Assessment of Senior Secondary School Physics Teachers' Knowledge of Multiple-Choice Test Construction Procedures

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Abstract

The main purpose of this study was to assess the senior secondary school physics teachers' knowledge of multiple-choice test construction. The study employed a survey type research design and the sample consisted of 50 senior secondary school teachers in Ilorin South, East, and West Local Government Areas, which were randomly selected as the sample for this study. Questionnaire was used as instrument that probed teachers' knowledge and their perceived use of test construction strategies. The reliability index of the instrument; Physics Teachers' Knowledge of Test Construction Procedure (PTKTCP) was determined using Cronbach's alpha approach, which enables one to estimate internal consistency when the scoring of items on a test is not limited to 1 point (for correct) or 0 points (for incorrect response). The collected data were analysed using mean, independent t-test and ANOVA to test if there was a significant difference among the teachers on all the scales. Findings from this study indicated that most teachers consider the preparation of test blueprints important during test construction and that there are no gender differences or influences of teachers' level of experience on their knowledge of multiple-choice test construction procedures. The study recommended that teachers in training colleges of education and universities should be exposed to the technicalities in preparing test blue print in order for their assessment instrument to be valid.

Keywords: *Assessment, test construction, multiple-choice test, teachers, physics, senior secondary schools*

1. Introduction

Assessment, specifically test construction, forms a critical part of the teaching and learning processes in school settings. A test is generally used as an assessment tool for obtaining information about students' learning performance. It should be made clear at this point that testing is a key component of educational assessment, testing what students know or have learned in an area of study. According to Quansah et al. (2019), a test is a device or procedure for

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measuring a sample of an individual's behavior in a specific learned activity or discipline. Blakeborough and Watson (2019) further described the test as a standard procedure for obtaining a sample of behavior from a specified domain.

These tests are normally administered to students after a period of instruction for achievement purposes. Considering the sensitive role that information from a test plays in making educational decisions for students as well as management, it is important to say that both test developers and users must make conscious efforts to improve the validity and reliability of the test in order to get objective information that approximates the individual's true characteristics, which the test developer seeks to estimate. Unfortunately, the test-construction role of teachers has been reported as a main source of anxiety, especially for those with a few years of teaching experience. This anxiety, according to Ankomah et al. (2020), largely stems from the inadequate test construction skills of these teachers. Scholars have also argued that test construction among teachers is not encouraging (Quansah & Amoako, 2018; Quansah et al., 2019).

The implication is that teachers may end up collecting inaccurate information about student learning. For instance, Ede et al. (2021), assessed the test construction skills of teachers in Nigeria and found poor test construction skills among non-professional teachers. Another study by Abdul-Wahab and Ali (2022) found that most teachers construct poor items that actually fail to function as they were supposed to; some teachers acknowledge that they have weak test construction skills and hence resort to past or already existing questions to assess students. Similar findings have been found in Ghana. Quansah et al. (2019), in their study, found that teachers in the Central Region of Ghana have inadequate skills in constructing both essay and objective-type tests. Also, Quansah and Amoako (2018) found that the senior high school teachers in the Cape Coast Metropolis have a negative attitude towards test construction. The authors specifically found a poor attitude among teachers in the planning of tests, item writing, item review, and assembly of the items. Quansah and Amoako (2018) concluded that the attitude of teachers had an effect on the quality of the tests used for assessing students. It is essential to state that the poor attitude might not be due to their inadequate skills but also to the fact that some teachers see test construction as a burden to them. Exploring the test construction skills of teachers is significant if objective and accurate information is to be gathered from the students in the teaching and learning process.

Moreover, this study employed self-reported means to describe teachers' knowledge of test construction. This measurement procedure does not appropriately estimate the skills of teachers in test construction, but the majority

of these studies gathered their information through administering questionnaires to the respondents or by interviewing them. The mere asking of questions about how these teachers construct test items does not provide a comprehensive view of the knowledge the teacher had. It is even more likely that these teachers will provide responses that do not reflect their actual practice. In an actual sense, these studies just provide information about teachers' testing or test construction practices through the lens of the same teachers. It is essential to conduct an exploratory study to critically examine some questions crafted by these teachers to find out whether they have the competencies for test construction. With the advent of continuous assessment, there has been an increasing need for classroom teachers to prepare and administer tests in order to obtain certain vital information about what has been done during the teaching and learning processes.

