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DEVELOPMENT AND VALIDATION OF BUILDING SERVICES PRACTICAL SKILLS ASSESSMENT INSTRUMENT FOR NIGERIAN SECONDARY SCHOOLS

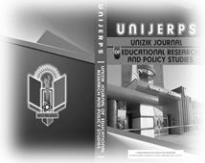
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Abstract

There appears a mismatch between the level of skills acquired by the Nigerian secondary school building construction students and the grades obtained. The aim of the study is to develop and validate an instrument for assessing students' practical skills in building services operations in Nigerian secondary schools. Five research questions guided the study. The study adopted instrumentation design. The area of the study was Taraba State. The population for the study was 107 comprising 82 final year senior secondary school building construction students, 18 building construction teachers and Seven professional builders. The sample size for the study was 47 which comprised all the 22 students offering building construction subject at Government Technical Training School, Jalingo, All the 18 teachers and the seven professional builders. The instrument used for data collection was Building Services Practical Skills Assessment Instrument (BSPSAI). The instrument was face validated by three experts. Content validation was carried out using a table of specifications based on Simpson's model of psychomotor domain. Factor Analysis was used to determine the construct validity of the instrument and a benchmark of 0.35 was pegged as an index for acceptance of an item. Mean was used to select the specific performance objectives of the instrument. The developed instrument was tried out on the 22 students offering building construction subject at Government technical Training School, Jalingo. Findings from the study indicated that 4 practical task items, 79 practical skill items, and five performance objectives were found to be appropriate for

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inclusion in the instrument. The instrument was found to be valid and reliable. Some recommendations were made based on the findings.

Introduction

The need to develop competent skilled workforce for the various sectors of the Nigeria economy cannot be over emphasize, in order to realized this, the Nigerian government through the Nigeria Education Research and Development Council (NERDC) have restructured the secondary school curriculum to allow for the integration of vocational subject under the various subject clusters . Building construction is one of the subjects that under the technology cluster (Nigeria Education Research and Development Council (NERDC), 2012). The subject is taught in senior secondary schools or its equivalent such as science and technical colleges. The subject is concerned with equipping the students with both the theory and practical skills needed to undertake simple building construction work. It also prepares the students for further studies in the field of technology either in the polytechnic, universities or other institutions of higher learning.

Building services is one of the operations taught in building construction subject (NERDC, 2012). Building services operations is concerned with the study of water lining that produced craftsmen with skills in the installation and maintenance of hot and cold water supply system, electrical installations, and sanitary services among others. It is therefore an important component of building construction subject. Students are therefore expected to acquire adequate skills in executing this operation. The level of skills acquired by the students in the course of their studies needs to be assessed using an assessment instrument.

Assessment instrument is a scheme used to determine the level at which the learner exhibits behaviour or the quality of that behaviour particularly while is being observed by an assessor or a team of assessors. Instruments to be used for assessment of practical skills acquired by students in building services and indeed all other subjects according to Uzoagulu (2011) must possess the following two key attributes for it to be useful in the assessment processes-validity and reliability. Validity of an instrument refers to the degree to which

an instrument measures what it is supposed to measure. Reliability on the other hand refers to the degree to which an assessment tool produces stable and consistent results (Ombugus, 2014). A test can be carried out at different times or under the assessment of different raters, the degree to which the results obtained relate with another is referred to as reliability.

Despite the laudable objectives of teaching building services operations component of senior secondary school building construction, several studies (Olaitan, 2014; Ombugus, 2014 &Umanah, 2016) indicated that the current way of assessment of practical skills in technical and vocational subject related areas, including building services component of building construction subject in Nigerian secondary schools is marred by the inability of most of the teachers to develop good assessment instrument. Majority of the teachers can't develop good assessment instrument. Few teachers relied on the instrument developed by the two examination bodies, West African Examination Council (WAEC) and the National Examination Council (NECO), however, these instruments only assessed "Building drawing". This is evident in the fact that the researchers observed that most of the students graduate with good grades but they can't perform the tasks and exhibit competencies expected of them in the field of work. This is an indication that the grades obtained by the students do not give a true reflection of the amount of skills possess by them. There is therefore a convincing reason to develop and validate instrument for assessing practical skills in building super-structure in Nigerian secondary schools.

