF SENIOR SECONDARY SCHOOL CHEMISTRY STUDENTS' COMMUNICATION, CRITICAL THINKING AND PROBLEM-SOLVING SKILLS IN ABUJA, FCT

BY

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Abstract

This study assessed the level of senior secondary school chemistry students' communication, critical thinking and problem-solving skills in Abuja, F.C.T. The research was guided by three research questions and one null hypotheses. The research adopted the descriptive survey research design. The population of the study comprised of all the 24,315 male and female 2022/2023 Senior Secondary School two (SS II) chemistry students in seventy-seven (77) public senior secondary schools in Abuja. A sample of 382 senior secondary two (SS2) chemistry students comprised of 198 males and 184 females was used for the study. Simple random sampling technique was used to select six schools from the six area councils within Abuja. The instruments for data collection was an adapted questionnaire titled senior secondary school communication, critical thinking and problem-solving skills questionnaire. The validity of the research instrument was done by three experts and average reliability co-efficient for the instrument used was calculated using Cronbach Alpha formula, which yielded average reliability co-efficient value of 0.8. Mean and standard deviation were used to answer the research questions one, mean rank and sum of rank were used to answer research question two and three. Mann-Whitney U-test test was used to test the hypotheses at 0.05 level of significance. The results indicated that senior secondary school chemistry students in Abuja have high level of communication skills. The findings also revealed that there is no significant mean difference in the mean critical thinking skills and problem-solving skills score between the male and female senior secondary school chemistry students. Based on the findings, it was recommended among others that curriculum developers, educational evaluators and school heads should encourage

teachers to incorporate critical thinking skills, communication and problem-solving skills into the subject curriculum and classroom experiences.

Keywords: Communication, skills, critical thinking, problem-solving, chemistry, gender

Introduction

An ever-changing world requires students to be able to think critically, communicate effectively and solve problems in various unexpected situations. The students also must be ready to implement the basic knowledge that they have when facing various unpredictable problems. Therefore, empowerment of super skills is one of the main goals of education in this era of globalization (Chinedu & Olabiyi, 2015). The era of globalization has had quite a broad impact on various aspects of life, including education demands. Education is required to be able to produce human resources who have 21st century skills. The 21st century is a century that demands quality in all human efforts and results (Jerome *et al.*, 2017). According to the NEA (National Education Association), there are four super skills needed to compete in the 21st century shortened to 4C, namely critical thinking and problem solving, communication, collaboration, creativity and innovation. Based on the 4C skills that have been proposed by the NEA (National Education Association), two among the 4c skills are being considered with regards to this research. One of them is critical thinking and problem-solving skills, and Communication skills. Communication skills, critical thinking and problem-solving skills are necessary skills that must be developed in students because human beings in this era are not only required to have cognitive intelligence but also must be creative and innovative to compete with themselves particularly in the area of chemistry (Muskitta & Djukri, 2016). Chemistry is one of the science subjects that play a significant role in society as it prepares students for the real world of work through carrier opportunities such as chemical engineering, medicine, pharmacy, food science, and environmental studies (Mahdi, 2014). The study of chemistry involves abstract chemical concepts built through process skills, which are the physical and mental skills of students that enable them to obtain and process information (Kriswantoro *et al.*, 2021). The process of acquiring and processing information is the basic foundation for students to communicate well. Generally, communication involves the exchange of ideas, opinions and information with a specific objective (Natalle & Crow 2013). Communication skills are the qualities required for achieving goals that include personal and interpersonal qualities and social abilities. Communication skills are comparable to sentiments or visions that enable individuals to read others. These skills are crucial for any human action and also required in workplace as almost all careers require engagement or interaction with others in a way or in another (Gioiosa & Kinkela, 2019).

Communicating chemistry covers the practice of disseminating chemical information be it news, discussion, data or structures which has been improved and complicated by advances in information technology (Glomo-Narzoles 2013). Therefore, Students' communication skill is thus a skill that should be prioritized as well as their critical thinking skills. Critical-thinking skills are necessary aspect that suit into the educational standard of 21st century particularly in the area of chemistry. According to experts such as Utami *et al.* (2018), critical-thinking is an inseparable part of education at any level because it is needed by humans to face today's world, which includes thinking about analyzing, evaluating, choosing, and providing solutions for the problems. Indicators of critical thinking skills emphasized in this study are the six critical thinking skills' constructs listed by Facione (2013): interpretation, analysis, evaluation, inference, explanation, and self-regulation. Critical-thinking skills encourage students to think independently and solve problems at school and in the context of their daily lives which is in accordance with educational specialists believe. However, result of a survey on critical-thinking skills by Prihatnawati *et al.* (2017) shows that the critical-thinking skills of junior high school students are low and under developed, not much different from the results of a study conducted by (Nuryanti *et al.*, 2018) which shows that students' critical-thinking skills are still poor. Good critical-thinking skills in a learning environment can have good implications for students in terms of fostering self-confidence, improving a person's ability to skillfully analyze and solve problems.

