



Enhancing Welding and Fabrication in North Eastern Nigeria: Implementing Workshop-Based Process Skill in Machine Shop Practice

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ABSTRACT

The study was carried out to develop and validate a workshop-based process skill test in welding and fabrication for improving students' skills in Colleges of Education in Northeast Nigeria. The study was guided by four research purposes, research questions, and a null hypothesis. The study was conducted in Northeast Nigeria with a major focus on colleges of education and adopted an instrumentation research design. The study involved 85 respondents. This comprised 30 metalwork lecturers and 55 NCE III students for the 2022/2023 academic sessions in all six colleges of education in the North East. All 30 metalwork lecturers across all six colleges of education in northeast Nigeria were used for this study. For the try-out, simple random sampling was employed to select three colleges of education that offer metalwork. The instrument for data collection was a structured questionnaire titled "Psychomotor Skills Needs of Welding and Fabrication Students / (PSNEWFS)". The questionnaire was divided into two sections, A and B, with 148 items. The reliability of the instrument was determined by trial-testing the instrument (PSNEWFS) on metalwork (welding and fabrication), and the data collected was tested using Cronbach's Alpha. A reliability coefficient of 0.096 was obtained. Data collected from the study was analyzed using SPSS, mean, standard deviation, factor analysis at 10% overlapping variance, Cronbach's alpha, and Fleiss KAPPA inter-rater reliability. The study revealed that (PSNEWFS) will facilitate the enhancement of teaching and learning processes related to welding and fabrication in colleges of education. These findings underscore the instrument's efficacy in precisely measuring the nuanced process skills of students in the context of welding and fabrication workshops. The study recommends continuous refinement of the assessment instrument, considering the dynamic nature of technological advancements in welding and fabrication.

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INTRODUCTION

Metalworks technology as a critical component of vocational education holds significant importance within Colleges of Education. The Metalworks technology program

equips students with practical skills and theoretical knowledge, fostering a comprehensive understanding of metallurgy, fabrication techniques, and design principles (Jumper, 2023). Metalwork Technology not only prepares students

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for careers in various metal-related industries but also promotes problem-solving skills and critical thinking by engaging learners in hands-on experiences (Venatius & Ekwok, 2023). Metalwork courses in Colleges of Education have been shown to enhance students' creativity and innovation, providing a platform for them to explore novel applications of metals in manufacturing and construction through welding and fabrication.

Welding and fabrication processes are part of the skills courses offered in metalworks technology at the Nigeria Certificate in Education (NCE) Technical, to produce teachers who will be able to teach scientific and technological attitudes and values to students in the society. The objectives of NCE (T) are to produce qualified teachers motivated to start the much-desired revolution of technological development right from the Nigerian schools; and to prepare technical teachers to qualify them for a post-NCE degree program in technical education (Muhammad, 2023). These objectives will be achieved through vigorous machine shop practice.

Machine shop practice skills in welding and fabrication play a pivotal role in the curriculum of technical education programs in Colleges of Education in Nigeria. These skills are critical components of vocational and technical education, equipping students with the competencies needed for various industrial and construction-related careers. This discussion delves into the concept of machine shop practice skills in welding and fabrication and their significance in the context of Colleges of Education.

Machine shop practice skills in welding and fabrication encompass a range of competencies related to the joining of materials and the construction of metal structures. Welding, in particular, involves the fusion of metals through various techniques such as arc welding, gas welding, and electric welding. Fabrication, on the other hand, focuses on shaping and assembling metal components to create functional structures or products. These skills are crucial for producing items like gates, windows, metal furniture, and even industrial machinery. They are central to

numerous sectors, including manufacturing, construction, and infrastructure development (Gyasi et al 2014).