Research Questions

The findings of the study provided answers to the following research questions:

1. What are the practical task contents appropriate for inclusion in the instrument?
2. What are the practical skills appropriate for inclusion in the instrument?
3. What are the specific performance objectives of the practical task contents of building super-structure operations?
4. What is the validity of the developed instrument?
5. What is the reliability of the developed instrument?

Methodology

The study adopted instrumentation design. This type of design is aimed at developing and authenticating the capability of an instrument for the purpose of measurement of a given behaviour. According to Creswell (2014), it is concerned with the processes and procedures of developing an instrument for gauging performance or for obtaining data for passing judgments on certain actions or behaviour. Instrumentation design is appropriate for this study because the study is aimed at developing and validating an instrument for assessing students' practical skills in building services in Nigerian secondary schools.

Participants and Sample

The number of participants for this study is 107, which consist of 82 building construction students in the final year of senior secondary school, 18 teachers teaching building construction subject in the 8 senior secondary schools offering building construction subject in Taraba State, and the seven professional builders employed by the Taraba state ministry of works.

The sample size for this study is 47. There was no sampling in the selection of teachers and professional builders, therefore, all the 18 teachers and the seven professional builders formed part of the sample size. However, for the students, only the 22 final year senior secondary school student offering building construction subject in Government Technical Training School, Jalingo were purposively selected for the try out the developed instrument. In order to determine the adequacy of the sample size and the suitability of the data for Factor Analysis, a Kaiser-Mayer-Olkin (KMO) Test was administered; and a value of 0.72 was obtained which according to Keiser as reported by IBM Knowledge Centre (2019) is adequate for the exercise.

Instrumentation

The instrument used for data collection was Building services practical skills assessment instrument (BSPSAI). The instrument was developed by the researcher based on the NERDC curriculum for building construction subject. The instrument is divided into two parts. Part one sought for the status of the respondent, while the part two which has three sections contained items that elicit for data to answer the research questions. A five point scale of Very High (VH), High (H), Moderately High (MH), Low (L) and Very Low (VL) were written against each statement to enable the teachers and the professional builders identify the level of

appropriateness of each item for inclusion in the instrument. The following stages which usually characterized instrumentation design for assessment of psychomotor outcomes was adopted:

1. Isolation of objectives of assessment from the curriculum
2. Identification of psychomotor skills areas in the building construction curriculum
3. Development of table of specifications
4. Generation of practical tasks, skills, and corresponding performance objective items
5. Content validation of the draft assessment instrument
6. Development of rating scale for the practical skills assessment instrument
7. Field testing of instrument to determine validity and reliability
8. Final Assembly of the selected items
9. Development of guidelines on how to use the instrument.

A table of specifications was developed based on the curriculum content and in line with the six out of the seven levels of Simpson's model of psychomotor domain. This is to ensure that the practical skill items are effectively distributed across the six levels of the domain. The draft practical skills assessment instrument was submitted for validation to three experts: one of the experts who specialized in building construction is a teacher at Government Science and Technical College, Potiskum; one expert is a professional builder in the employment of Taraba State University, Jalingo, while the remaining one is an expert in measurement and evaluation at Nnamdi Azikiwe University, Awka. The instrument was administered on the building construction teachers and the professional builders by the researcher and his assistants in their respective establishments. At the try-out stage, the instrument was administered on 22 SS 3 building construction students in Government Technical Training School, Jalingo, Taraba State under examination condition.

