CHEMISTRY TEACHERS' KNOWLEDGE OF TEST CONSTRUCTION PROCEDURES: IMPLICATIONS ON STUDENTS' ACADEMIC ACHIEVEMENT IN CHEMISTRY IN ANAMBRA STATE

[1]Obialor, Chris Okwuchukwu, Ph. D, co.obialor@unizik.edu.ng
[2]Ebelide, Micheal C.
[3]Egbojiugha Stephen C.

[1,2&3] Department of Science Education,
Nnamdi Azikiwe University Awka, Anambra State, Nigeria

Abstract

The study determined the chemistry teachers' knowledge of test construction procedures in chemistry objective test and its implications on students' academic achievement in chemistry in Awka Education Zone, Anambra State. Three research questions guided the study. The study employed descriptive survey research design. The population of the study consisted of all the 87 chemistry teachers in the 68 government-owned secondary schools in Awka Education zone of Anambra State. The sample size for the study comprised of 43 chemistry teachers selected using simple random sampling technique. The instrument for data collection was questionnaire titled "Chemistry Teachers' Knowledge of Test Construction Procedures in Chemistry Objective Test" (CTKTCPCOT). The instrument was validated by two experts in the Faculty of Education, Nnamdi Azikiwe University, Awka. The reliability of the instrument was determined using Cronbach-alpha statistic which yielded reliability coefficients of 0.71, 0.73 and 0.75. Data collected was analyzed using mean scores. The findings of the study revealed that gender differences, teaching experiences and professional qualifications of chemistry teachers have a significant influence on their knowledge of test construction procedures in chemistry objective test which affect students' academic achievement in chemistry. Based on the findings of the study, it was recommended among others that, the state ministry of Education should organize conferences, seminars and workshops for in-service training of chemistry teachers in order to update their knowledge on test construction procedures in chemistry objective tests so as to enhance students' academic achievement in Chemistry.

Key words: Chemistry, Academic Achievement, Test Construction Procedures, Objective tests.

Introduction

Chemistry is the science that deals with the properties, composition, and structure of substances (elements and compounds), the transformations they undergo, and the energy that is released or absorbed during these processes (Ussamel, Rocke 2022). Chemistry, therefore, is concerned not only with the sub-atomic domain but also with the properties of atoms and the laws governing their combinations and how the knowledge of these properties can be used to achieve specific purposes. Nigeria has in the national policy on education made chemistry a compulsory science subject at secondary school level and a compulsory subject requirement for all science related disciplines in University admission. It is therefore crucial to accurately assess students' comprehension of various chemistry concepts to gauge their progress and identify areas that need improvement. One effective method of assessment is through objective tests, which offer numerous advantages in terms of objectivity, reliability, and ease of grading.

Objective tests are written tests that require the learner to select the correct answer from among one or more options or complete statement or perform relatively simple calculations (London School of Economics, 2019). Objective tests typically consist of multiple choice questions, true/false statements, or matching items which are scored objectively and quickly often using computerized scoring systems (Gronlund & Waugh, 2016). To ensure the effectiveness and reliability of objective tests, teachers need to focus on objective test construction.

Objective test construction is an important part of assessing students understanding of course contents and it is said to be the method in which items are created (Ahmed et.al, 2022). That is why there is need for a classroom teacher to adopt sequential procedures in constructing an objective test. According to Ugodulunwa (2020), the number of sequential steps adopted in construction of a test is referred to as test development process/test construction procedure; and the steps to be followed by teachers are as follows: determining the purpose of the test, outlining the contents of topics to be covered by the test, outlining the instructional objectives, developing the table of specifications, selecting appropriate item format, writing relevant test items, assembling the test items. Hence, for an objective test to be effective, the steps listed above should be duly considered in order to improve the academic achievement of students.