In Colleges of Education, the inclusion of machine shop practice skills in welding and fabrication aligns with the broader objectives of technical and vocational education. These programs aim to equip students with practical skills that enhance their employability and entrepreneurship potential. By offering courses in welding and fabrication, these institutions empower students to pursue careers as skilled artisans, technicians, or even entrepreneurs in metalwork-related ventures. Welding and fabrication skills are highly marketable in Nigeria's job market, making them a valuable addition to the curriculum (Venatius et al 2021).

According to Boekholt (2000), the significance of machine shop practice skills in welding and fabrication extends beyond job opportunities. These skills foster creativity, problem-solving abilities, and hands-on experience, promoting experiential learning in the Colleges of Education. Welding and fabrication workshops provide an environment where students can apply theoretical knowledge to real-world projects. This hands-on approach enhances their understanding of engineering principles, metallurgy, and safety protocols. Furthermore, it encourages critical thinking and innovation as students design and build their projects, bridging the gap between theory and practice.

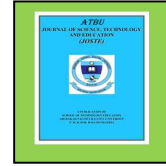
Within the Nigerian educational system, machine shop practice skills in welding and fabrication are essential for achieving the goals of the National Policy on Education (NPE). The NPE emphasizes the need to produce graduates who can contribute to national development, and technical and vocational education, including welding and fabrication, plays a vital role in achieving this objective. Graduates with these skills are well-prepared to contribute to the nation's industrialization efforts, infrastructure development, and economic growth. They can also engage in self-employment, addressing issues of unemployment and underemployment (Danson, 2021).

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Furthermore, machine shop practice skills in welding and fabrication support Nigeria's Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education), Goal 8 (Decent Work and Economic Growth), and Goal 9 (Industry, Innovation, and Infrastructure). Welding and fabrication skills promote quality education by offering practical, job-oriented training. They contribute to decent work and economic growth by providing opportunities for sustainable employment and entrepreneurship. Additionally, these skills align with Goal 9 by fostering innovation and supporting the development of industrial infrastructure in Nigeria.

The significance of acquiring machine shop practice skills is crucial, these competencies are vital in equipping students for professions in sectors that heavily depend on metalworking, such as automotive manufacturing, construction, and engineering (Wren 2008, UBANWA 2023). These skills include welding and fabrication, which are central to the production of metal-based products and structures.

1. **Relevance to Technical Education:** Machine shop practice skills align perfectly with the objectives of technical education in Nigeria. Technical education aims to equip students with practical skills and knowledge that are directly applicable to the world of work (Manubag 2023). Welding and fabrication, as components of machine shop practice, empower students with hands-on skills that are highly sought after by employers in various industries.
2. **Curriculum Integration:** The inclusion of machine shop practice skills in the curriculum of Colleges of Education is essential. According to Venatius and Ekwok (2023), integrating these skills into the curriculum ensures that students receive a well-rounded education that combines theoretical knowledge with practical application. The curriculum typically covers topics such as metal joining techniques, welding processes, and fabrication methods.
3. **Industrial Relevance:** Welding and fabrication are fundamental processes in the industrial sector Kumar et al (2023). Nigeria's

growing construction and manufacturing industries require a skilled workforce in these areas. Graduates from Colleges of Education who have received training in machine shop practice skills are well-prepared to contribute to these industries and support economic growth.

4. **Hands-On Learning:** Machine shop practice skills provide students with hands-on learning experiences. This practical approach enhances students' problem-solving abilities and critical thinking skills Subiyantoro et al (2023). It also fosters creativity as students work on real-world projects, encouraging them to explore innovative solutions.
5. **Challenges and Future Directions:** While machine shop practice skills are essential, there are challenges in implementing them effectively, such as the need for well-equipped workshops and qualified instructors (Nduononwi, et al 2024). However, with increased investment in technical education and collaboration between educational institutions and industries, Nigeria can overcome these challenges and continue to produce a skilled workforce capable of meeting the demands of the modern job market.

