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Development and Validation of Workshop-Based Process Skill Assessment Instrument for Assessing Skills in Maintenance of Suspension Systems in Motor Vehicles in Akwa Ibom State Technical Colleges

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Abstract
This study focused on the development and validation of a Workshop Based Process Skill Assessment Instrument (WBPSAI) aimed at improving the assessment of students in the maintenance of suspension systems at technical college level in Akwa Ibon State. Lecturers from the Department of Industrial Technical Education University of Nigeria, Nsukka and University of Uyo were used for face and content validation, while technical colleges teachers in motor vehicle mechanics work in Akwa Ibom state were used in item selection which were further tried out on technical college students in motor vehicle mechanics work who were not part of the main test. The study answered four research questions and tested one hypothesis. Data collected were analyzed using statistical Mean, Cronbach Alpha, and Analysis of variance (ANOVA). The result of the study showed that 182 process skill items were found appropriate for inclusion in the WBPSAI. The instrument was found to have a high reliability of 0.89. The analysis of variance revealed significance difference in the three ability groups (high ability, average ability, and low ability) It was recommended amongst others that National Business and Technical examination board and Motor vehicle mechanics work teachers from technical colleges should be encouraged to use the WBPSAI for assessing students' performance in maintenance of suspension systems in motor vehicles.

Key words: Development, Validation, Assessment, Assessment instrument, Process skills.

Introduction

Technical colleges in Nigeria offer technical and vocational education programmes for interested members of the society. One of the technical trades offered in technical colleges is Motor vehicle mechanics work. In motor vehicle mechanics work, students are taught how to carryout maintenance of various components of motor vehicles, such as suspension systems. Thus, the purpose of technical colleges is to produce individuals with sufficient knowledge and practical skills in various trade areas for the world of work. The Federal Republic of Nigeria (FRN) (2004) stated that the essence of technical colleges is to produce middle level manpower for the nation's economic and technological development. To this end, National technical certificate (NTC) is awarded by the National Business and Technical Examinations Board (NABTEB) to students at successful completion of their training programme (NABTEB 2004). Therefore, technical college students at graduation should acquire sufficient skills to carryout various practical tasks

competently in their chosen field of study. To ascertain the level at which the students have acquired the practical skills, they have to be assessed by their teachers at various times during the training programme.

Assessment is a systematic process of collecting, analyzing and communicating information about students' ability or performance in school subjects using appropriate assessment instruments. Assessment instrument may be viewed as a well designed tool for assessing students' performance in school subjects. Thus, the assessment programme may be to test knowledge, affective or skill domain of learning using appropriate assessment instrument. Skill domain of learning also known as psychomotor domain, has to do with the ability to perform tasks, and is assessed using various forms. Ogwo and Oranu (2006) identified alternative to practical test as a method used by the teachers and some examination bodies. Okwelle (2011) identified two forms to include product assessment and process assessment. Bukar (2006) stated that product assessment involves a mere looking at the students' finished product followed by awarding of marks without paying attention to the processes involved in performing the task. Robert (2018) maintained that product assessment involves a student submitting already prepared work to the assessor for grading. Many researchers have condemned the use of product assessment in assessing students' practical skills in technical colleges. For instance, Ombugus and Ogbuanya (2014) stated that with product assessment, students can get assistance from others to get the product completed for assessment, or students can buy finished products from the market and present same for final assessment. It is also obvious that in product assessment, students' level of safety consciousness and the ability to use tools and equipment correctly during practical test are not assessed.

On the other hand, Okwelle (2011) described process skills assessment as an assessment programme which takes into account the process of practical activities leading to the final product. Okwelle and Okoye (2012) maintained that process skill assessment requires attentive and consistent teacher's observation and rating of students' performance. Robert (2018) added that process skill assessment is the assessment technique that involves the use of rating scale to monitor how a student executes a task sequentially. The author added that Workshop-Based Process Skill Assessment Instrument (WBPSAI) is a device that presents step-by-step activities of tasks to be carried out by the examinee followed by a rating scale for the examiner to monitor and rate the student as the student executes the task in a workshop environment. Bukar (2006), Okwelle and Okeye (2012), Ombugus and Ogbuanya (2014), and Robert (2018) in their studies confirmed that competent craftsmen can be selected through the use of workshop-based process skill assessment instrument. The authors have also recommended the use of workshop-based process skill assessment instrument in assessing students in practical tasks in all technical areas in Nigeria. The demand for improved assessment instrument for technical colleges is a pointer to the fact that assessment plays important role in teaching/learning environment. Therefore, it is the responsibility of teachers in technical colleges to construct valid and reliable workshop based process skill assessment instrument. Validity of an instrument is the degree to which an instrument measures what it was designed to measure and not something else (Joshua 2009). Thus, validity focuses on

the level and scope of what the instrument is measuring. In the other hand, Robert (2018) posited that an instrument is reliable when the respondents to the items in the instrument give the same result any time the instrument is administered within the same condition.