Academic achievement referred to a person’s learning ability which could be positive or negative performance. Academic achievement could be used for placement of students in a class. Students academic achievement can be explained in form of grades obtained from tests or examination on course taken (Obialor 2016). Academic achievement is also the extent to which a student, teacher, institution, or educational system has accomplished

educational goals, measured by outcomes such as grades, test scores, and completion rates (American Psychological Association, 2020). Therefore, It represents the extent to which students have learned and mastered the content and skills necessary for success in school and future endeavors.

In spite of the importance of chemistry in national development, researchers Giginna and Nweze (2014) have observed low academic achievement in chemistry in senior secondary school certificate examinations. The percentage analysis of students' performance in West African Senior School Certificate Examination (WASSCE) shows that those who passed chemistry at credit level over the years has not been consistently increasing as compared to the percentage of students who enrolled for the examination. From 2007-2012, the percentage of those who passed chemistry at credit level was below 50% except in 2011. From 2013-2016, although, the percentage of those who passed chemistry at credit level was above 50%, there has been consistently decline in the percentage of those who made credit passes ; from 72.34% in 2013, 62.49% in 2014, 60.60% in 2015,and 57.74% in 2016. The poor achievement of students in chemistry has been blamed on teacher-related factors (Giginna & Nweze, 2014). This could be because the teachers did not consider the testing procedures required, lack of appropriate varied teaching methods, lack of activities and assignment that will involve the students' active engagement or lack of motivation and interest in learning particularly in senior secondary schools. As much as there may be many factors that could affect students' performance, the researchers intend to examine the impact teachers knowledge of test construction procedures could be having on students academic achievement.

Teachers Knowledge is simply the knowledge of teaching, where the context of their teaching includes who they teach (their student), where they teach (their classroom, schools, communities, and so on), and what they teach (the school subject, the level, the

curriculum, and its relationship to local, state, and national standards) (Feldman & Herman 2015). However, to ensure quality education, teachers must master the content knowledge (body of knowledge composed by facts), theories, principles, ideas, vocabulary they teach, as well as the appropriate pedagogy for teaching it. Therefore, teachers' knowledge of test construction refers to their understanding of the principles and techniques involved in creating valid, reliable, and fair assessments to evaluate students' learning and understanding. Effective test construction is essential to accurately measure students' knowledge, skills, and abilities. Hence, the need of this study which is to investigate the Teachers' Knowledge on Test Construction Procedure in Chemistry Objective Test and its implications on Students

Academic Achievement in chemistry in Awka Education Zone

Purpose of the Study

The purpose of the study is to investigate the Chemistry teachers' knowledge of test construction procedures and its Implication on students' academic achievement in chemistry in Awka Education Zone. Specifically, the study sought to identify the:

1. Students' academic achievement in chemistry through male and female chemistry teachers' knowledge of test construction procedures in chemistry objectives
2. Students' academic achievement in chemistry through the chemistry teachers' knowledge of test construction procedures in chemistry objective test based on their teaching experience.
3. Students' academic achievement through the chemistry teachers' knowledge of test construction procedures in chemistry objective test based on their teaching qualifications.

Research Questions

The following research questions were raised to guide the study:

1. What is the students' academic achievement through male and female chemistry teachers' knowledge of test construction procedures in chemistry objective test based on their teaching experience?
2. What is the students' academic achievement through chemistry teachers' knowledge of test construction procedures in chemistry objective test based on their teaching experience?
3. What is the students' academic achievement through chemistry teachers' knowledge of test construction procedures in chemistry objective test based on their teaching qualification?

