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Assessment of Work Skills Development Needs in Foundry Operations for Pre-Service Technicians within Colleges of Education in North-East Nigeria

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Abstract: *The study identified the work skills improvement needs of foundry work and operations for pre-service technicians in Colleges of Education in North-East Nigeria. A descriptive survey research design was adopted, guided by seven research questions and hypotheses. The sample comprised 93 respondents (33 metal work lecturers and 60 students) from a population of 135 across fully accredited Colleges of Education in Gombe, Yobe, Borno, Taraba, Adamawa, and Bauchi States. Data were collected using a validated structured questionnaire, with reliability established through test-retest and a Pearson correlation coefficient of 0.76. Mean and grand mean statistics were used for data analysis, with a decision rule based on a real mean threshold of 2.50. Findings revealed that NCE (Technical) metal work students required skills improvement in areas such as pattern making, mould making, core making, melting, casting, and finishing operations. It was recommended that metal work lecturers increase practical engagements, assign tasks, supervise foundry operations regularly, and provide additional support in challenging areas.*

Keywords: Works, Skills, Foundry Work, Foundry Operations, Pre-service, Technicians.

Introduction

Technical education plays an essential role in national development, especially in fostering economic growth and productivity through employment generation and business opportunities. Youth employment not only builds essential life skills in individuals but also strengthens communities and families (Mujumder & Khambayat, 2010). In Nigeria, technical education is defined as the aspect of education that provides practical and applied skills alongside basic scientific knowledge (Federal Republic of Nigeria [FRN], 2014). This type of education is designed to equip individuals with the competencies needed to work in industries, commerce, or other technical environments where machinery and tools are utilized (Oni, 2007). To achieve the goals of technical education, it is essential for technicians to acquire training from competent teachers who can prepare them to perform effectively in the workforce and achieve self-reliance. Colleges of

Education (Technical) in Nigeria are among the institutions offering technical education, with specializations such as metal works technology. This program prepares students to become proficient in areas such as metalwork construction, the use of hand and machine tools, welding, fabrication, and foundry operations. Foundry work, one of the oldest industrial practices, involves melting metals and casting them into desired shapes. As described by Gupta and Khurmi (2010), foundry work includes safety measures, pattern making, mold making, melting, casting, and finishing operations. These processes require both theoretical knowledge and hands-on practice to ensure skill acquisition and proficiency.

Despite its importance, technical education in Nigeria faces challenges in producing skilled and competent graduates. Stakeholders and employers have raised concerns over the low levels of practical skills exhibited by graduates of technical institutions, particularly in metalwork technology and foundry operations (Aminu, 2010; Abubakar, 2011). This gap in skill acquisition is attributed to inadequate training and insufficient exposure to practical applications, which are critical for effective learning. According to Enemali (2006), integrating theory with practice is essential for developing psychomotor skills, which are often retained longer than theoretical knowledge. Factors such as feedback, motivation, and practice play a significant role in skill acquisition, with regular practice being central to mastery (Encyclopedia Britannica, 2008). However, many pre-service technicians in Colleges of Education in North-East Nigeria lack the necessary work skills in foundry operations, thereby limiting their competence and self-reliance. This study aims to assess the work skill development needs in foundry operations for pre-service technicians in these institutions. By identifying areas of weakness and recommending targeted improvements, the study seeks to enhance the quality of training in foundry operations, ultimately contributing to the objectives of Nigeria's technical education program.

Methodology

The research design for this study was a descriptive survey design, which involved collecting and analyzing data through structured questionnaires. Gall and Borg (2007) described a descriptive survey design as a method of data collection that uses questionnaires or interviews to gather data from a sample selected to represent a population, with the findings being generalizable to the entire population. This design was suitable for the study as it enabled the collection of information from pre-service technicians and lecturers regarding the work skills improvement needs for foundry operations in Colleges of Education in North-East Nigeria. The study covered six states—Bauchi, Gombe, Adamawa, Yobe, Taraba, and Borno—because of their shared cultural and geographical proximity. The institutions involved were Federal College of Education (Technical) Gombe, Federal College of Education (Technical) Potiskum, Ramat Polytechnic Maiduguri, College of Education Zing, College of Education Hong, and Aminu Saleh College of Education Azare. These institutions were selected due to their accreditation by the National Commission for Colleges of Education (NCCE) and their uniform technical education curriculum.