In recent years, there has been extensive research on teachers' knowledge of test construction procedures in secondary schools in terms of topics such as the effect of item arrangement on performance in mathematics in secondary schools (Opara & Uwah, 2017) and the competencies of professional and non-professional teachers in Nigeria (Ololube, 2008). However, to the best of the researcher's knowledge, there has been no research into senior secondary school physics teachers' knowledge of multiple-choice test construction procedures in Kwara State, Nigeria.

1.1 Objectives of the Study

The objectives of this study were to:

1. determine the level of competence of physics teachers regarding their knowledge, skills, and constant utilization of the sequential stages of the test construction of a teacher-made achievement test.
2. find out if the tests constructed by the physics teachers as a tool for assessing students' level of achievement possess the basic psychometric properties,
3. find out if gender differences in teachers have any significant relationship with their knowledge of test construction.
4. explore the relationship between educational qualifications of physics teachers and their test construction skills.
5. explore the relationship between educational experience of physics teachers and their test construction skills.

1.2 Research Questions

The following research questions were posed and answered:

1. Do physics teachers consider the preparation of the test blueprint important during test construction?
2. Is there any difference between male and female physics teachers in terms of their knowledge of test construction procedures?

3. Does the professional qualification of physics teachers have any influence on their knowledge of test construction procedures?
4. Are the experienced physics teachers more knowledgeable in test construction procedures than the inexperienced teachers?

1.3 Hypotheses of the Study

The following null hypotheses were tested:

H_{01}: There is no significant difference in knowledge of test construction procedures exhibited by male and female physics teachers in the multiple choice objective achievement test.

H_{02}: There is no significant difference between qualified and unqualified physics teachers' knowledge of test construction procedures for teacher-made objective test.

H_{03}: There is no significant difference between experienced and inexperienced physics teachers in the knowledge of test construction procedures.

1.4 Significance of the Study

The findings of this study will be helpful to physics teachers who are interested in the knowledge of multiple-choice test construction. They are anticipated to be of enormous assistance to teachers on measuring and evaluation in colleges or university faculties of education, as well as practicing teachers. It is envisaged that science teachers, particularly physics teachers, will take inspiration from the phases involved in test construction to enhance their own methods, procedures, and approaches. This research emphasizes the need to create a table of requirements for every test so that the teacher can make sure that the subject's content is appropriately covered.

2. Literature Review

Classroom assessment practices, whether formative or summative, form a fundamental part of the teaching and learning process. Testing (or examining) is the process of administering a test to elicit and measure a certain behavior (concept) from which one can make inferences about certain characteristics of an individual, usually under standardized conditions. For example, tests are used to measure how much a student has learned in a given course or subject by means of more or less formal, systematic methods of assessment used to determine a student's knowledge with regard to a predetermined content. Most often, these methods require the use of paper and pencil instruments designed to elicit some definite behavior, knowledge, or skill from the test taker. Linn and Gronlund (1995) describe the test as a type of assessment that typically consists of a set of questions administered during a fixed period of time under reasonably comparable conditions for all students. Sometimes the results of assessing students are reported on a numerical scale, reflecting the quality of their learning

through a quantitative score or mark. Higher grades reflect higher levels of learning or competence, whereas lower grades reflect a deficiency or incompetence related to the target content.

The direct assessment procedure helped to validate teachers' responses to the self-report measure used in the assessment of their competence in constructing multiple-choice questions. Both quantitative and qualitative item analyses were employed to validate the self-reported competence of the teachers. These methods showed that though the teachers reported high levels of competence in constructing multiple-choice tests, the validation of their perceived competence using quantitative item analysis indicated that generally across the subject area, the number of problem items raised concerns about what they perceived about themselves and what their competence produced.

Burton et al. (1991) have indicated that good multiple-choice test items are more demanding and take a lot of time to craft as compared to other types of test items. Given that multiple-choice test construction has different stages, with each stage playing a significant role in test quality, teachers' lack of competence in any of the stages has the potential to mar the quality of tests (Agu et al., 2013). Thus, there is a need to ensure classroom teachers are practically exposed to item writing skills, especially ensuring content validity and crafting options for a multiple-choice item with good quality.