Data Analysis

To answer research questions 1 and 2, the identified practical tasks and practical skill items the data obtained was subjected to factor analysis using 0.35 factor loading as a benchmark for

acceptance (Abonyi, 2003). Mean was used to analyse data to answer research question 3 which seeks to determine the specific performance objectives of the practical task contents of building construction subject, any item with a mean rating ≥3.50 which is the lower limit of "High" on a five-point Likert type scale was considered as appropriate for inclusion. In answering research question 4, table of specifications was used to ensure the content validity of the instrument in line with Simpson's taxonomy of the psychomotor domain. This is in addition to the valuable comments of experts in building construction, and measurement and evaluation. Data for research question 5 was analysed using Cronbach alpha and Spearman Rank Order Correlation.

Results

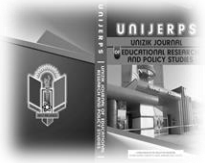
Findings from this study are presented in line with the five research questions raised.

Practical task contents appropriate for inclusion in the building services practical skills assessment instrument

In Table 1, data revealed that the four practical tasks presented had their factor loading > 0.35. Only one task (Task 5) was found to be factorially impure. Based on this, it can be concluded that the four out of the five practical tasks were found to be appropriate for inclusion in the building services practical skills assessment instrument.

Table 1: Practical task contents appropriate for inclusion in the building services practical skills assessment instrument

S/N	Operations/Practical Tasks	Factor Loading	Remarks
	Building Services Operations		
1	Drainage System Construction	0.60	Appropriate
2	Plumbing Installations	0.72	Appropriate
3	Electrical Installations	0.66	Appropriate
4	Sanitary appliances Installations	0.61	Appropriate
5	Solar system installations	0.32	Inappropriate


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Practical skills appropriate for inclusion in the building practical skills assessment instrument

Data presented in Table 2 indicated that 79 out of the 91 practical skill items presented had their factor loading > 0.35. One item (item 1) factor loaded < 0.35, while 11 items were technically inappropriate due to the failure of the task item that housed them to load up to 0.35. Based on this, it can be concluded that 79 practical skill items were found to be appropriate for inclusion in the building super-structure practical skill assessment instrument.

Table 2: Practical skills appropriate for inclusion in the building services practical skills assessment instrument

S/N	Practical Skills	Factor Loading	Remarks
	Task 1: Drainage System		
1	Select the right type of drainage system	0.34	Inappropriate
2	Apply the principles of drainage system	0.84	Appropriate
3	Select suitable drainage materials	0.62	Appropriate
4	Establish gradient for the drainage	0.84	Appropriate
5	Position the manhole	0.58	Appropriate
6	Select suitable position of septic tank	0.68	Appropriate
7	Identify suitable depth for septic tank	0.84	Appropriate
8	Select suitable position of soakaway	0.94	Appropriate
9	Identify suitable depth for soakaway	0.83	Appropriate
10	Select suitable position for inspection chamber	0.90	Appropriate
11	Position air vent	0.90	Appropriate
	Task 2: Plumbing Installations		
12	Select type of pipe to be used	0.94	Appropriate
13	Select the type of plumbing fittings	0.64	Appropriate

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14	Estimate the quantity needed	0.84	Appropriate
15	Cut pipe to the required length	0.95	Appropriate
16	Thread the pipe where necessary	0.39	Appropriate
17	Apply thread tape	0.45	Appropriate
18	Perforate wall surface to accommodate the pipe	0.35	Appropriate
19	Use "elbow" appropriately	0.67	Appropriate
20	Use "tee" appropriately	0.89	Appropriate
21	Use "adaptor" appropriately	0.97	Appropriate
22	Apply adhesives appropriately	0.85	Appropriate
23	Demonstrate the use of chalk-line	0.74	Appropriate
24	Locate the position and installing "stop cock" appropriately	0.47	Appropriate
25	Locate and installing 'tap" appropriately	0.68	Appropriate
	Task 3: Electrical Installations		
26	Cut conduit pipe	0.66	Appropriate
27	Thread conduit pipe	0.94	Appropriate
28	Measure and mark out the service points	0.96	Appropriate
29	Perforate wall surface to "bury" the pipe	0.89	Appropriate
30	Install "knock-out boxes" for switches	0.49	Appropriate
31	Install "knock-out boxes" for sockets	0.79	Appropriate
32	Install the distribution board	0.78	Appropriate
33	Install the ELCB	0.78	Appropriate
34	Insert the pipe on the perforated surface as specified	0.54	Appropriate
35	"patch" the perforated potion with cement mortar	0.98	Appropriate
36	Link all the pipes appropriately	0.44	Appropriate
37	Install the lightening points on the link pipes	0.95	Appropriate