The concept of Machine Shop Practice Skills in welding and fabrication is a Fundamental aspect of technical education in Nigerian Colleges of Education. These skills are highly relevant to the industrial and manufacturing sectors, aligning with the objectives of technical education. Integrating machine shop practice skills into the curriculum provides students with hands-on learning experiences and equips them with practical knowledge for future careers and better academic performance assessed through processed skill instruments.

Assessment is a concept that occupies a position of importance in all fields of learning including Metal Work Technology. According to Gallardo (2020), assessment is the judgment, and consideration concerning the merits of a particular object or someone's performance. Assessment



with regard to educational achievement is the process whereby the quality of students' performance is judged. Ismail et al (2022), defined assessment as a diagnostic process that measures an individual's behavior, motivator, attitude, or other selected qualities. To be valuable to individuals and organizations, an assessment must be accurate and objective. In addition, it must meet scientific criteria, as well as provide meaningful insight. Assessment gives organizations more than just data and information. It opens doors to strategic change and helps to measure the progress of educational objectives. Assessment technique in Metalwork Technology is regarded as the most vital of all processes. Ahmed (2020), stated that teachers in the field of vocational and technical education use the result of the assessment process to monitor the progress of students, diagnose their needs, and make instructional plans. Ahmed, further stated that for instruction in Metalwork Technology to produce good results, there must be effective and factual assessment. There are several methods and techniques for assessing skills in Metalwork Technology. This is because instructional objective attainment in Metalwork Technology is multifaceted.

The teacher of Metalwork Technology assesses the student's total learning experiences in terms of the progress made in the cognitive, affective, and psychomotor domains by way of data collection. The collecting of data for educational assessment of learning objectives can be done through testing or non-testing techniques (Imasuen & Adeosun 2022). While testing technique deals with psychological tests that cover the cognitive or intellectual traits (e.g. achievement tests, intelligence tests, and aptitude tests), affective traits (interest scales, attitude tests, and personality tests), psychomotor and psycho-productive traits (tests of motor skills), the non-testing technique is therefore, concerned with the use of observation, inquiry, case study, autobiography and cumulative records to obtain relevant data on certain aspects of a person. This, therefore, means that no single assessment procedure can possibly provide data to appraise the extent of what has been taught and learned.

According to Adom et al (2020), a complete assessment method will include a variety of measuring devices selected based on their appropriateness in measuring specific area of student achievement. The type of knowledge and skills to be assessed can affect the choice of assessment method.

STATEMENT OF THE PROBLEM

The lack of standardized assessment tools tailored to the specific needs of welding and fabrication education in North Eastern Nigeria presents a significant challenge in ensuring the quality and relevance of vocational training. Currently, there is a notable absence of workshop-based process skill tests designed to evaluate students' proficiency in machine shop practice within colleges of education in this region. This gap hampers the effectiveness of skill development programs and impedes graduates' ability to meet industry demands, ultimately hindering economic growth and job creation. Therefore, there is an urgent need to address this issue by developing and implementing workshop-based process skill tests that accurately assess students' competencies in welding and fabrication within the context of machine shop practice, thereby enhancing the overall quality and relevance of vocational education in North Eastern Nigeria.

Purpose of the Study

The main purpose of the study was to develop and implement workshop-based process skills in machine shop practice. Specifically, the study sought to

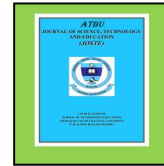
1. Determine the machine shop practice skills necessary for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria.
2. Determine the validity of the developed instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria.
3. Determine the reliability of the developed instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria.

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4. To determine the outcome of the instrument using the trial test.

Research Questions

The following research questions guided the study

1. What are the machine shop practice skills necessary for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria?
2. What is the validity of the developed instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria?
3. What is the reliability of the developed instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria?
4. What is the outcome of Trial tested instrument?