However, evidence from research studies Bukar (2006), Okwelle (2011), Ombugus and Ogbuanya (2014), and Robert (2018) revealed that technical college teachers assess students' practical skills by mere looking at the students' finished products with little or no attention given to the processes involved in executing a task. The authors also maintained that though NABTEB is not using product assessment but marking scheme checklist to assess students performance in practical examinations, the method is still faulty because it only highlights the major skills to be rated. Robert (2018) stated that the marking scheme checklists used by NABTEB are inadequate since they do not highlight the step-by-step processes involved in arriving at the finished product.

Literatures available to the researcher revealed that there is no workshop-based process skill assessment instrument in suspension system in technical colleges in Nigeria. Therefore, the absence of valid and reliable assessment instruments for assessing practical skills in motor vehicle maintenance work, and other subjects in technical colleges has resulted in producing graduates who cannot fit into the work environment; hence there is high rate of unemployment among technical college graduates. Against this background, this study is poised to develop and validate workshop-based process skill assessment instrument (WBPSAI) for assessing students in the maintenance of suspension systems in motor vehicles in Nigerian technical colleges.

Purpose of the study

The general purpose of the study is to develop and validate a workshop based process skill assessment instrument for assessing students in the maintenance of suspension systems in motor vehicles at NTC level. Specifically, the study was set to:

1. Determine the process skill items that are appropriate for inclusion in WBPSAI for assessing students in the maintenance of suspension systems in motor vehicle at NTC level
2. Determine the validity of the developed WBPSAI for assessing students in the maintenance of suspension systems in motor vehicle at NTC level
3. Determine the reliability of the developed WBPSAI for assessing students in the maintenance of suspension systems in motor vehicle at NTC level
4. Determine the ability groups of students in the developed WBPSAI for assessing students in the maintenance of suspension system in motor vehicles?

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Research Questions

1. What are the process skills items that are appropriate for inclusion in the WBPSAI for assessing students in the maintenance of suspension systems in motor vehicles at NTC level?

2. What is the validity of the developed WBPSAI for assessing students in the maintenance of suspension systems in motor vehicles at NTC level?

3. What is the reliability of the developed WBPSAI for assessing students in the maintenance of suspension systems in motor vehicles at NTC level?

4 What are the ability groups of students in the developed WBPSAI for assessing students in the maintenance of suspension system in motor vehicles?

Hypothesis

H_O There is no significance difference in the mean rating of students on the developed workshop-based process skill assessment instrument based on their ability group (high, medium and low).

Methodology

Design of the study

The study adopted instrumentation research design. Gay (1996) opined that instrumentation research design is best suitable if the purpose is to produce a new or modified content, procedure or instrument for educational practices

Area of the study: The study was conducted in Akwa Ibom State, Nigeria, and covered nine state owned technical colleges.

Population for the study: There were two target groups of populations in this study. One group consisting of 12 teachers and 10 workshop technologists in motor vehicle mechanics work in all the technical colleges offering motor vehicle mechanics work; while the other group has 130 final year students in Motor vehicle mechanics' work from all the state owned technical colleges accredited by NBTE to mount NTC programme in motor vehicle mechanics' work.

Sample and sampling Technique: The sample size for the study was 36 students. Purposive sampling technique was used for selecting Government Technical College Ewet that has the 36 final year students for the field testing of the assessment instrument. The choice of the college is because the college is well equipped with all the needed facilities for the tests. However, no sampling was done, on the teachers and technologists, because the number was small and manageable.

Instrument of the Study: The procedure adopted for the development of the instrument is a multi-stage approach sequentially arranged as shown below.

1 Review of related literature in NABTEB curriculum on motor vehicle mechanics' works
2 Isolation of specific objectives from the curriculum
3 Identification of major tasks
4 Development of table specification
5 Generation of test items
6 Writing of draft test form
7 Submission of the draft copy to experts for validation
8 Administration of revised test form on subject teachers and workshop technologists for selection of appropriate test items for inclusion in the WBPSAI
9 Writing the revise test form
10 Pilot testing
11 Final assembling of the instrument
12 Field testing of the final instrument on students.

Validation of the Instrument: Validation is a quality review process which involves checking an assessment instrument to ascertain whether the instrument produces valid, reliable, and useable results. The validation of this instrument was done in three stages. These include the panel of experts' questionnaire, the teacher questionnaire and the pilot test stage. Thus the face and content validity was done by lecturers as follows: Three from the Department of Industrial Technical Education University of Nigeria, Nsukka, two from the Department of Industrial Technology Education, University of Uyo, and two lecturers in management and evaluation. Thus the draft copy of the instrument, table of specification, identified task areas in suspension systems in NABTEB curriculum in motor vehicle mechanics' work at NTC level and a four point rating scale were submitted to the experts. The development of table of specification was based on Padelford's (1984) model of psychomotor domain with the following six levels: perceiving, motivating, imitating; performing, adapting and innovating. This helped in ensuring that the 182 process skills were adequately distributed across the six levels of Padelford's psychomotor domain