Problem-solving is one of the most important issues in teaching and learning. The role of problem-solving in science particularly chemistry is indispensable. The notion of problem-solving which is described as a core skill has received much attention in the literature of science education. Problem-solving skills refer to our ability to solve problems in an effective and timely manner without any impediments. It involves being able to identify and define the problem, generate alternative situations, evaluate and select the best alternative and implement the selected solutions (Yuriev *et al.*, 2019). In Chemistry classroom, students usually face problems in their learning and some of these problems are more complex than others. Whether they face big or small problems, problem solving skills helps them navigate through effectively. However, there are several other factors that influence students' communication, critical-thinking and problem-solving skills such as gender. Gender is one dimension that influences the conceptualization process in education. The development of a gender perspective has influenced several scientific disciplines, male and female students have different perspectives in describing ideas, and gender differences also affect the different ways in which male and female students communicate effectively, think critically and solve chemical problems between male and female students (Rachmatullah & Ha, 2019).

Statement of the Research Problem

The role of chemistry in wealth creation and nation building cannot be overemphasized. This is probably why educational psychologists, science teachers and educators have continued the search for variables that could be influenced to improve students understanding of the subject and hence achieve better in external examinations (Nwuba, 2021). Of all the identified variables, most researchers have placed emphasis majorly on the environmental variables, such as teaching strategies, the learning environment, class size, abstract and difficult concepts in secondary school chemistry curriculum, while little or no attention has been paid to these students' personal (psychological) variables like problem solving skills, creativity, communication skills, critical thinking skills, emotional intelligence among others which in all could be the underlying variables influencing students learning outcome in chemistry. Hence, to ascertain the level at which the secondary school's student possess these skills, the researcher embarked on this study. Therefore, the study sought to assess the senior secondary school chemistry students' critical-thinking skills, problem-solving skills and communication skills in Abuja, FCT.

Objectives of the Study

The aim of the study is to assess the senior secondary school chemistry students' communication skills, critical-thinking and problem-solving skills in Abuja, Federal Capital Territory. Specifically, the study aimed to achieve the following objectives, to:

1. determine the level of communication skills of senior secondary school chemistry students in Abuja, FCT;
2. find out the difference in the critical-thinking skills scores between male and female senior secondary school chemistry students in Abuja, FCT;
3. find out the difference in the problem-solving skills scores between male and female senior secondary school chemistry students in Abuja, FCT;

Research Questions

The following research questions were raised to guide the study

1. What is the level of communication skills among senior secondary school chemistry students' in Abuja, FCT?
2. What is the difference in the mean critical-thinking skills scores between the male and female senior secondary school chemistry students in Abuja, FCT?
3. What is the difference in the mean problem-solving skills scores between male and female senior secondary school chemistry student in Abuja, FCT?

Null Hypotheses

The null hypotheses were formulated and tested at 0.05 level of significance.

HO: There is no significant difference in the mean problem-solving skills between Male and Female secondary school chemistry students in Abuja, F.C.T

Methodology

The research adopted a descriptive survey research design to collate quantitative information based on assessment of senior secondary school chemistry students' communication, critical-thinking and problem-solving skills in Abuja, Federal Capital Territory. This design was adopted since it allowed the researcher to collect, observe and interpret existing features about a specific population relating to a particular concept or topic of interest. The population of the study comprises of all the male and female Senior Secondary School two (SS II) chemistry students in public senior secondary schools in Federal Capital Territory (FCT) Abuja. Based on the statistics obtained from Federal Capital Territory (FCT) secondary education board (2022), there are total of 24,351 students comprising of twelve thousand, two hundred and sixty-four (12,264) male students and twelve thousand, and eighty-seven (12,087) female senior secondary schools chemistry students respectively in the six area councils within Federal Capital Territory (FCT), Abuja. Three hundred and eighty-two (382) Public Senior Secondary school two (SS II) chemistry students made up of 198 male and 184 female students were sampled from the entire population using simple random sampling technique. In this study, Krejcie and Morgan's table for determining sample size (1970) was used to determine the appropriate sample size for the study.