METHODOLOGY

The study employed an instrumentation research design, chosen to create a novel tool for assessing psychomotor skills in metalwork students. The study was conducted in Northeast Nigeria and involved a population of 85 individuals, including 30 metalwork lecturers and 55 NCE III metalwork students from six Colleges of Education in the Northeast. The sample includes all 30 metalwork lecturers, while purposive sampling is used to select the Federal College of Education (Technical) Potiskum, Yobe State for the try-out phase based on specific criteria related to the availability of electrical power, functional workshops, and moderate student populations.

The instrument for data collection was a structured questionnaire developed by the researchers titled: "Psychomotor Skills Needs of Welding and Fabrication Students in Machine shop Practice (PSNWFSMP) extracted from the course syllabus for Metalworks Technology in machine shop practice. A modified five-point Likert scale was used to determine the skills needed using the response options of Highly Appropriate (HA) =5, Appropriate (A) =4, Moderately

Appropriate (MA) =3, Slightly Appropriate (SA) =2 and Not Appropriate (NA) =1.

The instrument was subjected to face and content validation by three experts from the Department of Technology Education, Modibbo Adama University, Yola, Adamawa State, Nigeria. The instrument reliability was obtained through the trial test on 3 metalwork lecturers in the Federal College of Education Bichi, Kano State, and a 0.89 reliability coefficient was obtained using Cronbach's Alpha. The reliability index indicated that the instrument was suitable and reliable for data collection. Research question 1 was answered using the mean and standard deviation of the metalwork lecturers to select the machine shop practice skills necessary for inclusion into the workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria. A mean cut-off of 3.00 was chosen. Therefore, any skill with a mean score of 3.00 or above was considered appropriate for inclusion in the Machine Shop Psychomotor Skills Assessment Instrument (MSPSAI), while skills with a mean score below 3.00 were considered inappropriate.

Research question 2 was subjected to factor analysis using 0.30 as a loading factor at 10% overlapping variance. Summarily, any task with factor loading of 0.30 and above was considered valid while any item with factor loading less than 0.30 was considered invalid. For research question 3, Cronbach's Alpha was used to determine the internal consistency; while for research question 4 data generated from the try-out of MSPSAI was analyzed using Fleiss KAPPA inter-rater reliability. The development of the assessment instrument follows a multi-stage approach, adapted from Akpan et al. (2019), including the identification of psychomotor contents and tasks, item writing, and validation by experts.

RESULTS

Research Question 1: What are the machine shop practice skills necessary for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria?

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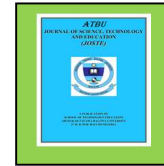


Table 1: Mean Response of Respondents on the Machine Shop Practice Skills Necessary for Assessing Workshop-Based Process Skills in Welding and Fabrication

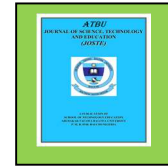
S/No	Items	\bar{x}	SD	Remark
TASK 1: General safety				
1.	Thorough pre-operation inspection of equipment and machinery to ensure they are in good working condition.	4.20	1.52	Necessary
2.	Check for any visible damage, loose parts, or leaks.	3.97	1.47	Necessary
3.	Ensure that all personnel involved in the operation are wearing appropriate PPE, such as helmets, safety glasses, gloves, and steel-toed boots.	4.00	1.64	Necessary
4.	Ensure that all personnel involved in the operation are wearing appropriate PPE, such as helmets, safety glasses, gloves, and steel-toed boots.	4.63	0.67	Necessary
5.	Review and communicate emergency procedures with all team members	4.30	1.39	Necessary
6.	Identify emergency exits, assembly points, and emergency contact information.	3.73	1.53	Necessary
7.	Implement proper lockout/tagout procedures to isolate energy sources before performing maintenance or repair work on equipment.	3.73	1.70	Necessary
8.	Ensure that all personnel involved in the operation are adequately trained and competent in their assigned tasks.	3.50	1.87	Necessary
9.	Train personnel on proper lifting techniques to prevent injuries	3.60	1.50	Necessary
10.	Use lifting equipment (such as cranes or forklifts) safely and in accordance with guidelines	3.73	1.44	Necessary
11.	Follow proper procedures for handling and storing chemicals.	3.87	1.41	Necessary
12.	Use appropriate ventilation and personal protective equipment when working with hazardous substances	3.60	1.73	Necessary
13.	Identify fire hazards in the work area and have fire extinguishers readily available.	3.67	1.86	Necessary
14.	Conduct regular fire drills and ensure everyone knows the location of fire exits.	3.77	1.17	Necessary
15.	Ensure that machinery is equipped with proper guards to prevent accidental contact with moving parts.	3.57	1.07	Necessary
16.	Do not bypass or remove safety guards.	3.70	1.42	Necessary
17.	Use fall protection equipment, such as harnesses and guardrails, when working at heights	4.20	0.85	Necessary
18.	Inspect and maintain fall protection gear regularly	4.00	1.14	Necessary
19.	Inspect electrical equipment for damaged cords or connections	3.73	1.48	Necessary
20.	Follow proper procedures for working with electricity, including de-energizing equipment before maintenance.	3.60	1.43	Necessary
TASK 2: General Workshop Practice Process Skill				
21.	Secure the work piece in the milling machine.	3.97	1.35	Necessary
22.	Install the appropriate cutting tool for Operation	4.13	1.33	Necessary
23.	Set up the machine parameters such as speed, feed rate, and depth of cut.	3.60	1.81	Necessary