Maba (2017) has also indicated that competence as ability is modifiable and that new experience can be integrated. For instance, teachers' competence in developing multiple-choice test items with acceptable difficulty and discrimination indices improved significantly through training in constructing multiple-choice tests (Abdulghani et al., 2015). Consequently, new experiences gained by teachers as a result of exposure to constant training and practice in ensuring the quality of multiple-choice tests can lead to the integration and modification of their multiple-choice test construction competence.

Unfortunately, multiple-choice test items are the predominant type of items that are used during almost every examination in Nigeria, largely due to the large class sizes. Thus, poor multiple-choice test constructions do not only affect students but also their families and the country's quality of education. This is because teachers' decisions based on these low-quality multiple-choice items may lack valid evidence and may not represent the actual achievements of students. This implies that educational stakeholders will not be able to adequately provide support and educational opportunities that meet each student's needs.

A test is a task administered to students to determine what they have learned or not learned. The tests are constructed through standardized agreed-upon procedures. These tests, construction procedures, and skills are essential

devices required by any physics teacher if teaching and learning goals are to be met or attained. Test construction skills include drawing a table of specifications involving item writing, blue print, arrangement of the items according to weightage, item review and editing, try-out of the items, testing item difficulty levels, and considering principles of test construction (Kojigili, 2018). A well-constructed test shows the strengths and weaknesses of students in the learning process. Therefore, the significance of tests in the school system cannot be overemphasized since they are the means by which any meaningful educational goals are achieved.

Rudner and Schafer (2002) opined that teachers have a need to be knowledgeable consumers of test information and constructors of good tests. According to Koksal (2004), faulty test items affect students' comprehension, knowledge, and ability to provide accurate answers to the items, so the inference drawn about what students know and understand may be compromised. In addition, most test items used for continuous assessments and end-of-term examinations in Nigerian secondary schools contain ambiguous and misleading items, which may be the reason why some of the students fail their continuous assessments, end-of-term examinations, and external examinations.

Gender parity has been another issue in Nigeria's educational system. This issue is inevitably present with regard to test construction, as reported by some researchers. For instance, Bandele and Oluwatayo (2013) reported in their study that a significant difference exists between male and female teachers' knowledge of test construction. The study showed that female teachers had better knowledge of test construction than their male counterparts. Derri (2012) opined that male teachers presented higher knowledge of test construction than female teachers. Agu et al. (2013) confirmed that the test construction skill inventory is stable across genders and could be appropriately used to assess the test construction skills of both male and female teachers. Ololube (2008) evaluated the knowledge of trained and untrained teachers in Nigerian secondary schools and found that trained teachers tend to construct various effective evaluative instruments more than untrained teachers, who may be experienced teachers. Dosuma (2002) argued that the more experienced a teacher (any teacher who has taught in senior secondary school for ten years and above) is, the more he begins to understand, appreciate, and use some important test construction skills. It does not mean a teacher has to be trained to do that. Silker (2003) made similar observations and concluded that years of experience may be a significant factor that affects tests.

3. Research Methodology

3.1 Research Design

This study followed a survey type of research design. The design was considered appropriate because it helped the researcher to describe and explore variables and constructs of interest in the research.

3.2 Population of Study

The population of this study consisted of 248 senior secondary schools in Kwara State. The target population comprised 199 public senior secondary schools offering physics in the Ilorin metropolis of Kwara State, Nigeria. (Ilorin metropolis comprised Ilorin East, West, and South Local Government Areas of Kwara State, where most public secondary schools dominated.)

3.3 Sample and Sampling Techniques

A multi-stage sampling procedure comprising stratified, proportionate, and convenient sampling techniques was employed for the effective selection of physics teachers in the study. A stratified sampling technique was used to categorize schools in the three local government areas, which therefore brought about 199 public secondary schools (Kwara State Ministry of Education and Human Capital Development, 2023). A proportionate sampling technique was used to select 25% of 35 in Ilorin East, 25% of 88 in Ilorin West, and 25% of 76 in Ilorin South secondary schools, for a total of 50 senior secondary schools. In addition, convenient sampling techniques were used to select all the physics teachers in the schools visited by the researcher. Convenient sampling techniques were used because the researcher involved all the physics teachers in each of the schools visited.