Method

The research design employed in this study is descriptive survey design. The study was carried out in Awka Education Zone which comprise of Awka North, Awka South, Anaocha, Dunukofia and Njikoka local government areas of Anambra state. The population of this study consisted of eighty-seven (87) Chemistry teachers in the sixty-eight (68) government owned secondary schools in Awka education zone. The sample size consists of Forty-three (43) chemistry teachers in government-owned secondary schools in Awka North and Awka South local government area. Out of the 68 public

secondary schools in Awka education zone, 33 schools with 43 chemistry teachers in Awka North and Awka South were selected through simple random sampling. The instrument for data collection in this study was a structured questionnaire titled "Chemistry Teachers' Knowledge of Test Construction Procedures in Chemistry Objective Test"(CTKTCPCOT). The questionnaire was divided into two sections "A" and "B". Section "A" sought to collect information on the respondents' personal data (Bio-data) while Section "B" sought to collect information chemistry teachers' knowledge on test construction procedures in chemistry objective test in senior secondary schools in Awka North and Awka South L.G.A in Anambra state. The questionnaire was structured using a four-point Likert scale. The questionnaire was validated by two experts in the department of science education in Nnamdi Azikiwe University, Awka to determine the degree at which the instrument can be used for the purpose it was designed for. The reliability was established using cronbach's alpha reliability coefficient which yielded reliability coefficients of 0.71, 0.73 and 0.75. The data collected in the study were analyzed using arithmetic mean score to provide answers to the research questions. A mean score of 2.50 indicated Acceptance while a mean score below 2.50 indicated not accepted.

Results

Table 1: Mean ratings of the responses of male and female chemistry teachers' knowledge of test construction procedures in chemistry objectives test

S/N	Items	Gender	N	Mean	Mean Diff.
1.	To determine the purpose of the test	Male	15	3.53	0.10
		Female	28	3.43	
2.	Not to outline the contents of the topics to be covered by the test before setting the test	Male	15	2.13	0.17
		Female	28	1.96	
3.	Not to outline the optional objectives before setting the test	Male	15	1.93	0.11
		Female	28	1.82	

4.	To prepare a test blueprint as a guide in the test construction	Male	15	3.53	0.14
		Female	28	3.39	
5.	To select appropriate item format	Male	15	3.20	0.16
		Female	28	3.36	
6.	Not to prepare relevant test items so that both high and low achievers can understand	Male	15	2.60	0.46
		Female	28	2.14	
7.	To give instructions to guide the test takers	Male	15	2.20	0.59
		Female	28	2.79	
8.	Not to prepare a marking guide while constructing the test	Male	15	2.00	0.07
		Female	28	1.93	
9.	To ensure that the items are measuring the determined objectives	Male	15	3.60	0.10
		Female	28	3.50	
10.	Not to set test considering the time available for testing	Male	15	1.93	0.11
		Female	28	2.04	
	OVERALL	**Male**	**15**	**2.67**	**0.03**
		Female	**27**	**2.64**	

Data in table 1 shows that the grand mean score for the male category was 2.67 while that of the female category was 2.64. This indicates that both male and 2female chemistry teachers' knowledge of test construction procedures in chemistry objective test were high as the grand mean scores was above the acceptable mean of 2.50. However, there is a statistical difference between males' and females' chemistry teachers' knowledge of test construction procedures in chemistry objective test and this shows that the male category is higher than that of the female category. Thus, this might influence the academic achievement of students in chemistry as chemistry students taught by male chemistry

teachers may likely perform better than those taught by female chemistry teachers. The evidence is justified with the grand mean 2.67 which is greater than 2.64.

Table 2: Mean ratings of the responses of chemistry teachers knowledge of test construction procedures in chemistry objective test based on their teaching experience

S/N	Items	Years Of Teaching Experience	N	Mean
1.	To determine the purpose of the test	1-5 Years	16	3.31
		6-10 Years	17	3.76
		11-15 Years	6	3.33
		16-20 Years	1	1.00
		21 Years and above	3	3.67
2.	Not to outline the contents of the topics to be covered by the test before setting the test	1-5 Years	16	2.31
		6-10 Years	17	1.94
		11-15 Years	6	1.83
		16-20 Years	1	1.00
		21 Years and above	3	2.00
3.	Not to outline this optional objectives before setting the test	1-5 Years	16	2.06
		6-10 Years	17	1.88
		11-15 Years	6	1.67
		16-20 Years	1	1.00
		21 Years and above	3	2.00
4.	To prepare a test blueprint as a guide in the test construction	1-5 Years	16	3.31
		6-10 Years	17	3.41