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S/No	Items	\bar{x}	SD	Remark
24.	Face the workpiece to ensure a flat and smooth surface.	3.93	1.57	Necessary
25.	Check dimensions to meet required specifications	3.77	1.48	Necessary
26.	Drill holes at specified locations and depths.	4.33	0.96	Necessary
27.	Use peck drilling to clear chips and prevent tool breakage.	4.23	1.52	Necessary
28.	Perform milling operations as per the detailed design.	4.33	1.45	Necessary
29.	Ensure precise dimensions and surface finish.	3.57	1.81	Necessary
30.	Use a reamer to achieve accurate hole dimensions.	3.60	1.90	Necessary
31.	Check for proper alignment and concentricity.	4.03	1.71	Necessary
32.	Tap threaded holes as required.	4.30	1.51	Necessary
33.	Use appropriate lubrication to enhance tool life.	4.40	1.38	Necessary
34.	Add chamfers to the edges or holes for safety and aesthetics.	3.93	1.80	Necessary
35.	Inspect for uniform chamfer dimensions.	4.17	1.53	Necessary
36.	Verify dimensions using measuring instruments.	4.07	0.83	Necessary
37.	Ensure all features meet design specifications.	3.70	0.88	Necessary
38.	Remove any sharp edges or burrs.	4.07	0.83	Necessary
39.	Clean the work piece to remove cutting fluids and debris.	3.70	0.88	Necessary
40.	Ensure the final product is free from contaminants.	4.10	1.32	Necessary
41.	Perform a final inspection to confirm all requirements are met.	3.73	1.70	Necessary
42.	Check for any defects or deviations.	4.00	1.02	Necessary
43.	Pack the finished components securely for transport.	4.53	1.07	Necessary
44.	Include necessary documentation	4.13	1.43	Necessary
	Grand Mean	3.94	1.40	Necessary

Table 1 showed the machine shop practice skills necessary for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria. The respondents indicated that 44 task items grouped in 2 clusters: General Safety (Task 1) and General Workshop Practice Process Skill (Task 2) were considered necessary as the mean values ranged between 3.50 and 4.20 which were above the criterion mark of 3.00. The standard deviation also ranged between 0.67 and 1.81 respectively. This showed that the responses were clustered together and there was homogeneity in the responses. With a grand mean of 3.94, this result showed that only 44 task items among which were

pre-operation inspection, use of personal protective equipment, adherence to safety procedures, securing workpieces, milling operations, dimensional accuracy, and final inspection were considered necessary for inclusion into the assessment instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria.

Research Question 2: What is the validity of the developed instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria?