The experts were required to critically examine the items to ensure that they are relevant, properly worded, organized into the six levels of Padelford's Taxonomy. They were also required to review, reword or delete where necessary. Their corrections and suggestions were utilized in improving the instrument. The second stage of the validation was done by 12 technical teachers and 10 technologists in motor vehicle mechanics work from eight technical colleges in Akwa Ibom State,Nigeria. They were asked to rate the items to ensure that the step by step processes in carrying out each task were appropriate for inclusion in the instrument. A five point likert rating scale with response options of Highly Appropriate, Appropriate, Moderately Appropriate, Inappropriate, and Highly Inappropriate with assigned values of 5, 4, 3, 2, and 1, to each item, guided the respondents. Out of the 184 skill items two were dropped. The result of this was used to assemble the final copy form of the WBPSAI with new rating options of Excellent, Very good, Good, Fair, and Poor, with assigned values of 5, 4, 3, 2, and 1 respectively. The final form of the WBPSAI was tried on 15 students in motor vehicle mechanics work from one of the other technical colleges that was not selected for the main test.

Reliability of the Instrument

The developed instrument was pilot tested on 15 final year students in motor vehicle mechanics' work from one of the technical colleges that was not selected for the main test. The purpose of the pilot test was to determine the internal consistency of the items in the instrument by calculating the Cronbach alpha reliability coefficient. Thus, the reliability test yielded coefficient of .89. The choice of Cronbach alpha method in determining the reliability coefficient in this study was in line with the view of Trochim (2006) who posited that Cronbach alpha method is suitable for testing reliability coefficient of instrument with lots of test items and in clusters. Each of the 15 final year students were rated by three research assistants selected for the study. Their rated scores were analysed using Kendal coefficient of concordance (Tau). The result revealed that the Kendal correlation coefficient between rater 1 and 2; 1 and 3; 2 and 3 were high.

Data Collection and Analysis

There were four rounds of data collections in this study. The first was collected from experts who did the face and content validity of the draft copy of the instrument developed. The second was from the teachers and workshop technologists who determined the appropriateness of the test items for inclusion in the instrument. The third was the pilot test that was used to determine the internal consistency reliability of the instrument; and the fourth being the data from the field testing of the sample group

To answer research question 1, the selection of test items appropriate for inclusion in the instrument, a mean cut-off of 3-00 which is moderately appropriate was adopted. Therefore, any item with a mean score of 3.00, and above was appropriate for inclusion in the WBPSAI, while any item with a mean score below 3.00 was considered inappropriate. To answer research question 2, the content validity of the instrument was determined by the six lecturers who were panel of experts using table of specification consisting of the six levels of Padelford's (1984) model for psychomotor domain namely: perceiving, motivating, imitating, performing, adapting, and innovating, in which the test items were spread. Cronbach alpha coefficient was used to test the degree of reliability of the instrument. For ability level, students scores were computed, ranked from highest to lowest and grouped into three levels based on Adeyemo's (2010) ability level classification of 70 marks and above for high ability , 50-69% for average ability and 0 – 49% for low ability.

The null hypothesis was tested at 0.05 level of probability using analysis of Variance (ANOVA) while the Scheffe Multiple comparism test was used to calculate the degree of agreement in the raters' rating scores. For testing of the hypothesis if, the obtained F- value is greater than the stipulated level of significance of 0.05, the hypothesis is rejected while if the F $^{-}$ value is less than the stipulated level of significance (0.05) the hypothesis is upheld.

Research Question 1: What are the processes skill items that are appropriate for inclusion in the workshop-based process skill test instrument for assessing student's practical skills in the maintenance of suspension system in motor vehicles?

Table 1: Mean rating scale of practical skills for maintenance of suspension system in motor vehicles