		11-15 Years	6	3.50
		16-20 Years	1	4.00
		21 Years and above	3	4.00
5.	To select appropriate item format	1-5 Years	16	3.25
		6-10 Years	17	3.47
		11-15 Years	6	3.00
		16-20 Years	1	3.00
		21 Years and above	3	3.33
6.	Not to prepare relevant test items so that both high and low achievers can understand	1-5 Years	16	1.88
		6-10 Years	17	2.47
		11-15 Years	6	2.33
		16-20 Years	1	4.00
		21 Years and above	3	3.00
7.	To give instructions to guide the test takers	1-5 Years	16	2.38
		6-10 Years	17	2.53
		11-15 Years	6	3.17
		16-20 Years	1	4.00
		21 Years and above	3	2.00
8.	Not to prepare a marking guide while constructing the test	1-5 Years	16	2.13
		6-10 Years	17	1.82
		11-15 Years	6	1.50
		16-20 Years	1	3.00
		21 Years and above	3	2.33
9.	To ensure that the items are measuring determined	1-5 Years	16	3.56

	objectives	6-10 Years	17	3.59
		11-15 Years	6	3.17
		16-20 Years	1	4.00
		21 Years and above	3	3.67
10.	Not to set test considering the time available for testing	1-5 Years	16	2.00
		6-10 Years	17	2.00
		11-15 Years	6	1.67
		16-20 Years	1	4.00
		21 Years and above	3	2.00
	OVERALL	**1-5 Years**	**16**	**2.62**
		6-10 Years	**17**	**2.69**
		11-15 Years	**6**	**2.52**
		16-20 Years	**1**	**2.90**
		21Years and above	**3**	**2.80**

Data presented in Table 2 indicates that the grand mean scores for all the teaching experiences are above the acceptable mean of 2.50. But the teaching experience of 16-20 years is higher than that of 21 years and above, followed by 6-10 years, 1-5 years and 11-15years. This further indicates that there is a significant difference between the more experienced chemistry teachers and the less experienced teachers in test construction procedures in chemistry objective test. This shows that teachers teaching experience influence students academic achievement in chemistry as students taught by teachers with more years of teaching experience tend to achieve better than those taught with less years of teaching experience in chemistry.

Table 3: Mean ratings of the responses of chemistry teachers knowledge of test construction in chemistry objective test based on their teaching qualifications

S/N	Items	Teaching Qualifications	N	Mean
1.	To determine the purpose of the test	NCE	2	3.55
		BSC	13	3.69
		BSC(ED)	18	3.33
		MSC	6	3.00
		MSC(ED)	1	4.00
		PGDE	2	4.00
		PHD	1	4.00
2.	Not to outline the contents of the topics before setting the test	NCE	2	2.50
		2BSC	13	2.15
		BSC(ED)	18	1.89
		MSC	6	2.00
		MSC(ED)	1	2.00
		PGDE	2	2.00
		PHD	1	2.00
3.	Not to outline the instructional objectives before setting the test	NCE	2	1/00
		BSC	13	2.00
		BSC(ED)	18	1.72
		MSC	6	2.00
		MSC(ED)	1	2.00

		PGDE	2	1.00
		PHD	1	2.00
4.	To prepare a test blueprint as a guide in the test construction	NCE	2	2.50
		BSC	13	3.31
		BSC(ED)	18	3.67
		MSC	6	3.17
		MSC(ED)	1	4.00
		PGDE	2	4.00
		PHD	1	3.00
5.	To select appropriate item format	NCE	2	3.50
		BSC	13	3.38
		BSC(ED)	18	3.33
		MSC	6	2.83
		MSC(ED)	1	4.00
		PGDE	2	3.50
		PHD	1	3.00
6.	Not to prepare relevant test items so that both high and low achievers can understand	NCE	2	2.00
		BSC	13	2.23
		BSC(ED)	18	2.30
		MSC	6	2.30
		MSC(ED)	1	2.00
		PGDE	2	2.00