3.4 Instrumentation

The instrument used in this study was a questionnaire that probed the teachers' knowledge and their perceived use of test construction strategies and asked the teachers to consider the nature and extent of their knowledge in assessing test construction. The instrument is called the Physics Teachers' Knowledge of Test Construction Procedure (PTKTCP). The instrument was based on a four-point Likert scale of "not relevant, "relevant, "fairly relevant," and "very relevant." The instrument was a twenty-four-item (24) scale.

3.5 Validation of Research Instrument

The instrument was validated by two lecturers in test and measurement as well as one senior physics teacher in a government school. But for the fact that the instrument was adopted, it was revalidated by two professors in the Department of Physics to confirm its internal consistency. The items were judged to be highly relevant by the experts, and the content validity index for scales (S-CVI) was computed to be 0.80. The reliability index of the instrument PTKTCP

was determined using Cronbach's alpha approach, which enables one to estimate internal consistency when the scoring of items on a test is not limited to 1 point (for a correct response) or 0 points (for an incorrect response). A reliability index of 0.85 was found and is adjudged to be reliable.

3.6 Data Collection

The duration of data collection lasted for a period of 2 weeks (10 working days) due to the randomized transportation around the Ilorin South, East, and West Local Government Area for the collection of data from various schools. The researcher visited the schools where the study was carried out. Copies of an informed consent form were distributed to the physics teachers for endorsement to indicate their willingness to participate in the study.

The researcher makes it clear to the teachers that their participation is voluntary in the study, in conformity with standard ethical practice. If any participant, however, decides to withdraw from the research at any time, such participant may do so without any hindrances. Participants were not exposed to any risk because all the activities took place in the school during school opening hours. All school rules were adhered to, and all necessary precautions were taken to prevent any form of hazard to the participants. The names of the sampled schools as well as those of the participating teachers were handled with the utmost confidentiality and not disclosed at any point in this study. The participants were told that the questionnaire collected from them would be used for data analysis.

4. Data Analysis and Interpretation

Descriptive and inferential statistics were carried out on the data obtained using Microsoft Excel and SPSS version 23.0. Specifically, all five research questions raised were answered using the mean and standard deviation, while the research hypotheses were tested using the t-test and ANOVA at a 0.05 alpha level of significance. In this study, a bench-mark mean of above 2.5 is regarded as relevant or very relevant, while below 2.5 is regarded as fairly relevant or not relevant.

Research Question 1: Table 1 presents the mean and standard deviation of data collected from physics teachers.

Table 1

The Preparation of Test Blue Print Important during Test Construction

	Items	N	Mean	S.D
1.	State the purpose of the test.	50	3.20	0.61
2.	Obtain a list of instructional objectives.	50	3.12	0.69
3.	Write the instructional objectives to reflect a higher level of cognitive, affective, and psychomotor	50	3.16	0.71

	domains.			
4.	Define the instructional objectives to reflect a higher level of cognitive domain.	50	3.04	0.70
5.	Determine the content to be covered at a stipulated time.	50	2.86	0.78
6.	Examine how the content area selected relates to the already-stated instructional objectives.	50	3.02	0.74
7.	Emphasize only the actual content area taught, not actually all that is stated in the scheme of work.	50	2.78	0.89
8.	Examine if the number of topics and sub-topics in the content area to be tested is evenly distributed.	50	3.14	0.73
9.	Develop a table of specifications or test the blue print.	50	2.62	0.83
10.	Develop test items to meet the specifications in each test blue-print cell.	50	2.74	0.72
11.	Ensure that the table of specifications prepared specifies the proportion of the test item in relation to the objective and the content stated.	50	3.12	0.77
12.	Ensure that the test item to be constructed reflects the instructional objectives and content covered in equal proportion.	50	3.04	0.70
13.	Decide on the type of item format to use in the construction.	50	3.16	0.71
14.	Write out the test item.	50	3.18	0.69
15.	Consider the merits and demerits of the chosen item type to be used.	50	3.14	0.76
16.	Consider the purpose of the test, the time of testing, and the number of candidates to be tested before item type selection.	50	3.32	0.71
17.	Analyze the students' responses to the test items.	50	3.26	0.78
18.	Determine the discrimination index of the test.	50	2.92	0.78
19.	Determine the difficulty index of the test.	50	2.98	0.74
20.	Estimate the effectiveness of the distraction items.	50	2.90	0.84
21.	Determine the validity of the test.	50	3.14	0.70
22.	Determine the reliability of the test items using any of the measures of reliability.	50	3.18	0.77
23.	Rewrite the test items that are deficient after item analysis has been carried out.	50	3.04	0.73
24.	Examine the teacher's determination of the practicability of the test.	50	3.04	0.81
	Average Mean		2.91	0.74