ITEM	MEAN ($\bar{X}$)	SD	REMARK
ITEM 1	4.41	0.59	Appropriate
ITEM 2	4.36	0.58	Appropriate
ITEM 3	4.27	0.70	Appropriate
ITEM 4	4.32	0.57	, Appropriate
ITEM 5	4.45	0.51	Appropriate
ITEM 6	4.27	0.55	Appropriate
ITEM 7	4.45	0.51	Appropriate
ITEM 8	4.36	0.58	Appropriate
ITEM 9	4.41	0.59	Appropriate
ITEM 10	4.09	0.87	Appropriate
ITEM 11	4.14	0.83	Appropriate
ITEM 12	4.14	0.77	Appropriate
ITEM 13	4.45	0.51	Appropriate
ITEM 14	4.27	0.70	Appropriate
ITEM 15	4.27	0.63	Appropriate
ITEM 16	4.23	0.53	Appropriate
ITEM 17	4.14	0.56	Appropriate
ITEM 18	4.36	0.58	Appropriate
ITEM 19	4.45	0.51	Appropriate
ITEM 20	4.41	0.5	Appropriate
ITEM 21	4.27	0.7	Appropriate
ITEM 22	4.45	0.51	Appropriate
ITEM 23	4.32	0.57	Appropriate
ITEM 24	4.45	0.51	Appropriate
ITEM 25	4.32	0.72	Appropriate
ITEM 26	4.36	0.58	Appropriate
ITEM 27	4.36	0.66	Appropriate
ITEM 28	4.27	0.63	Appropriate
ITEM 29	4.27	0.70	Appropriate
ITEM 30	4.22	0.69	Appropriate
ITEM 31	4.4	0.59	Appropriate
ITEM 32	4.41	0.5	Appropriate
ITEM 33	4.05	0.84	Appropriate
ITEM 34	4.36	0.66	Appropriate
TASK 2			
ITEM 35	4.41	0.59	Appropriate
ITEM 36	4.14	0.83	Appropriate
ITEM 37	4.27	0.63	Appropriate
ITEM 38	4.41	0.59	Appropriate
ITEM 39	4.36	0.58	Appropriate
ITEM 40	4.41	0.5	Appropriate
ITEM 41	4.36	0.49	Appropriate
ITEM 42	4.23	0.61	Appropriate
ITEM 43	4.18	0.73	Appropriate
ITEM 44	4.36	0.58	Appropriate
ITEM 45	3.91	0.92	Appropriate
ITEM 46	4.18	0.66	Appropriate
ITEM 47	4.09	0.68	Appropriate
ITEM 48	4.36	0.58	Appropriate
ITEM 49	4.05	0.72	Appropriate
ITEM 50	4.18	0.66	Appropriate
ITEM 51	4.22	0.69	Appropriate
ITEM 52	4.09	0.81	Appropriate
ITEM 53	4.18	0.59	Appropriate
ITEM 54	4.45	0.51	Appropriate
ITEM 55	4.41	0.5	Appropriate
ITEM 56	4.45	0.51	Appropriate
ITEM 57	4.5	0.51	Appropriate
ITEM 58	4.55	0.59	Appropriate
ITEM 59	4.32	0.65	Appropriate
ITEM 60	4.41	0.59	Appropriate
TASK 3			

ITEM 61	4.41	0.59	Appropriate
ITEM 62	4.5	0.51	Appropriate
ITEM 63	4.45	0.51	Appropriate
ITEM 64	4.55	0.59	Appropriate
ITEM 65	4.32	0.65	Appropriate
ITEM 66	4.55	0.59	Appropriate
ITEM 67	4.27	0.63	Appropriate
ITEM 68	4.41	0.59	Appropriate
ITEM 69	4.32	0.65	Appropriate
ITEM 70	4.27	0.7	Appropriate
ITEM 71	4.27	0.63	Appropriate
ITEM 72	4.36	0.58	Appropriate
ITEM 73	4.45	0.51	Appropriate
ITEM 74	4.41	0.5	Appropriate
ITEM 75	4.45	0.51	Appropriate
ITEM 76	4.23	0.75	Appropriate
ITEM 77	4.36	0.58	Appropriate
ITEM 78	4.09	0.75	Appropriate
ITEM 79	4.36	0.58	Appropriate
ITEM 80	4.05	0.79	Appropriate
ITEM 81	4.45	0.51	Appropriate
ITEM 82	4.5	0.51	Appropriate
ITEM 83	3.77	1.11	Appropriate
ITEM 84	4.27	0.63	Appropriate
ITEM 85	4.45	0.51	Appropriate
ITEM 86	4.41	0.5	Appropriate
ITEM 87	4.45	0.51	Appropriate
ITEM 88	4.36	0.58	Appropriate
ITEM 89	4.45	0.51	Appropriate
ITEM 90	4.5	0.51	Appropriate
ITEM 91	4.45	0.51	Appropriate
ITEM 92	4.55	0.59	Appropriate
ITEM 93	4.18	0.73	Appropriate
ITEM 94	4.45	0.6	Appropriate
TASK 4			
ITEM 95	4.45	0.6	Appropriate
ITEM 96	4.41	0.5	Appropriate
ITEM 97	4.23	0.75	Appropriate
ITEM 98	4.27	0.7	Appropriate
ITEM 99	4.45	0.51	Appropriate
ITEM 100	4.31	0.65	Appropriate
ITEM 101	4.45	0.51	Appropriate
ITEM 102	4.27	0.7	Appropriate
ITEM 103	4.36	0.66	Appropriate
ITEM 104	4.41	0.5	Appropriate
ITEM 105	4.55	0.59	Appropriate
ITEM 106	4.14	0.83	Appropriate
ITEM 107	4.36	0.58	Appropriate
ITEM 108	4.6	0.5	Appropriate
ITEM 109	4.45	0.51	Appropriate
ITEM 110	4.5	0.51	Appropriate
ITEM 111	4.41	0.5	Appropriate
ITEM 112	4.5	0.51	Appropriate
ITEM 113	4.55	0.59	Appropriate
ITEM 114	4.45	0.51	Appropriate
ITEM 115	4.27	0.7	Appropriate
ITEM 116	4.5	0.51	Appropriate
TASK 5			
ITEM 117	4.55	0.59	Appropriate
ITEM 118	4.41	0.5	Appropriate
ITEM 119	4.27	0.7	Appropriate
ITEM 120	4.32	0.57	Appropriate
ITEM 121	4.45	0.51	Appropriate