		PHD	1	3.00
7.	To give instructions to guide the test takers	NCE	2	2.00
		BSC	13	2.54
		BSC(ED)	18	2.67
		MSC	6	2.83
		MSC(ED)	1	2.00
		PGDE	2	2.50
		PHD	1	2.00
8.	Not to prepare a marking guide while constructing the test	NCE	2	2.50
		BSC	13	1.85
		BSC(ED)	18	1.94
		MSC	6	2.17
		MSC(ED)	1	2.00
		PGDE	2	1.50
		PHD	1	2.00
9.	To ensure that the items are measuring determined objectives	NCE	2	3.50
		BSC	13	3.38
		BSC(ED)	18	3.56
		MSC	6	3.50
		MSC(ED)	1	4.00
		PGDE	2	4.00
		PHD	1	3.00

10.	Not to set test considering the time available for testing	NCE	2	2.50
		BSC	13	1.85
		BSC(ED)	18	1.89
		MSC	6	2.33
		MSC(ED)	1	2.00
		PGDE	2	2.50
		PHD	1	2.00
	OVERALL			
		NCE	**2**	**2.52**
		BSC	**13**	**3.64**
		BSC(ED)	**18**	**2.63**
		MSC	**6**	**2.61**
		MSC(ED)	**1**	**2.80**
		PGDE	**2**	**2.70**
		PHD	**1**	**2.60**

From the result in Table 3, the grand mean for the professional qualifications of NCE, B.Sc, B.Sc(Ed), M. Sc, M. Sc(Ed), PGDE and Ph.D are above the acceptable mean of 2.50 but the professional qualification of MSC(ED) is higher than of PGDE, followed by BSC, BSC(ED), PHD, and NCE. This further indicates that the professional qualifications of chemistry teachers have high influence on their knowledge of test construction procedures in chemistry objective test and this will also affect students' academic achievement in chemistry as students taught by chemistry teachers with Masters degree in chemistry education may likely perform better in chemistry than students taught by chemistry teachers with other professional qualification.

Discussion

The findings of the revealed that there is differences in the responses of male and female chemistry teachers knowledge on test construction procedures in chemistry objective test as this influence the academic achievement of students in chemistry. The findings of the study concurs with Bandele & Oluwatayo (2013) that there is significant difference between male and female teachers' knowledge of test construction exist. Derri (2012) opined that male teachers presented higher knowledge of test construction than the female teachers which also concurs with this study. The findings of this study did not agree with Ahmed, Abdullahi, & Bashir (2022) who reported that there is no significant difference on teachers' knowledge of test construction between male and female teachers, and also, teachers' level of experience. It was concluded that gender and level of experience have no significant effect on teacher's knowledge on test construction in chemistry.

The findings of research question two revealed that the more experienced chemistry teachers are more knowledgeable in test construction procedure than the less experienced ones which have an influence on academic achievement of senior secondary school students. This is visible in table 2 where teachers with teaching experience of 16-20 years are more knowledgeable than that of 21 years and above, followed by 6-10 years, 1-5 years and 11-15years. This further indicated that there is a significant difference between the more experienced chemistry teachers and the less experienced ones in test construction procedure. The findings of the study concur with Dosuma, (2002), who argued that the more experience the teacher is, the more he begins to understand, to appreciate and uses some important test construction skills. Silker, (2003), made similar observation and conclude that years of experience may be a significant factor that affect test. The author further observed that there was a significant difference in the mean ratings of more experienced teachers than the less experienced teachers in terms of test construction which also concurs with this study. This difference observed is an indication

that test construction skills (TCS) is sensitive to years of experience. This study is in disagreement with the study carried out by Agu, Onyekaba and Anyichie (2013), that there is no significant difference in test constructed by more experienced and less experienced science(chemistry) teachers.