The instrument used in this research study was an adapted questionnaire titled: Senior Secondary School Chemistry Students Communication skills, Critical-thinking and Problem-solving skills (COCTAPSS). The questionnaire contains sixty (60) close-ended items designed to obtain appropriate and adequate information from the respondents to answer the research questions. The questionnaire is divided into four sections; A to D. Section A part of the questionnaire contains two (2) items about the demographic background of the respondents such as name of school and gender. Section B contains twenty (20) relevant items measuring the communication skills level of the senior secondary schools' students adapted from (Mentoor, 2015). Section C contains twenty (20) items which was adapted from (Okan, 2012: Kobylark *et al*., 2022) measuring the level of critical-thinking skills of the secondary school students, Section D contains twenty (20) relevant items adapted from Barkman and Machtmes (2002) measuring the level of problem-solving skills of senior secondary school students. The item statements in Section B, C and D were measured based on four likert-scales which indicate how the respondents feel about the statements. The four likert rating scale for section B, C and D are as follows 4 = Very High (VH), 3 = High (H), 2 = Low (L) 1 = Very Low (VL). The mean score criterion that was used for decision making

point was the group mean, therefore any mean score greater than the group mean was accepted, while a mean less than the group was rejected. To determine the face, contents and construct validity of the instrument, the instrument was given to experts; two science educators in the Department of Science Education, Federal University of Technology, Minna and one from Department of Education Foundations, Niger State College of Education, Minna. They critically examined the suitability and appropriateness of the items, the clarity and adequacy of language, among other things. The comments and suggestions made by the experts were used in the final construction of the research instrument. To determine the reliability of the instruments, a pilot study was conducted on thirty (30) public senior secondary school chemistry students (SSII) from Government Secondary School Idu Karimo, Abuja. The secondary school used for the pilot study was part of the study population who are not among the sampled public senior secondary school chemistry students (SSII) used for the study. The scores obtained from the respondents were used to justify the items and the reliability co-efficient was calculated using Cronbach Alpha Reliability Coefficient formula using Statistical Package for Social Science (SPSS). However, the instrument, Communication skills questionnaire (CSQ) containing 20 items yielded an estimated value of 0.83, the instrument Critical-thinking skills questionnaire (CTSQ) containing 20 items yielded an estimated value of 0.89 and the instrument Problem-solving skills questionnaire (PSSQ) containing 20 items yielded an estimated value of 0.90. The average Cronbach-Alpha reliability co-efficient value for the three instruments that were tested was 0.87. Therefore, the instrument was considered reliable and valid for the research study. The researcher collected an introductory letter from the Head of Department (HOD), Department of Science Education, Federal University of Technology, Minna which served as evidence to enable the researcher carry out the study effectively. The introductory letter was presented to the various sampled schools seeking permission to use their Senior Secondary School (SSII) chemistry students as respondents to the instruments of the study. The questionnaire administered on the respondents was filled and returned to the researcher at the appropriate time to avoid damages or case of missing them; this is to ensure 100% retrieval of the questionnaire. The collected data was used for statistical analysis. The result of the statistical analysis served as basis of the analysis, interpretation, conclusion, findings, and recommendation. The data collected from the respondents were analyzed using frequencies and percentages for the bio-data variables of respondents, mean and standard deviation for the research question one, two and three, mean rank and sum of rank was used to answer research question four, five and six, while Mann-Whitney test was used to provide answers to the research hypotheses at 0.05 level stated in chapter one using statistical package for social science (SPSS) version 23

Results

Research Question 1: What is the level of communication skills among senior secondary school chemistry students in Abuja, FCT?

Table 1

Mean and Standard Deviation of Secondary School Chemistry Students' Level of Communication Skills

S/N	Items	Mean ($\bar{X}$)	Std. Deviation	Remarks
1.	I ask open-ended questions from my teacher to gain insight into any difficult chemistry concept taught	3.07	.84	High
2.	I feel confident when I make a presentation on chemistry task in front of the class,	2.84	.89	High
3.	I ask for more details and clarification in chemistry class when necessary	2.21	.71	Low
4.	I discuss difficult chemistry concepts with my fellow students	2.58	.82	Low
5.	I answer the teacher immediately I am asked a question during chemistry lessons	2.71	.95	High
6.	When I encounter any challenge in learning chemistry, I am able to discuss it calmly.	2.69	.96	High
7.	I accept critical feedback from others during chemistry tasks.	2.52	.96	Low
8.	I accept suggestions from fellow students with whom I am paired during chemistry tasks.	2.59	.89	Low
9.	I encourage others to clarify their thoughts during group work that involves chemistry activity	2.85	.98	High
10.	I speak clearly and concisely to my classmates about chemistry tasks performed in the class.	2.39	.93	Low
11.	I think I am a good listener because I perceive what is said accurately and completely in chemistry class	2.52	.99	Low
12.	I don't get nervous when I have to say something during chemistry lessons.	2.68	.98	High
13'.	I don't get easily distracted by noise during discussions in chemistry class	2.70	.99	High
14.	I sit close to the teacher to hear and understand the teacher during chemistry lessons	2.76	.97	High