ITEM 122	4.32	0.57	Appropriate
ITEM 123	4.5	0.51	Appropriate
ITEM 124	2.72*	1.24	Inappropriate*
ITEM 125	4.45	0.51	Appropriate
ITEM 126	4.36	0.58	Appropriate
ITEM 127	4.55	0.59	Appropriate
ITEM 128	4.41	0.5	Appropriate
ITEM 129	4.55	0.51	Appropriate
ITEM 130	4.55	0.51	Appropriate
ITEM 131	4.41	0.5	Appropriate
ITEM 132	4.45	0.51	Appropriate
ITEM 133	4.5	0.51	Appropriate
ITEM 134	4.09	0.92	Appropriate
ITEM 135	4.41	0.59	Appropriate
TASK 6			
ITEM 136	4.5	0.51	Appropriate
ITEM 137	4.45	0.51	Appropriate
ITEM 138	4.36	0.58	Appropriate
ITEM 139	4.32	0.57	Appropriate
ITEM 140	4.45	0.51	Appropriate
ITEM 141	4.32	0.65	Appropriate
ITEM 142	4.55	0.59	Appropriate
ITEM 143	4.27	0.7	Appropriate
ITEM 144	4.41	0.59	Appropriate
ITEM 145	4.32	0.65	Appropriate
ITEM 146	4.45	0.51	Appropriate
ITEM 147	4.18	0.73	Appropriate
ITEM 148	4.32	0.65	Appropriate
ITEM 149	4.41	0.59	Appropriate
ITEM 150	4.5	0.51	Appropriate
ITEM 151	4.32	0.57	Appropriate
ITEM 152	4.55	0.59	Appropriate
ITEM 153	4.41	0.5	Appropriate
ITEM 154	4.45	0.51	Appropriate
ITEM 155	4.5	0.51	Appropriate
ITEM 156	4.36	0.58	Appropriate
ITEM 157	4.41	0.59	Appropriate
TASK 7			
ITEM 158	4.45	0.51	Appropriate
ITEM 159	3.91	0.97	Appropriate
ITEM 160	4.36	0.58	Appropriate
ITEM 161	4.18	0.73	Appropriate
ITEM 162	4.36	0.58	Appropriate
ITEM 163	4.32	0.57	Appropriate
ITEM 164	4.41	0.59	Appropriate
ITEM 165	4.23	0.69	Appropriate

ITEM 166	3.91	1.02	Appropriate	ITEM 176	4.36	0.49	Appropriate
ITEM 167	4.23	0.69	Appropriate	ITEM 177	4.36	0.58	Appropriate
ITEM 168	3.95	0.9	Appropriate	ITEM 178	4.41	0.5	Appropriate
ITEM 169	4.27	0.55	Appropriate	ITEM 179	4.45	0.51	Appropriate
ITEM 170	4.09	0.75	Appropriate	ITEM 180	4.45	0.51	Appropriate
ITEM 171	4.14	0.64	Appropriate	ITEM 181	2.64	1.26	Inappropriate *
ITEM 172	4.45	0.51	Appropriate	ITEM 182	4.45	0.51	Appropriate
ITEM 173	4.27	0.63	Appropriate	ITEM 183	4.27	0.63	Appropriate
ITEM 174	4.36	0.58	Appropriate	ITEM 184	4.36	0.58	Appropriate
ITEM 175	4.45	0.51	Appropriate				

The result on table 1 showed that 182 process skill items had factor loading of 0.40 and above while 2 test items had factor loading below 0.40. this implies that majority of the respondents used in the study considered the 182 test items as being appropriate for maintenance of suspension systems in motor vehicles. Hence, they were selected while 2 test items had factor loading less than 0.40 and were discarded as not being appropriate for inclusion in the instrument.

Research Question 2: What is the validity of the developed workshop-based process skill instrument on suspension system in motor vehicles?

Table 2: Table of specification

		Padelford Psychomotor Domain level						
	Tasks on suspension system	**Perceiving**	**Motivating**	**Imitating**	**Performing**	**Adapting**	**Innovating**	**Total**
1	Replacing of a damaged telescopic damper (shock absorber)	1	2	5	24	2	-	34
2	Replacing of a broken leaf spring	1	2	5	17	1	-	26
3	Servicing of a front telescopic damper (shock absorber)	1	2	7	22	2	-	34
4	Fixing of a new coil spring	1	2	5	12	2	-	22
5	Fixing of a new stabilizer	1	2	5	9	1	-	18

6	Replacing of damaged front lower control arm	2	2	9	8	1	-	22
7	Replacing of damaged rear lower control arm	1	2	10	12	1	-	26
		8	14	46	104	10	-	182

Padelford (1984) model on psychomotor was used. The dimensions include perceiving, motivating, imitating, performing, adapting and innovating. The seven tasks in suspension system have the following: Eight items are on perceiving, 14 items on motivating, 46 items on imitating, 104 items on performing, 10 items on adapting while there was no item on innovating, making a total of 182 items. Before arriving at the above, the draft test items were submitted to the experts in industrial technical education, and educational foundation of Nigerian universities who reviewed the draft copies of the instrument to ascertain the appropriateness of the items, carried out the face and content validity of the psychomotor domain based on Padelford's model. The experts also helped in rewording, restructuring of the items and made useful comments that helped in establishing the validity of the instrument.