38	Tighten all loose contacts	0.72	Appropriate
39	Install earth continuity conductor	0.87	Appropriate
40	Determine the right cable size	0.63	Appropriate
41	Draw the cables inside the conduit pipe	0.89	Appropriate
42	Install the switches	0.63	Appropriate
43	Install the correctly rated sockets	0.46	Appropriate
44	Install the correctly rated lightening fittings	0.56	Appropriate
45	Demonstrate the use of "test lamp'	0.93	Appropriate
46	Carry out various installation tests	0.65	Appropriate
	Task 4: Sanitary Appliances		
47	Demonstrate ability to distinguish between soil and waste appliances	0.75	Appropriate
48	Determine the right diameter and thickness of pipe for cold water supply	0.98	Appropriate
49	Determine the right diameter and thickness of pipe for hot water supply	0.68	Appropriate
50	Determine the right diameter and thickness of pipe for waste water discharge	0.85	Appropriate
51	Determine the right diameter and thickness of pipe for soil water discharge	0.95	Appropriate
52	Measure and marking out the service points	0.64	Appropriate
53	Cut cold water supply pipe to specification	0.77	Appropriate
54	Thread cold water supply pipe	0.76	Appropriate
55	Cut hot water supply pipe to specification	0.90	Appropriate
56	Thread hot water supply pipe	0.68	Appropriate
57	Cut soil water discharge pipe to specification	0.73	Appropriate
58	Thread soil water discharge pipe	0.93	Appropriate
59	Cut waste water discharge pipe to	0.63	Appropriate

	specification		
60	Thread waste water discharge pipe	0.63	Appropriate
61	Perforate wall surface to "bury" the pipe	0.89	Appropriate
62	Excavate ground surface to "bury" the waste water pipe	0.48	Appropriate
63	Establish the gradient in the excavated area	0.94	Appropriate
64	Insert the pipe on the perforated surface as specified	0.87	Appropriate
65	"patch" the perforated potion with cement mortar	0.79	Appropriate
66	Link all the pipes appropriately	0.55	Appropriate
67	Install the Water Closet (WC)	0.54	Appropriate
68	Install the Kitchen sink	0.46	Appropriate
69	Install the Wash hand basin	0.76	Appropriate
70	Install the shower tray	0.67	Appropriate
71	Install the shower	0.96	Appropriate
72	Install the urinal	0.89	Appropriate
73	Install the WC tank	0.99	Appropriate
74	Install the toilet roll holder	0.64	Appropriate
75	Install the towel roll holder	0.84	Appropriate
76	Install the soap dish	0.67	Appropriate
77	Locate the position of manhole	0.45	Appropriate
78	Determine the size of the manhole	0.88	Appropriate
79	Install the manhole	0.65	Appropriate
80	Connect the manhole to the septic tank/public sewer	0.90	Appropriate
	Task 5: Solar System Installation		
81	Select the right semi-conductor panel	*	*
82	Select the right inverter	*	*

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83	Identify the right fasteners for the panels	*	*
84	Fasten the panels to the frame	*	*
85	Connect the cables from the panel to the inverter	*	*
86	Select the right cable	*	*
87	Select the right pipe	*	*
88	Perforate the wall surface to "conduit" the pipe	*	*
89	Dress the wall surface	*	*
90	Fix the cable caps and plugs	*	*
91	Connect the cable from the inverter to the distribution board	*	*

***** Practical skill items whose practical task was found to be factorially impure (factor loading < 0.35)

Specific performance objectives of the practical task contents of building services

In Table 3, the respondents rated the specific performance objectives of the practical task contents of building services. The mean rating ranges from 3.22 to 4.42. Items 3 and 4 had mean rating of 3.22 and 3.48 respectively which is < 3.50. The other five items had their mean ratings > 3.50. Based on this, it can be concluded that five specific performance objectives were considered by the respondents as appropriate for inclusion in assessing students' practical task in building services.