15. I pay attention to the teacher from wherever I sit in the classroom	2.65	.95	High
16. I find it easier to discuss chemistry with other students when he or she shows enthusiasm for the subject	2.65	.99	High
17. I look at the teacher when a difficult chemistry concept is being explained in the class	2.58	.90	Low
18. I could easily tell if my teacher or fellow students are happy in the classroom through their facial expressions.	2.72	.92	High
19. I nod my head while the teacher explains the chemistry exercise in the class.	2.58	.96	Low
20. I keep eye contact while listening to my teacher explain chemistry concepts in the class	2.42	1.00	Low
Average	2.64	.83	

Table 1 shows the level of communication skills among senior secondary school chemistry students in Abuja, FCT. The group mean of 2.64 was used as the benchmark for decision making on the level of communication skills among senior secondary school students. The mean of less than 2.64 (<2.64) was considered low communication skills. While the mean of 2.64 and above is considered high. Consequently, items 1, 2,5, 6, 9, 12, 13, 14, 15, 16 and 18, have corresponding mean of 3.07, 2.84, 2.71, 2.69, 2.85, 2.68, 2.70, 2.76, 2.65, 2.65 and 2.72. The items listed above have mean scores between 2.64 and 3.07, indicating that senior secondary school chemistry students have high level of communication skills. On the other hand data indicates that items 3, 4, 7, 8, 10, 11, 17, 19 and 20 with corresponding mean score of 2.21, 2.58, 2.52, 2.59, 2.52, 2.58, 2.58, and 2.42 respectively shows low level of ability to ask for more details and clarification in chemistry class when necessary, accept critical feedback from others during chemistry tasks, accept suggestions from fellow students when paired, speak clearly and concisely to class mates about chemistry task performed in the class, listening in chemistry class, looking at the teacher when a difficult chemistry concept is being explained in the class, nod head while the teacher explain chemistry concepts in class and keep eye contact while listening to teachers explaining chemistry concept in the class respectively. The highest mean score from the items indicates that students ask open-ended questions to gain insight into any difficult chemistry concept taught (item1), encourage others to clarify their thought during group work that involves chemistry activities (item 9), feel confident when presenting chemistry task in front of the class (item 2) with corresponding mean scores of 3.07, 2.85 and 2.84 respectively improves student's communication skills. The findings

also show the grand mean of 2.64 which indicates that senior secondary chemistry students have high communication skills in Abuja, FCT.

The standard deviation of the respondents on level of communication skills are between 0.71-1.00 while the standard deviation of group mean is 0.83 indicating that there is no meaningful deviation of respondents' level of communication, from each other.

Research Question 2: **What is the difference in the mean critical-thinking skills scores between the male and female senior secondary school chemistry students in Abuja, FCT?**

Table 2

Mean Rank and Sum of Ranks of Male and Female Secondary School Chemistry Students' Level of Critical-thinking Skills.

Gender	N	Mean Rank	Sum of Ranks	Mean Rank Diff.
Male	198	189.72	37564.00	3.70
Female	184	193.42	35589.00	
Total	382			

Table 2 above indicated the mean rank and sum of ranks of male and female Secondary School Chemistry Students' Level of Critical-thinking Skills in Abuja, FCT. The mean rank of the male and female Secondary School Chemistry Students' Level of critical-thinking Skills are 189.72 and 193.42 respectively. The sum of ranks is 37564.00 and 35589.00 respectively, indicating the mean rank difference of 3.70 in favour of the female respondents. Therefore, this result shows that the female secondary school chemistry students have high level of critical-thinking skills than their male counterpart with a mean rank difference of 3.70.