Research Question 3: What is the reliability of the workshop-based process skill assessment instrument on automotive braking system at NTC level?

Summary of Gronbach alpha reliability indices of the developed workshop-based process skill/ assessment instrument

Table 3: Summary of Cronbach alpha Reliability indices of the developed workshop-based process skill assessment instrument

	Task	Cronbach alpha	No. of item
1	Replacing of damaged telescopic damper (shock absorber)	0.822	34
2	Replacing of broken leaf spring	0.868	26
3	Servicing of front telescopic damper	0.715	34
4	Fixing of a new coil spring	0.739	22
5	Fixing of a new stabilizer	0.894	16
6	Replacing of a damaged front lower control arm	0.967	22
7	Replacing of a damaged rear lower control arm	0.904	26
		0.880	**182**

The data for reliability of the developed workshop-based process skill assessment instrument are given in table 3 above. The analysis in table 3 revealed that each of the 7 tasks areas in suspension systems had high reliability coefficient ranging from 0.715 to 0.967. The level of reliability as indicated in the above table is in line with the recommendation of Uzoagulu (2011) who pointed out that the acceptable reliability of instrument used in education is within the range of 0.50 – 0.95. Thus, the items in the WBPSAI were reliable and are appropriate for assessing student's competency in the maintenance of suspension systems at NTC level.

Research Question 4: What is the ability level of students in the maintenance of suspension systems at NTC level based on the developed workshop-based process skill assessment instrument?

Table 4: Ability level of students in the maintenance of suspension systems at NTC based on the developed workshop-based process skill assessment instrument

SN	Ability Level	N	S	SD
1	High	8	73.00	3.55
2	Average	19	59.05	5.71
3	Low	9	46.11	1.45
	Total	**36**	**58.92**	**10.36**

The data on Table 4 above shows ability levels of students on process skill test items. The Table reveals that 8 out of the 36 students representing 22.2% of the students fell under the high ability; 19 students, or 52. 78% of the students fell under the average ability group, while 9 students representing 25% of the students fell under the low ability group.

Ho1: There is no significant difference in the mean rating of students on the workshop-based process skill assessment instrument in automotive braking system.

Table 5: Summary of analysis of variance of the mean performance of students on the workshop-based process skill assessment instrument on maintenance of suspension systems based on their ability levels**.**

	Sum of square	df	Mean of square	F	Sig.	Decision
Between groups	3062.91	2	1531.46	73.05	0.00	S
Within Groups	691.84	33	20.97			
Total	3754.75	35				

Table 5 shows the result of the analysis of variance, conducted to test for significant difference in the mean performance of high, average, and low ability students on the workshop based process skill assessment instrument. The result indicates significant difference in the mean performance of students involved in the study.

Discussion of the Findings

The findings of research question one revealed that out of the 184 process skill items, 182 were considered appropriate for inclusion in the developed WBPSAI. This implies that motor vehicle mechanics work teachers and Technologists in technical colleges considered the 182 process skill items appropriate for use in assessing students' performance in the maintenance of suspension systems. The findings is consistent with Okwelle (2011), who used process skill items considered by respondents as appropriate for assessing students' performance in practical tasks to develop an assessment instrument for assessing practical skills in Radio and Television systems.

On the validity of the instrument, the result of the study indicated that, the developed WBPSAI possesses high content validity. This is as indicated in the balanced spread of the process skill items in the table of specification constructed by the researcher, based on the six levels of Padelford (1984) model on psychomotor domain and as ascertained by a team of experts from the Department of Industrial Technical education university of Nigeria, Nsukka. The present study satisfied the condition stated by Khan (2007) that for a test to have content validity, a table of specification that satisfies the conditions of covering both the content areas and various levels of educational objectives be prepared.

Also, the agreement of teachers and workshop technologists in motor vehicle mechanics' work from technical colleges on the processes of performing each of the tasks confirmed the validity of the developed instrument. This is in line with the view of Okoro (2012) that content validity of psychomotor domain could be ascertained by submitting the list of drawn up test items to experts to obtain degree of conscientious agreement on the importance of the items for inclusion in assessment instrument. The result is also in agreement with the view of Okwelle (2011) that the fairer the degree of distribution of test items, the better the representation of the behavioral domain and the higher the content validity of the test instrument.

The developed WBPSAI is highly reliable. This is because each of the tasks has a reliability coefficient ranging from 0.715 to 0.967 This consideration is in agreement with the recommendation of Uzoagbu (2011) who stated that acceptable reliability of instrument used in education is within the range of 0.50 – 0.95.

From the analysis of data relating to the null hypothesis, it was revealed that there was significant main effect for ability levels, (P = 73.05, P= 0.00. Thus, the obtained p-value is greater than the stipulated p-value of 0.05. Therefore, there is significant difference in the mean performance of technical college students in motor vehicle mechanics work in the maintenance of suspension systems. Using Scheffe's post hoc comparison of the mean scores of the three groups, it was revealed that the mean difference between high ability group and average ability group was in favour of high ability group. It is also revealed that the performance of average ability group was better than the performance of the low ability group. Similarly, the performance of high ability group was by far better than the performance of low ability group. This finding is in agreement with the view of Adeyemo (2010) which stated that students are qualitatively difference in their ability level.