Table 2: Factor Analysis on Validity of the Developed Instrument for Assessing Workshop-Based Process Skills in Welding and Fabrication

S/No	Items	Factor Loading	Remark
Machine Shop Practice Skills			
TASK 1: General safety			
1.	Thorough pre-operation inspection of equipment and machinery to ensure they are in good working condition.	0.995	Valid

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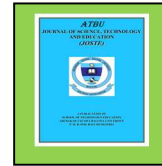
S/No	Items	Factor Loading	Remark
2.	Check for any visible damage, loose parts, or leaks.	0.996	Valid
3.	Ensure that all personnel involved in the operation are wearing appropriate PPE, such as helmets, safety glasses, gloves, and steel-toed boots.	0.956	Valid
4.	Ensure that all personnel involved in the operation are wearing appropriate PPE, such as helmets, safety glasses, gloves, and steel-toed boots.	0.980	Valid
5.	Review and communicate emergency procedures with all team members	0.983	Valid
6.	Identify emergency exits, assembly points, and emergency contact information.	0.979	Valid
7.	Implement proper lockout/tagout procedures to isolate energy sources before performing maintenance or repair work on equipment.	0.981	Valid
8.	Ensure that all personnel involved in the operation are adequately trained and competent in their assigned tasks.	0.993	Valid
9.	Train personnel on proper lifting techniques to prevent injuries	0.982	Valid
10.	Use lifting equipment (such as cranes or forklifts) safely and in accordance with guidelines	0.986	Valid
11.	Follow proper procedures for handling and storing chemicals.	0.982	Valid
12.	Use appropriate ventilation and personal protective equipment when working with hazardous substances	0.974	Valid
13.	Identify fire hazards in the work area and have fire extinguishers readily available.	0.992	Valid
14.	Conduct regular fire drills and ensure everyone knows the location of fire exits.	0.959	Valid
15.	Ensure that machinery is equipped with proper guards to prevent accidental contact with moving parts.	0.979	Valid
16.	Do not bypass or remove safety guards.	0.962	Valid
17.	Use fall protection equipment, such as harnesses and guardrails, when working at heights	0.987	Valid
18.	Inspect and maintain fall protection gear regularly	0.989	Valid
19.	Inspect electrical equipment for damaged cords or connections	0.963	Valid
20.	Follow proper procedures for working with electricity, including de-energizing equipment before maintenance.	0.985	Valid
TASK 2: General workshop practice process skill			
21.	Secure the work piece in the milling machine.	0.984	Valid
22.	Install the appropriate cutting tool for Operation	0.964	Valid
23.	Set up the machine parameters such as speed, feed rate, and depth of cut.	0.995	Valid
24.	Face the workpiece to ensure a flat and smooth surface.	0.986	Valid
25.	Check dimensions to meet required specifications	0.974	Valid
26.	Drill holes at specified locations and depths.	0.991	Valid
27.	Use peck drilling to clear chips and prevent tool breakage.	0.974	Valid
28.	Perform milling operations as per the detailed design.	0.992	Valid
29.	Ensure precise dimensions and surface finish.	0.989	Valid

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S/No	Items	Factor Loading	Remark
30.	Use a reamer to achieve accurate hole dimensions.	0.988	Valid
31.	Check for proper alignment and concentricity.	0.987	Valid
32.	Tap threaded holes as required.	0.998	Valid
33.	Use appropriate lubrication to enhance tool life.	0.997	Valid
34.	Add chamfers to the edges or holes for safety and aesthetics.	0.988	Valid
35.	Inspect for uniform chamfer dimensions.	0.999	Valid
36.	Verify dimensions using measuring instruments.	0.994	Valid
37.	Ensure all features meet design specifications.	0.993	Valid
38.	Remove any sharp edges or burrs.	0.994	Valid
39.	Clean the work piece to remove cutting fluids and debris.	0.993	Valid
40.	Ensure the final product is free from contaminants.	0.936	Valid
41.	Perform a final inspection to confirm all requirements are met.	0.999	Valid
42.	Check for any defects or deviations.	0.973	Valid
43.	Pack the finished components securely for transport.	0.987	Valid
44.	Include necessary documentation	0.994	Valid