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Table 3: Specific performance objectives of the practical task contents of building Services

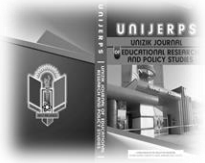
S/N	Performance Objectives	Mean	Remarks
1	Identify appropriate tools for the task accomplishment	4.42	Appropriate
2	Use working tools appropriately	4.37	Appropriate
3	Read and interpreted blue-prints	3.22	Inappropriate
4	Conserve materials and supplies	3.48	Inappropriate
5	Consider safety measures	3.90	Appropriate
6	Execute task Independently	4.24	Appropriate
7	Ensure quality of the completed task	3.83	Appropriate

Validity of the developed instrument for assessing practical skills in building services in Nigerian Secondary Schools

The data in Table 4 revealed that 4 practical tasks and 79 out of the 91 practical skill items were found to be valid thereby appropriate for inclusion in the building super-structure practical skills assessment instrument. For the face validity, comments of three experts (Building Construction Teacher in a Secondary School, Registered Builder who practiced in the field, and an Expert in Measurement and evaluation who is a Lecturer in a Nigerian University) who examined the instrument for proper wording, consistency, and representativeness were utilized to improve the instrument. For the construct validity, Factor Analysis was used and a factor loading of 0.35 and above was considered as an index for acceptance.

Table 4: Validated Practical Tasks and Skill Items for assessing practical skills in building services in Nigerian Secondary Schools

S/N	Operations	No. of Skills Items	Remarks
1	Drainage System Construction	10	Valid
2	Plumbing Installations	14	Valid
3	Electrical Installations	21	Valid
4	Sanitary appliances Installations	34	Valid
5	Solar system installations	*	Invalid
	Total	79	Valid



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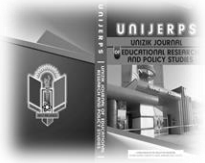
Reliability of the developed instrument for assessing practical skills in building services in Nigerian Secondary Schools

The data presented in Table 5 indicated that, the reliability coefficient with regards to the internal consistency of all the 79 practical skill items across the 4 task clusters ranges from 0.75 to 0.82 with the overall reliability coefficient of the instrument at 0.78. The summary of the inter-rater reliability is presented in Table 6, the reliability coefficient of the four raters ranges from 0.72 to 0.83 with the overall reliability coefficient for the four raters was found to be 0.79. Based on this, it can be concluded that, the instrument is highly reliable for assessing students' practical skills in building services in Nigerian Secondary Schools.

Table 5:Internal Consistency of Practical Tasks and Skill Items for assessing practical skills in building Services in Nigerian Secondary Schools

S/N	Practical Tasks	No. of Skill Items	Internal Consistency	Remarks
1	Drainage System Construction	10	0.75	Highly Reliable
2	Plumbing Installations	14	0.82	Highly Reliable
3	Electrical Installations	21	0.79	Highly Reliable
4	Sanitary appliances Installations	34	0.77	Highly Reliable
5	Solar system installations	*	*	*
	Reliability Coefficient	79	0.78	Highly Reliable

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Table 6: Summary of Inter Rater Reliability of building construction Practical Skills assessment Instrument

S/N	Raters	Reliability Coefficient	Remarks
1	Rater 1 &Rater 2	0.83	Highly Reliable
2	Rater 1 &Rater 3	0.78	Highly Reliable
3	Rater 1 &Rater 4	0.83	Highly Reliable
4	Rater 2 &Rater 3	0.72	Highly Reliable
5	Rater 2 &Rater 4	0.79	Highly Reliable
6	Rater 3 &Rater 4	0.81	Highly Reliable
	Reliability coefficient	0.79	Highly Reliable

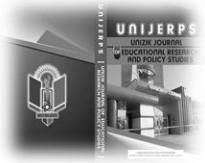
Discussions

The finding on research question 1 shows that, four Practical tasks were found to be appropriate for inclusion in the building services practical skills assessment instrument. This finding is in agreement with the works of Ibrahim (2012), and Okeme (2011) who opined that only items that satisfied all psychometric properties in addition to possessing high factor loading should be considered as appropriate for inclusion in practical skills assessment instrument.