The result from Table 1 shows the physics teachers' perceptions on the importance of the preparation of the text blue print during text construction, with an average mean score of 2.91 and a standard deviation of 0.74. This indicated that the physics teachers found the preparation of test blueprints during test construction important. Moreover, all responses obtained mean values higher than the 2.5 benchmark mean.

Research Question 2: Table 2 shows the results of the difference between the male and female teachers on their knowledge of test construction procedures, with mean scores of 66.44 for male and 62.31 for female teachers. The male respondents had the highest mean of (64.44) and the female respondents had a mean of (62.31), which implies that there was a difference in the mean score in favor of the male.

Table 2

Mean Comparison between Male and Female Teachers

Gender	N	Mean	S.D
Male	18	64.44	11.4
Female	32	62.31	12.3
Total	50	63.08	11.9

H_{01}: The result in Table 3 shows an independent sample t-test computed to compare the mean score of male and female physics teachers on the knowledge of test construction procedures in the multiple-choice objective achievement test with a calculated p-value of 0.549 ($t_{(198)} = 0.604$, $p > 0.05$). This implies that no significant difference existed between the knowledge of test construction procedures among male and female teachers. Hence, hypothesis 1, which states that there is no significant difference in knowledge of test construction procedures exhibited by male and female physics teachers in the multiple-choice objective achievement test, was not rejected.

Table 3

Independent t-test between Male and Female Physics Teachers

Mean Difference	t	df	P-value
2.13	0.604	198	0.549

$p>0.05$

Research Question 3: Table 4 shows the result of teachers' qualification on their knowledge of test construction procedures, with mean scores of 62.09 and 65.00, respectively where the mean value for an unqualified physics teacher was (62.09) and the mean value for a qualified physics teacher was (65.00). This means that

the mean score of the qualified physics teachers was higher than that of the unqualified physics teachers.

Table 4

Mean Comparison between Qualified and Unqualified Teachers

Qualification	Mean	N	S.D
Unqualified	62.09	33	10.9
Qualified	65.00	17	13.8
Total	63.08	50	11.9

H_{02}: Table 5 An independent sample t-test was computed to compare the mean score of qualified and unqualified physics teachers' knowledge of test construction procedures for teacher-made objective tests with a calculated p-value of 0.419 ($t_{(48)} = 0.820$, $p > 0.05$). This implies that there is no significant difference between qualified and unqualified physics teachers' knowledge of test construction procedures for teacher-made objective tests. Hence, hypothesis 2, which states that there is no significant difference between qualified and unqualified physics teachers' knowledge of test construction procedures for teacher-made objective tests, was not rejected.

Table 5

Independent t-test Between Qualified and Unqualified physics Teachers

Mean Difference	t	df	P-value
2.91	0.820	48	0.419

$p>0.05$

Research Question 4: Table 6 presents the results of experienced and inexperienced teachers on their knowledge of test construction procedures, with mean scores of 63.64 and 60.13, respectively when the mean value for experienced physics teachers was (63.64) and the mean value for inexperienced physics teachers was (60.13). This means that the mean score of the experienced physics teachers was higher than that of the inexperienced physics teachers.

Table 6

Mean Comparison between Experience and Inexperience Teachers

Teachers' experience	Mean	N	S.D
Inexperience	60.13	8	6.5
Experience	63.64	42	12.7
Total	63.08	50	11.9

H_{03}: The result in Table 7 shows an independent sample t-test computed to compare the mean score of experienced and inexperienced physics teachers knowledge of test construction procedures with a calculated p-value of 0.449 ($t_{(48)} = 0.763$, $p > 0.05$). This implies that no significant difference existed between

experienced and inexperienced physics teachers' knowledge of test construction procedures. Hence, hypothesis 3, which states that there is no significant difference between experienced and inexperienced physics teachers in their knowledge of test construction procedures, was not rejected.