The sample for the study consisted of 93 respondents, including 33 metalwork lecturers and 60 metalwork students, drawn from a population of 135 respondents. Data was collected using a structured questionnaire developed by the researcher. The instrument was divided into two sections: Section A collected demographic data, while Section B contained 63 skill items designed to address the research questions. A four-point rating scale—Highly Needed (4), Needed (3), Not Needed (2), and Highly Not Needed (1)—was

used to determine the level of training needs. The instrument was validated by three experts in metalwork/mechanical production technology education from Federal College of Education (Technical) Potiskum, Modibbo Adama University of Technology, and Federal College of Education (Technical) Gombe. Their feedback informed the refinement of the instrument. The reliability of the questionnaire was determined through a pilot test conducted at Federal College of Education (Technical) Potiskum using the test-retest method. Pearson's Product Moment Correlation yielded a reliability coefficient of 0.76, deemed adequate per Usman (2015). Data collection was facilitated by 12 research assistants, and analysis was conducted using SPSS, employing mean and grand mean statistics to answer the research questions and a Z-test at a 0.05 significance level to test the hypotheses. The decision-making criteria followed Ogbu's (2004) real limits of numbers, where a mean of 2.50 and above indicated needed skills, while a mean below 2.50 indicated not needed skills.

Results and Discussion

Research Question One: -What are the foundry works and operations by NCE (Technical) metal work students to carryout safety operations.

Table 1: Mean ratings on work skills improvement needed by NCE (Technical) metal work students to carryout safety operations.

SN	Skills Items N_1= 33 N_2 = 60 NT = 93	$\bar{x}$	SD	Remarks
1	Always keep the foundry area clean.	3.75	0.583	HN
2	Ability to provide ventilation available	3.55	0.599	HN
3	Be sure your safety clothing is in first-class condition.	3.63	0.586	HN
4	Never pour a molten metal to the mould unless you are wearing protective clothing and goggles	3.58	0.596	HN
5	Place hot castings where they will not cause accidents bums.	3.33	0.712	HN
6	Use tong to remove crucible which contain molten metal from the furnace (forged) in order to avoid burnt.	3.40	0.678	HN

7	Use safety mask to cover the face in order to avoid burnt.	3.42	0.665	HN
8	Use goggles to cover the eyes to avoid ultraviolet and infrared light which can damage the eyes	3.48	0.716	HN
9	Before using crucibles check for cracks or leaks	3.33	0.757	HN
10	Always ladles should be thoroughly dry before melted metal is poured into them.	3.30	0.704	HN
11	Always pouring of molten metal into mould should be handle floor level.	3.28	0.799	HN

Key: N_1 = Number of lecturers, N_2 = Number of students, HN = Highly Needed
N = Needed, NN = Not Needed, NHN = Not Highly Needed
X = Grand means responses of lecturers of students,
$\bar{x}$ = Mean, S.D = Standard Deviation

The Data presented in Table 1 shows that for work skills improvement needed in safety operations metal work students highly needed work skills in all 11 skills items with grand mean ranging from 3.28 to 3.75. This indicating that all 11 skills items where highly needed for metal work students for safety operations.

Research Question Two: -What are the foundry work and operation by NCE (Technical) metal work students to carryout pattern making operations.

Table 2: Mean ratings on work skills improvement needed by NCE (Technical) Metal work students to carryout pattern making operations

SN	**Skills Items** **N_1= 33 N_2 = 60 NT = 93**	$\bar{x}$	**SD**	**Remarks**
12.	Ability to design pattern using working drawing	3.56	0.541	HN
13.	Ability to interpret working drawing of patterns	3.41	0.576	N
14.	Ability to determine pattern allowance	3.25	0.732	N
15.	Ability to select material for pattern making	3.40	0.678	N

16.	Ability to Shape stock to dimension	3.23	0.709	N
17.	Ability to selection reference or datum line	3.14	0.802	N
18.	Gluing and clamping of pattern	3.27	0.678	N
19.	Allowances of contraction, tapes and fillets.	3.32	0.754	N
20.	Surfaces smoothing of pattern	3.44	0.616	N
21.	Ability to fix pattern correctly.	3.51	0.636	HN

The Data presented in Table 2 Shows that for work skills improvement neeed in pattern making operations metal work students highly needed works skills in 2 skills items with grand mean ranging from 3.51 to 3.56 and work skills improvement needed in the 8 skills items with grand mean ranging from 3.14 to 3.44. Therefore, metal work students' needs work skills improvement on pattern making operations.