Findings from research question 2 revealed that 79 Practical skill items were found to be appropriate for inclusion in the building services practical skills assessment instrument. This finding is in disagreement with the study of Effiong (2006) who carried out a study on development and validation of alternative to practical test for measuring skills in electronics device and circuit in technical colleges. According to the instrument developed by Effiong, students must not necessarily to go to the shop to conduct practical for the practical skills in their possession can be measured, instead, an instrument with alternative to shop practice items can be develop to measure same construct. However, the findings is in agreement with Yalams (2001) and Garba (1993) who emphasized that only items that satisfied all the relevant psychometric properties should be considered as appropriate for inclusion in a practical skill assessment instrument.

For research question 3, findings revealed that five specific performance objectives were found to be appropriate

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for inclusion in assessing students' practical task in building services. This finding is supported by Enya (1995) who conducted a study on development and preliminary validation of an electricity achievement test for technical colleges. According to Enya, an instrument must be developed to measure the specific objectives of the instructional contents under consideration so that whatever the outcome of the assessment may be, it will not be far from what the examiner set to achieve. The finding is also consistent with Achusi (1997) in assessing practical skills, performance objectives must be clearly identified and be stated in a measurable term so that the assessor can be properly guided on areas to observe while the examinee execute the assigned task.

The findings for research question 4 shows that 4 practical tasks and 79 practical skills items were found to be valid and appropriate for inclusion in the building services practical skills assessment instrument. This finding is in line with Umanah (2016) who opined that validity of an instrument for assessing practical skills is a basic requirement for the instrument to fulfil its obligation. According to the author, the instrument must be subjected to face, contents, and construct validation, when that is done, the instrument will naturally appear to possess the ability to fulfil the predictive validity requirements.

Findings from research question 5 indicated that the developed instrument having attained an internal consistency of 0.81 and inter-rater reliability of 0.80 of the four practical tasks and 79 practical skill items was found to be reliable for assessing students' practical skills in Building services in Nigeria secondary Schools. This finding is in slight disagreement with the study conducted by Olaitan (2014) on development and validation of test for assessing technical college students on motor vehicle mechanic works. While the internal consistency of the instrument developed by Olaitan ranges from 0.84 to 0.96, the internal consistency of this instrument ranges from 0.75 to 0.82. With respect to inter-rater reliability, the study conducted by Olaitan had its inter-rater reliability coefficient ranging from 0.55 to 0.84 which is an indication of the level of variation existing between the two findings.

Conclusion

The study identified the practical tasks, practical skills contents, and the specific performance objectives appropriate for inclusion in the building

services practical skills assessment instrument. It is expected that when the instrument is effectively put into use in assessing secondary school students in building services component of building construction subject, it will bring to the fore the amount of skills the students acquired in the course of their studies. This will assist greatly in passing a valid judgment about the level of competence the students might have attained in handling practical task component of the subject which will form the basis for their certification.

Recommendations

Based on the findings of this study, it is recommended that:

1. The two major examination bodies (WAEC & NECO) should ensure that all the practical tasks and skill items of all the major operations found in building construction curriculum are included in their instrument for the conduct of terminal examinations.
2. Building construction teachers in Nigerian secondary schools should ensure that only valid and reliable instruments are used in their formative and summative evaluation of students in building services practical classes.
3. Government and private school owners offering building construction and being examined by WAEC and NECO should organized workshops for building construction teachers on methods of assessing practical skills in the subject.

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