Table 7

Independent t- test between Experience and Inexperience Physics Teachers

Mean Difference	t	df	P-value
3.52	0.763	48	0.449

$p>0.05$

5. Discussion and Conclusion

Findings from this study indicated that physics teachers found preparation of the test blueprint important during test construction, such that they stated the purpose of the test, developed a table of specification or test blueprint, ensured that the table of specification prepared specifies the proportion of the test item in relation to the objective and of the content stated, and consider the purpose of the test, time of testing, and number of candidates to be tested before item type selection. These results correspond to those obtained by (Asamoah et al. 2019; Ovati & Ofemi, 2017; Raymond & Grande, 2019), whose steps in the construction of a test range from the purpose of the test, test blueprint development, selection of appropriate item types, and preparation of relevant test items to being important.

The result of these findings also indicated that there is no significant difference in knowledge of test construction procedures exhibited by male and female physics teachers in multiple-choice objective physics achievement tests. The findings from this study confirmed with those of (Amusan, 2020; Ibrahim et al., 2022; Ramadhan, et al. 2020), who found no significant difference in the knowledge of test construction procedures between male and female test constructors. On the contrary, Akanni (2021) found out that there is significant difference between the assessment of male and female teachers' competencies in test construction skills. This discrepancy in their findings might be due to have had equal opportunities for professional development, including training in test construction by both male and female teachers. While male and female teachers may have different teaching styles, which could influence their approach to test construction and therefore the assessment of their competencies may be different.

Also from this study, it was shown that there is no significant difference between qualified and unqualified physics teachers in their knowledge of test construction procedures for teacher-made objective physics tests. This finding agrees with Adodo (2014), who also found no significant differences between

educational qualifications and teachers' knowledge of test construction procedures. However, the mode of training a teacher receives will impact more on his or her knowledge of test construction than his or her educational qualifications. A highly educated person who has never taken training in test construction may not be knowledgeable enough to construct test items with the proper qualities. Teachers' qualifications do not have any effect on how to determine the objectives of the test, construct the test blueprint, or evaluate students' learning outcomes. Findings from Hypothesis 3 showed that there is no significant difference between experienced and inexperienced physics teachers in their knowledge of test construction. This finding is in agreement with (Bika & Buba, 2020; Ibrahim et al., 2022), who found that years of experience did not make any significant difference in teachers' knowledge of test construction procedures. It could be that teachers perceive the test construction procedure as a waste of time and non-motivating, which is why even if they have experience doing it, they fail to utilize it.

The implications of this study underscore the importance of preparing a test blueprint during test construction. This could lead to more structured and objective-driven tests, improving the quality of student assessment. The study found no significant difference in test construction knowledge between male and female teachers. This supports the push for gender equality in the education sector, showing that both genders can equally contribute to the test construction process. The study suggests that the mode of training a teacher receives impacts their knowledge of test construction more than their educational qualifications. This could lead to a shift in focus from qualifications to relevant training in teacher recruitment and development processes. The study found that years of experience did not significantly impact a teacher's knowledge of test construction procedures. This could encourage a culture of continuous learning and professional development among teachers, rather than relying solely on years of experience. The study could lead to improvements in the quality of student assessments. By understanding the factors that impact a teacher's ability to construct effective tests, educational institutions can take steps to improve these areas, leading to more accurate and fair assessments of students' learning.

6. Recommendations

Based on the findings, the following recommendations were made:

1. Teachers in training colleges of education and universities should be exposed to the technicalities of preparing test blueprints in order for their assessment instruments to be valid.

2. There should be a proactive measure to ensure that there is some gender balance in terms of test construction procedures among senior secondary school teachers.
3. For the professional growth of teachers, conferences, seminars, workshops, and pre- and in-service training programmes should be given adequate attention by the Ministry of Education, State and Federal Government.
4. Teacher retention should be encouraged in schools, as experience is important in implementing procedures that can enhance the validity and evidence of multiple-choice test construction.

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