The findings of research question three revealed that the professional qualifications of chemistry teachers have a significant influence on their knowledge of test construction procedures. This is reflected in Table 3 where the knowledge of test construction of teachers with professional qualifications of MSC(ED) is higher than of PGDE, followed by BSC, BSC(ED), PHD, and NCE. This further indicates that the professional

qualifications of chemistry teachers have a significant influence on their knowledge of test construction procedures. The findings of the study agrees with Linda and Paul , (2011) that professional qualifications play a crucial role in test construction as they equip individuals with the necessary knowledge and skills to develop valid and reliable tests. This study is in disagreement with the study carried out by Smith (2015) which challenges the belief that formal qualifications are the sole indicators of expertise in test construction. Smith went further to propose that a combination of hands-on experience, mentorship and continuous professional development can be equally effective in fostering knowledge of test construction.

Conclusion

Based on the findings of this study, it was concluded that gender differences, teaching experiences and professional qualifications of chemistry teachers have a significance influence on their knowledge of test construction procedures in objective test as this in turn influences the academic achievement of students' in chemistry.

Recommendations

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

1. The state ministry of Education should organize conferences, seminars, workshops for in-service training chemistry teachers in order to update their knowledge on test construction procedures in chemistry objectives test that can enhance students' academic achievement in Chemistry

2. Chemistry teachers in Awka education zone should get used to the application of the Bloom's taxonomy when setting their examination question. This will promote academic achievement of students in chemistry.

References

Agu, N. N., Onyekuba, C., &Anyichie, A. C. (2013). Measuring teachers'competencies in constructing classroom-based tests in Nigerian secondary schools: Need for a test construction skill inventory. *Educational Research and Reviews*, 8(8), 431.-439.

Ahmed, I., Abdullahi, I. & Bashir, M. A. (2022). Assessment of Test construction knowledge of senior secondary school teachers in Ungogo local government area of Kano state,Nigeria. Asian basic and applied research journal 6(2): 26-30, 2022.

American Psychological Association. (2020). Academic achievement. *In APA dictionary of psychology (3rd ed.). American Psychological Association. https://doi.org/10.1037/0000000-000.*

Bandele, S. O., &Oluwatayo, J. A. (2013). Assessing assessment literacy of science teachers in public secondary schools in Ekiti State. *Journal of Education and Practice, 4*(28), 56-63.

Derri, V (2012) in his study, opined that male teachers presented higher knowledge of test construction than the female teachers which also concurs with this study.

Dosumu CT (2002). Issues in teacher-made tests. Ibadan: Olatunji and Sons Publishers.

Feldman, A., Herman, B.C. (2015). Teacher Contextual Knowledge. In: *Gunstone, R. (eds) Encyclopedia of Science Education. Springer, Dordrecht. pp 1020-1021.*

Giginna, J., & Nweze, N. J. (2014). Factors influencing students' poor achievement in chemistry in senior secondary school certificate examinations. *Journal of Education and Practice, 5(6), 119-125.*

Gronlund, N. E., & Waugh, C. K. (2016). Objective tests: Assessing knowledge through predetermined alternatives. In Assessment of Student Achievement.

LSE. (2017). Using class participation to develop student engagement. LSE Teaching and Learning Centre, Resources, Small and Large Group Teaching. Retrieved from *https://info.lse.ac.uk/staff/divisions/Teaching-and-Learning-Centre/Assets/Documents/Using-class-participation-to-develop-student-engagement-FINAL.pdf*

Obialor, C. O. (2016). Effects of project work on students science process skill acquisition and achievement in secondary school Biology. Unpublished masters project Nnamdi Azikiwe University Awka.

Silker RT (2003). Teachers and tests. London: *Basil Blackwell.*

Usselman, M. C. and Rocke, . Alan J. (2022). chemistry. *Encyclopedia Britannica. https://www.britannica.com/science/chemistry.*