Research Question Three: -What are the foundry work and operations skills needed of NCE (Technical) metal work students to carryout mould making operations.

Table 3: Mean ratings on work skills improvement needed by NCE (Technical) Metal work students to carry out mould making operations

SN	**Skills Items**	$\bar{x}$	**SD**	**Remarks**
	N_1= 33 N_2 = 60 NT = 93			
22.	Classify and selection of correct sand for mould making	3.56	0.598	HN
23.	Sand preparation and mixing	3.37	0.639	N
24.	Tempering sand (mixing 0_2)	3.37	0.688	N
25.	Testing for mould making	3.39	0.692	N
26.	Sand distribution to moulding station	3.39	0.692	N
27.	Facing sprinkle sand	3.42	0.681	N
28.	Ramming of sand against the pattern	3.26	0.750	N
29.	Provision of runner and feeding system	3.28	0.771	N
30.	Withdrawal of pattern from mould	3.38	0.706	N
31.	Brushing and final cleaning of mould	3.29	0.815	N

The data presented in Table 3 shows that for work skills improvement needs in mould making operations metal work students highly needed in 1 skills item range 3.56, needed in 9 skills item with grand mean ranging from 3.26 to 3.42. This indicates that metal work students' needs mould making operations.

Research Question four: -What are the foundry work and operations skills needed of NCE (Technical) metal work students to carryout core making operations.

Table 4: Mean ratings on work skills improvement needed by NCE (Technical) Metal work students to carryout core making operations.

SN	Skills Items N_1= 33 N_2 = 60 NT = 93	$\bar{x}$	SD	Remarks
32.	Classify and selection of correct core sand for core making.	3.46	0.600	N
33.	Core sand preparation using required additives	3.59	0.594	HN
34.	Composition testing of the core	3.34	0.617	N
35.	Core construction using core boxes	3.39	0.660	N
36.	Use of core reinforcement	3.41	0.663	N
37.	Use of core carriers and handles	3.41	0.663	N
38.	Core dressing	3.34	0.651	N
39.	Core baking	3.35	0.747	N
40.	Assembling of baked cores	3.27	0.613	N

The data presented in Table 4 shows that for work skills improvement needs in core making operations metal work students highly needed in 1 skills item with grand mean range 3.59 and needed in 8 skills item with grand mean ranging from 3.27 to 3.46. This indicates that metal work students needed core making operations.

Research Question five: -What are the foundry work and operations skills needed of NCE (Technical) metal work students to carryout melting operations.

Table 5: Mean ratings on work skills improvement needed by NCE (Technical) metal work students to carryout in foundry work and melting operations

SN	Skills Items N_1= 33 N_2 = 60 NT = 93	$\bar{x}$	SD	Remarks
41.	Check the furnace and switch of the furnace	3.32	0.694	N

42.	Filling the crucible with the metal pieces & place in the furnace	3.57	0.597	HN
43.	Check the temperature frequently as the metal melt, overheated	3.39	0.708	N
44.	Add a flux to the molten metal and stir it in just before approaching the correct temperature.	3.54	0.635	HN
45.	Skim off the slag at the top of the melted metals	3.41	0.679	N

The data presented in table 5 shows that for work skills improvement needs in melting operations metal work students highly needed in 1 skills item with grand mean range from 3.54 to 3.57 while 3 are needed work skills item with grand mean ranging from 3.32 to 3.41. This indicates that student needed work skills improvement need in melting making operations.

Research Question Six: -What are the foundry work and operation by NCE (Technical) metal work students to carryout casting operations.

Table 6: Mean ratings on work skills improvement needed by NCE (Technical) metal work students to carryout in foundry work and casting operations

S/N	**Skills Items** N_1= 33 N_2 = 60 NT = 93	$\bar{x}$	**SD**	**Remarks**
46.	Pouring of molten metal into the mould box.	3.39	0.767	N
47.	Switch off the furnace and remove the crucible from the furnace.	3.58	0.614	HN
48.	Taping and pouring the melted metals into mould	3.42	0.798	N
49.	Allow the casting to cool and solidify	3.46	0.618	N
50.	Ladle selection	3.56	0.650	HN
51.	Ladle preparation and metal pouring	3.37	0.763	N

The data presented in table 6 shows that for work skills improvement needs in casting operations metal work students highly needed in 2 skills item with grand mean range from 3.56 to 3.58 while 3 are needed work skills item with grand mean ranging from 3.37 to 3.46. This indicates that student needed work skills improvement need in casting making operations.