Table 2 shows the construct validity of the developed instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria. The table consists of various tasks related to machine shop practice skills. 44 task items considered necessary were subjected to validation and the result showed that all of the task items were valid. The Psychomotor skills identified in the assessment instrument indicated that the task items had their factor loading ranging from 0.936 to 0.999 and were all greater than the factor loading of 0.30 at 10% overlapping variance with two component matrix indicating that the

developed instrument is a valid for assessing the specified process skills in welding and fabrication. The instrument validity of 0.984 confirmed individual items within each task, indicating the robustness of the instrument for evaluating diverse aspects of workshop-based skills in the context of welding and fabrication in the specified educational setting.

Research Question 3: What is the reliability of the developed instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria?

Table 3: Cronbach's Alpha Reliability Index on the Developed Instrument for Assessing Workshop-Based Process Skills in Welding and Fabrication

S/N	Items	No. of Items	Cronbach's Alpha Index	Remark
Machine Shop Practice Skills				
1.	Task 1: General safety	20	0.99	Reliable
2.	Task 2: General workshop practice process skill	24	0.99	Reliable
Developed Instrument Reliability		44	0.99	Reliable

The developed instrument was subjected to a reliability test and Cronbach alpha was used to determine the reliability confidence of the items. The results indicated that 44 psychomotor task skills grouped in two (2) clusters the Machine Shop Practice, were reliable with a

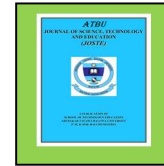
reliability index of 0.99 each after the try-out. The instrument reliability of 0.99 indicates that the instrument for assessing workshop-based process skills was reliable.

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Research Question 4: What is the outcome of Trial tested instrument?

Table 4: Fleiss Multi-rater Reliability of the Developed Instrument for Assessing Workshop-Based Process Skills in Welding and Fabrication

S/N	Items	No. of Items	No. of Raters	Kappa - Indices	Indices Significant	Remark
Machine Shop Practice Skills						
1.	Task 1: General safety	20	6	0.902	0.000	Reliable
2.	Task 2: General workshop practice process skill	24	6	0.715	0.000	Reliable
Developed Instrument Reliability		44	6	0.809	0.000	Reliable

Table 4, shows the Fleiss Multi-rater Kappa or inter-rater reliability of the assessment instrument. On the whole, there are 2 clusters of psychomotor skills with corresponding 44 task items spread across the Machine Shop Practice module with paired inter-rater indices ranging between 0.715 and 0.902 which indicates a very high agreement between the raters. The result further revealed the significant values (p-value) of the raters rating the psychomotor skills in workshop-based process skills having 0.000 each respectively. These values are less than the 0.05 level of significance, thus indicating that raters' ratings of the developed instrument for assessing workshop-based process skills of students statistically significant and highly reliable with 0.866 reliability index.

FINDINGS OF THE STUDY

Based on the results presented, the following are the major findings of the study:

1. 44 task items among which are pre-operation inspection, use of personal protective equipment, adherence to safety procedures, securing workpieces, milling operations, dimensional accuracy, and final inspection were considered necessary for inclusion into the assessment instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria.
2. The developed instrument was a valid for assessing the specified process skills in

- welding and fabrication with validity index of 0.984
3. The developed instrument was reliable for assessing workshop-based process skills with 0.99 reliability coefficient
4. The raters' ratings of the developed instrument for assessing workshop-based process skills of students statistically are significant and highly reliable with 0.809 reliability index and significant value of 0.000.