Conclusion

Assessment of practical skills in Technical colleges has become a major area of concern among educational stakeholders over the past two decades. This is because the products from technical colleges are lacking employable skills in their trade areas. This is as reflected in having a huge number of unemployed youth including youths from technical colleges. Lack of valid and reliable instruments for assessing students' practical skills by teachers in technical colleges and NABTEB has been identified. However, data obtained from this study reveal that, the developed WBPSAI is valid and reliable, thus could be used in assessing students' practical skills in maintenance of suspension system in motor vehicles at NTC level.

Recommendations

1. Akwa Ibom State Government should encourage technical college teachers in Motor vehicle mechanics work and other trade areas to adopt WBPSAI in assessing students' practical skills
2. National Business and Technical Examination Board (NABTEB) and other examination bodies should consider the use of WBPSAI for assessing students' practical skills in suspension systems and other practical areas.
3. Government should consider practical work assessment allowance for technical college teachers in view of the fact that WBPSAI is more a more detail assessment programme
4. National Business and Technical Examination Board NABTEB should organize seminars and conferences for capacity building on the development of WBPSAI for assessing students in tasks performance

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PROCESS SKILLS IN THE MAINTENANCE OF SUSPENSION SYSTEMS

SKILLS ON SUSPENSION SYSTEM

Task 1: Replacing of telescopic damper (shock absorber)

Procedural steps/skill items

1 Wearing appropriate safety wear
2 Wedging the vehicle
3 Selecting appropriate tools before commencement of task
4 Slacking the wheel nuts
5 Positioning the jack appropriately and jacking up the vehicle
6 Supporting the vehicle with axle stand
7 Removing the wheel nuts/bolt and tyre
8 Loosening telescopic damper from the knuckle
9 Loosening telescopic damper pad from vehicle frame or upper control arm (UCA)
10 Pulling out telescopic damper from its seating
11 Securing the telescopic damper in a bench vice or other suitable device
12 Slacking telescopic damper nut
13 Compressing the spring
14 Loosening telescopic damper clip
15 Removing telescopic damper nut
16 Removing coiling spring
17 Pulling out dust cover
18 Pulling out lower insulator
19 Fixing new telescopic damper
20 Fixing lower insulator
21 Fixing dust cover
22 Fixing coil spring
23 Fixing telescopic damper pad
24 Tightening telescopic damper nut
25 Releasing the clamp
26 Fixing in the suspension unit to vehicle frame/upper control arm (UCA)
27 Tightening telescopic damper pad to the vehicle frame/ UCA
28 Tightening telescopic damper to the knuckle
29 Fixing the tire
30 Jacking up the vehicle to remove axle stand
31 Jacking down and remove jack
32 Tightening the wheel nuts/bolts
33 Cleaning tools after completion of task
34 Returning tools to their appropriate places

Task 2: Replacing of broken leaf spring/bushing

Procedural steps/skill items

35 Wearing appropriate safety wear
36 Wedging the vehicle
37 Selecting appropriate tools before commencement of task
38 Slacking the wheel nuts
39 Positioning the jack appropriately and jacking up the vehicle
40 Supporting the vehicle with axle stand
41 Removing wheel nuts/bolt and tyre
42 Loosening U-bolt from axle
43 Removing rubber packing
44 Removing shock bolt from the spring bracket
45 Removing shackle pins from the shackles
46 Removing center bolts from leaf springs
47 Removing rebound clips from the leaf springs
48 Replacing the broken leaf spring and assembling the entire springs
49 Fixing the center bolt to the springs
50 Fixing the rebound clips to the springs
51 Fixing leaf springs to the swinging shackles
52 Fixing U-bolt to the axle and springs
53 Fixing rubber parking to U-bolt
54 Tightening all the bolts on the leaf springs and to the chassis
55 Fixing the tyres
56 Jacking up the vehicle to remove axle stand
57 Jacking down and remove jack
58 Tightening the wheel nuts/bolts
59 Cleaning tools after completion of task
60 Returning tools to their appropriate places

Task 3: Servicing of front damper (shock absorber)

Procedural steps/skill items

61 Wearing appropriate safety wears
62 Wedging the vehicle
63 Slacking the wheel nuts/bolts
64 Positioning of jack and jacking up the vehicle
65 Supporting the vehicle with axle stand
66 Removing the wheel nuts/bolts and tyre
67 Removing the tie-rod end nut
68 Removing tie-rod end from knuckle
69 Removing suspension unit from knuckle
70 Removing suspension bolts and shock pad from the chassis
71 Removing the cone bushing
72 Removing the stabilizer linkage
73 Pulling out the shock absorber
74 Selecting appropriate shock kits (ring bushing, shock belt, shock valve, shock absorber oil)
75 Compressing the spring
76 Loosening the shock pad from the shock absorber
77 Removing the spring and galloping rubber
78 Removing the shock absorber lock nut from the casing
79 Pulling out the shock shaft, shaft casing, ring bushing and shock ring rubber