Research Question Seven: -What are the foundry work and operation by NCE (Technical) metal work students to carryout finishing operations.

Table 7: Mean ratings on work skills improvement needed by NCE (Technical) metal work students to carryout in foundry work and finishing operations

SN	Skills Items N_1= 33 N_2 = 60 NT = 93	$\bar{x}$	SD	Remarks
52.	Mould knock-out operation	3.39	0.723	N
53.	Fettling or removal of runners/risers	3.44	0.699	N
54.	Blasting and tumbling operations	3.30	0.777	N
55.	Mould dressing, washing and weighing of the casting	3.38	0.721	N
56.	Grinding of sharp edges of the casting	3.42	0.742	N
57.	Polishing and cleaning of the casting	3.54	0.700	HN
58.	Inspection of the casting	3.54	0.652	HN
59.	Final check of all sizes of the casting	3.43	0.728	N
60.	Quality control checking of casting	3.39	0.626	N
61.	Packaging of the casting	3.40	0.724	N
62.	Conveying completed casting	3.30	0.734	N
63.	Carrying out heat treatment on cast object	3.34	0.699	N

The data presented in table 7 shows that for work skills improvement needs in finishing operations metal work students highly needed in 2 skills item with grand mean range from 3.54 – 3.54 while 10 are needed work skills item with grand mean ranging from 3.30 to 3.44. This indicates that student needed work skills improvement need in finishing making operations.

Hypothesis One: There is no significant difference between the mean responses of metal work lecturers and students on work skills improvement needed in safety operations.

Table 8: Z-Test analysis of the mean ratings of the respondents on work skills improvement needed in safety operations

GROUPS	N	$\bar{x}$	SD.	Z – Cal	Z- Crt	Decision
LECTURERS	33	3.5592	.28031	.083	1.753	Accepted
STUDENTS	60	3.4061	.45607			

Table 8 Revealed that the value of the calculated Z of 0.83 is less than the critical value of 1.753 at 0.05 level of significance, therefore the null hypothesis (H_{01}) is accepted. This implies that the group shared similar opinion on the work skills needed in safety practice operations.

Hypothesis Two: There is no significant difference between the mean responses of metal work lecturers and students on the work skills improvement needs in foundry work and operation in pattern making operations.

Table 9: Z-test Analysis of the mean ratings of the respondents on work skills improvement needed in pattern making operations.

GROUPS	N	$\bar{x}$	SD.	Z – Cal	Z- Crt	Decision
LECTUREIS	33	3.4576	.30622	0.56	1.939	Accepted
STUDENTS	60	3.2933	.42977			

Table 9 revealed that the value of the calculated Z of 0.056 is less than the critical value of 1.939 at 0.05 level of significance; therefore, the null hypothesis (H_{01}) is accepted. This implies that the group shared similar opinion on the work skills needed in pattern making operations.

Hypothesis Three: There is no significant difference between the mean responses of metal work lecturers and students on the work skills improvement i needed in mould making operations.

Table 10: Z-test Analysis of the mean ratings of the respondents on work skills improvement needed in mould making operations.

GROUPS	N	$\bar{x}$	SD.	Z – Cal	Z- Crt	Decision
LECTURERS	33	3.4512	.26740	0.111	1.610	Accepted
STUDENTS	60	3.3156	.44086			

Table 10 revealed that the value of the calculated Z of 0.111 is less than the critical value of 1.610 at 0.05 level of significance, therefore the null hypothesis (H_{01}) is accepted. This implies that the group shared similar opinion on the work skills needed in mould making operations.

Hypothesis Four: There is no significant difference between the mean responses of metal work lecturers and students on the work skills improvement needed in core making operations.

Table 11: Z-test Analysis of the mean ratings of the respondents on work skills improvement needed in core making operations.

GROUPS	N	$\bar{x}$	SD.	Z – Cal	Z- Crt	Decision
LECTUREIS	33	3.4579	0.35000	0.290	1.064	Accepted

STUDENTS	60	3.3648	0.43013

Table 11 revealed that the value of the calculated Z of 0.290 is less than the critical value of 1.064 at 0.05 level of significance, therefore the null hypothesis (H_{01}) is accepted. This implies that the group shared similar opinion on the work skills needed in core making operations.

Hypothesis Five: There is no significant difference between the mean responses of metal work lecturers and students on the work skills improvement needed in melting operations.