DISCUSSION OF FINDINGS

The findings of the study with regard to research question one revealed that 44 task items among which are pre-operation inspection, use of personal protective equipment, adherence to safety procedures, securing workpieces, milling operations, dimensional accuracy, and final inspection were considered necessary for inclusion into the assessment instrument for assessing workshop-based process skills in welding and fabrication in Colleges of Education in Northeast Nigeria. The findings is in agreement with Ibrahim (2023) who developed an instrument for evaluating the performance of teachers in Science and Technical Colleges in northeastern states of Nigeria. Shanga (2021), reported that 50 items were found appropriate and required for evaluating performance in electrical installation and maintenance works. In the same vein, Okoye (2023) who developed and validated an instrument for assessing practical skills in Nigerian technical colleges found out that 61 practical skills were appropriate for inclusion into the ESSAS.

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The findings revealed that the developed instrument was valid for assessing the specified process skills in welding and fabrication with a validity index of 0.983. The findings align with established principles of construct validity assessment articulated by Okoye (2023) reflecting a meticulous examination of the measurement tool's ability to accurately capture the targeted psychomotor skills. This alignment is underscored by the results, which resonate with the concept of content validity, demonstrating that the selected task items effectively encapsulate the breadth and depth of the intended construct definition. Furthermore, the instrument validity extends to the criterion-related validity concept, implying a robust correlation between the task items and the constructs they are designed to measure, akin to evaluating the measurement tool against a predefined criterion, as elucidated by Schneider (2024)

The findings of the study further revealed that the developed instrument was reliable for assessing workshop-based process skills with 0.99 reliability coefficient. The findings concord with Mbagi, et al. (2022) and Okoye and Auta (2020) who in their separate submissions reported that the instrument developed by their study was found reliable as it measured what was supposed to be measured. Furthermore, Moses et al (2017) who developed an instrument for assessing practical skills in domestic installation processes at the Technical College Level in Yobe State, Nigeria reported that the instrument was reliable with a reliability index of 0.89.

The findings of the study revealed that the raters' ratings of the developed instrument for assessing workshop-based process skills of students statistically are significant and highly reliable with a 0.866 reliability index and a significant value of 0.000. This finding is related to the findings of Abdullahi (2016) and Gishua (2015) where the Kendall coefficient of concordance and Pearson product-moment correlation respectively were used to determine the correlation coefficient between raters. After the inter-rater reliability procedures in their studies, it was found that the developed instrument possessed a high inter-rater reliability. Therefore, these findings have

minimized errors such as personal bias, halo effect, logical error, generosity error, and central tendency error mostly encountered in rating students' skills.

CONCLUSION

In conclusion, the implementation of workshop-based process skill testing in machine shop practice presents an important step toward enhancing welding and fabrication education in North Eastern Nigeria. By introducing robust assessment tools tailored to the region's vocational education context, colleges of education can better prepare students for the demands of the workforce, bridging the skills gap and fostering a skilled labor force. The validation of the assessments ensures its relevance and effectiveness in accurately evaluating students' practical abilities, thereby facilitating targeted interventions and curriculum enhancements. Ultimately, this initiative not only strengthens the quality of welding and fabrication but also contributes to the socio-economic development of the northeast by empowering individuals with industry-relevant skills essential for employment and entrepreneurship in the welding and fabrication sectors.

RECOMMENDATIONS

Based on the findings, the following recommendations were made:

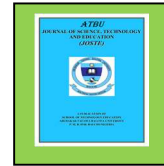
1. The NCCE should integrate the identified 44 task items into the curriculum of welding and fabrication programs across all Colleges of Education.
2. The Ministry of Education should establish a framework for continuous validation and improvement of the workshop-based process skill assessment instrument.
3. The colleges of Education should provide comprehensive training and capacity-building programs for instructors and assessors involved in administering the workshop-based process skill assessments.

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- The Colleges of Education administrators should foster partnerships between Colleges of Education and local welding and fabrication industries to create internship opportunities for students.

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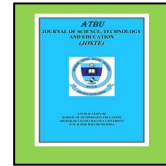
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