80 Washing the shock casing, shaft casing, shock shaft, shock cone, ring rubber, shock seal and shock absorber casing nut
81 Fixing shock shaft, and shock absorber kits into shock casing
82 Bleeding the shock absorber with shock absorber oil by pouring the shock absorber oil into the shock absorber casing and checking the level
83 Pressing the shock shaft to determine the amount of compression. If the compression is not adequate, add oil and repeat the exercise; until okay
84 Placing the coil spring to its seating
85 Releasing the spring and assemble the suspension unit
86 Fixing suspension unit to the upper chassis
87 Fixing the lower suspension unit to knuckle, stabilizer linkage
88 Fixing tie-rod end to the knuckle
89 Fixing the tyre
90 Jacking up the vehicle to remove axle stand
91 Jacking down the vehicle and removing jack
92 Tightening wheel nuts/bolts
93 Cleaning tools after completion of task
94 Returning tools to appropriate places

Task 4: Replacing of coil spring
Procedural steps/ skill items

95 Wearing appropriate safety wears
96 Wedging the vehicle
97 Selecting appropriate tools before commencement of task
98 Slacking the wheel nuts/bolts
99 Positioning jack appropriately and jacking up the vehicle
100 Supporting the vehicle with axle stand
101 Removing wheel nuts/bolts and tyre
102 Removing suspension unit nut from chassis or upper control arm
103 Removing suspension unit nut and bolt from knuckle / lower control arm (LCA)
104 Pulling out suspension unit (telescopic damper) from seating
105 Compressing the spring using appropriate device/method
106 Loosening pad nut on telescopic damper
107 Removing the spring from telescopic damper
108 Fixing new coil spring
109 Tightening telescopic damper nut to appropriate tension
110 Fixing suspension unit in its position
111 Fixing the tyre
112 Jacking up the vehicle and removing axle stand
113 Jacking down the vehicle and removing jack
114 Tightening the wheel nuts/bolts
115 Cleaning tools after completion of task
116 Returning tools to their appropriate places

Task 5: Replacing of Stabilizer
Procedural steps/skill items

117 Wearing appropriate safety wears
118 Wedging the vehicle
119 Selecting appropriate tools before commencement of task
120 Slacking the wheel nuts/bolts
121 Positioning jack appropriately and jacking up the vehicle
122 Supporting the vehicle with axle stand
123 Removing wheel nuts/bolts and tyre
124 Loosening linkages from damper
125 Removing stabilizer from linkage/lower control arm
126 Removing stabilizer bracket from chassis
127 Placing new stabilizer to its seating
128 Fixing stabilizer bracket to chassis
129 Fixing stabilizer to linkage/lower control arm/ suspension unit
130 Fixing the tyre
131 Jacking up the vehicle and removing axle stand
132 Jacking down the vehicle and removing jack
133 Tightening the wheel nuts/bolts
134 Cleaning tools after completion of task
135 Returning tools to their appropriate places

Task 6: Replacing of front Lower control arm
Procedural steps/skill items

136 Wearing appropriate safety wear
137 Wedging the vehicle
138 Selecting appropriate tools before commencement of task
139 Slacking wheel nuts/bolts
140 Positioning the jack appropriately and jacking up the vehicle
141 Supporting the vehicle with axle stand
142 Removing wheel nuts/bolts and trye
143 Removing tie rod end from knuckle
144 Removing knuckle from Lower control arm (LCA)
145 Removing stabilizer linkage from LCA
146 Removing LCA bolts from chassis /shock absorber (telescopic damper)
147 Assessing LCA bushes for possible wear
148 Connecting new lower control arm to the chassis
149 Connecting stabilizer linkage to LCA
150 Connecting ball joint/knuckle to lower control arm
151 Connecting tie rod end to the knuckle
152 Fixing the tyre
153 Jacking up the vehicle and removing axle stand
154 Jacking down the vehicle and removing jack
155 Tightening the wheel nuts/bolts
156 Cleaning tools after completion of task
157 Returning tools to their appropriate places

Task 7: Replacing of rear lower control arm

Procedural steps/skill items

158 Wearing appropriate safety wears
159 Parking the vehicle properly
160 Wedging the vehicle
161 Selecting appropriate tools before commencement of task
162 Slacking the wheel nuts/bolts
163 Positioning jack appropriately and jacking up the vehicle
164 Positioning the axle stand
165 Removing wheel nuts/bolts and tyres
166 Disconnecting hand brake cable from wheel drum
167 Removing brake shoes
168 Pulling out hand brake cable
169 Loosening brake pipe from brake pot
170 Loosening fluid absorber
171 Loosening and removing the lower control arm
172 Fixing a new lower control arm
173 Fixing fluid absorber
174 Fixing brake pipe to brake pot
175 Fixing hand brake cable
176 Fixing brake shoe
177 Connecting brake shoe to wheel drum
178 Fixing the two back tyres
179 Jacking up the vehicle and removing axle stands
180 Jacking down the vehicle
181 Removing the jack
182 Tightening the wheel nuts/bolts
183 Cleaning tools after completion of task
184 Returning tools to their appropriate places