Research Question 3: **What is the difference in the mean problem-solving skills scores between male and female senior secondary school chemistry students in Abuja, FCT**

Table 3

Mean Rank and Sum of Ranks of male and female Secondary School Chemistry Students' Level of Problem-Solving Skills

Gender	N	Mean Rank	Sum of Ranks	Mean Rank Diff.
Male	198	189.60	37540.00	3.95
Female	184	193.55	35613.00	
Total	382			

Table 3 above indicated the mean rank and sum of ranks of male and female Secondary School Chemistry Students' Level of Problem-Solving Skills in Abuja, FCT. The mean rank of the male and female Secondary School Chemistry Students' Level of Problem-Solving Skills is 189.60 and 193.55 respectively. The sum of ranks is 37540.00 and 35613.00 respectively, indicating the mean rank difference of 3.95 in favour of the female respondents. Therefore, the result showed that female secondary school chemistry students have high level Problem-Solving skills than their male counterpart with a mean rank difference of 3.95.

Testing of Null Hypotheses

Hypothesis: There is no significant difference in the mean problem-solving skills between Male and Female secondary school chemistry students in Abuja, F.C.T.

Table 4

Mann-Whitney U Test between Male and Female Secondary School Chemistry Students' Level of Problem-solving Skills

Gender	N	Mean Rank	Sum Ranks	U	P-value
Male	198	189.60	37540.00	17839.000	0.73
Female	184	193.55	35613.00		
Total	382				

The table 4 presents the result of a Mann Whitney U-Test that was conducted to test the null hypothesis that male and female Chemistry students do not differ in their level of Problem-Solving Skills. Male students had an average rank of 189.60 with sum ranks of 37540.00 while the female chemistry students had an average rank of 193.55 with sum ranks of 35613.00. The result shows a P- value of 0.73 which is greater than the significance value of 0.05, ($p > 0.05$). Therefore, the null hypothesis which stated no significance difference in the mean Problem-Solving skills between the Male and Female senior secondary school chemistry students was retained. Therefore, there is no significance difference in the mean rank Problem-Solving skills between the mean rating for Male and Female senior secondary school chemistry students in Abuja, FCT.

Summary of Major Findings

From the data collected, computed, analyzed and interpreted in this study, the findings are summarized as follow:

1. Senior secondary school chemistry students have high level of communication skills in Abuja, FCT

2. There is no significance difference in the mean critical thinking skills between the male and female senior secondary school chemistry students' in Abuja, FCT
3. There is no significance difference in the mean problem-solving skills between the male and female senior secondary school chemistry students' in Abuja, FCT

Discussion of Findings

Finding from the study one revealed that senior secondary school chemistry students have high level of communication skills in Abuja, FCT. The finding was in line with Suheir *et al.* (2020) whose findings revealed that university students have achieved a high level of communication skills in three dimensions (listening, speaking, and understanding others). It also showed a medium level in controlling emotions. Findings also revealed that chemistry students acquire communication and collaborative skills effectively when working as a team; construct knowledge when guided to generate new ideas that involve higher order cognition and are unable to think critically when communicating discrepant events in chemistry (Okafor *et al.*, 2015).

Result from the analysis in this study showed that female secondary school chemistry students have high level critical-thinking skills than their male counterpart. This finding agreed with the findings of Ryzal and Budiyono (2019) whose study shows that the critical-thinking skills of female students are better than those of male students. This finding disagrees with the study of Okafor and Nwonu (2021) whose result reveal that male students taught with 7ELCM and LEM had the highest mean scores than the females in promoting critical thinking skills in chemistry.

The findings from this study show that there is no significant difference in the mean problem-solving skills between the Male and Female between senior secondary school chemistry students in Abuja, FCT. This is in line with Dawngliani and Lallianzuali, (2020) whose result reveals that no significant difference was found in relation to gender. The finding is also in line with that of Jakhar (2019) whose result indicated that there is no significant difference in the problem-solving ability of the students on the basis of gender at secondary level.

Conclusion

Therefore, the study generally concluded that it has become imperative that chemistry teachers should provide learning opportunities that would make students take ownership of their learning by compelling them to learn meaningfully think critically, communicate effectively and solve problems judiciously irrespective of gender roles.

Recommendations

Based on the findings of the study, the following recommendations are made

1. Ministry of Education and school administrators should organize Train-the-Trainers for all the secondary school chemistry teachers on how to fully incorporate 21st century learning skills among chemistry students in Abuja, FCT.
2. Since the National Policy on Education has included Critical Thinking as one of the objectives of Nigerian education. The curriculum developers, implementers and educational evaluators and heads of schools should encourage teachers to incorporate Critical Thinking Skills into subject curriculum and classroom experiences. This is one of the options that can produce a citizen that will be prepared to solve the myriad problems of daily living at individual and corporate levels.

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