Table 12: Z-test Analysis of the mean ratings of the respondents on work skills improvement needed in melting operations.

GROUPS	N	$\bar{x}$	SD.	Z – Cal	Z- Crt	Decision
LECTUREI	33	3.5333	0.33789	0.163	1.405	Accepted
STUDENTS	60	3.3967	0.49880			

Table 12 revealed that the value of the calculated Z of 0.163 is less than the critical value of 1.405 at 0.05 level of significance, therefore the null hypothesis (H_{01}) is accepted. This implies that the group shared similar opinion on the work skills needed in melting making operations.

Hypothesis six: There is no significant difference between the mean responses of metal work lecturers and students on the work skills improvement needed in casting operations.

Table 13: Z-test Analysis of the mean ratings of the respondents on work skills improvement needed in casting operations.

GROUPS	N	$\bar{x}$	SD.	Z – Cal	Z- Crt	Decision
LECTURERS	33	3.6212	0.37793	0.014	2.505	Accepted
STUDENTS	60	3.3750	0.48965			

Table 13 revealed that the value of the calculated Z of 0.014 is less than the critical value of 2.505 at 0.05 level of significance, therefore the null hypothesis (H_{01}) is accepted. This implies that the group shared similar opinion on the work skills needed in casting operations.

Hypothesis Seven: There is no significant difference between the mean responses of metal work lecturers and students on the work skills improvement needed in finishing operations.

Table 14: Z-test Analysis of the mean ratings of the respondents on work skills improvement in finishing operations.

GROUPS	N	$\bar{x}$	SD.	Z – Cal	Z- Crt	Decision
LECTUREIS	33	3.4571	0.38081	0.428	0.797	Accepted
STUDENTS	60	3.3764	0.50805			

Table 14 revealed that the value of the calculated Z of 0.428 is less than the critical value of 0.797 at 0.05 level of significance, therefore the null hypothesis (H_{01}) is accepted. This implies that the group shared similar opinion on the work skills needed in finishing operations.

Discussion of Results

The findings of this study revealed that the majority of the work skills items evaluated were deemed necessary for the effective training of pre-service technicians in foundry operations across the Colleges of Education in North-East Nigeria. Both lecturers and students identified key skill areas, including metal molding, casting, and pattern development, as highly needed to enhance technical competence. The calculated mean scores for most items exceeded the threshold of 2.50, signifying a strong agreement among respondents on the necessity of these skills for improving foundry operations training. This underscores the relevance of aligning technical education programs with industry-specific skill demands to ensure graduates are well-prepared for the workforce. The results further validated the study's objective of assessing skill gaps in foundry operations, highlighting the need for curriculum updates and targeted interventions to address these gaps.

Additionally, the hypothesis testing revealed statistically significant differences in the perceptions of lecturers and students regarding certain skill areas, suggesting a variation in the prioritization of skill needs. These differences could be attributed to lecturers' broader exposure to industry practices and their understanding of emerging trends in foundry technology. The findings align with Gall and Borg's (2007) assertion that descriptive survey designs are effective in generalizing data from representative samples. The use of a validated questionnaire, coupled with a reliability coefficient of 0.76, provided robust data for analysis. These results emphasize the importance of incorporating the identified skills into the curriculum and providing hands-on training to ensure pre-service technicians are adequately prepared for the demands of the modern foundry industry**.**

Conclusion:

The study highlighted the essential work skills required by NCE (Technical) metal work students in various foundry operations. The findings demonstrated that both safety and operational skills, including those related to pattern making, mould making, core making, melting, casting, and finishing, were all highly rated as necessary for improving students' technical competence in foundry work. The analysis revealed that students and lecturers shared similar views on the skills needed, though some differences in prioritization were observed. These discrepancies may be attributed to the lecturers' greater exposure to industry practices. The results emphasize the need for curriculum updates and practical training to bridge existing skill gaps and enhance the

preparedness of future technicians for the demands of the foundry industry. The statistical analysis confirmed the reliability and validity of the data, supporting the necessity of integrating these critical skills into technical education programs.

Recommendations:

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

1. All the skills items rated as needed option identified in the study should be included and taught to metal work students to prepare them skill fully prior to their graduation.
2. Other skill items identified not needed by the metal work students, metal work lecturers should lay emphasis on the teaching and learning of these work skills improvement during the program.
3. Metal work Lecturers should engage metal work students with more practical works on pattern making operations, mould making operations, core making, melting operations, casting operations and finishing operations.

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