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Technical Skills for Enhancing Self-Employment in Brazing Among Mechanical Engineering Craft-Practice Students in Technical Colleges in Rivers State

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Abstract

The study ascertained the extent to which students were exposed to technical skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State. Five research questions raised and corresponding five null hypotheses formulated guided the study. The descriptive survey research design was adopted for the study. The population comprised seven trainers and three workshop attendants in four government approved Government Technical Colleges in Rivers State that offered Mechanical Engineering Craft Practice. Structured questionnaire was used for data collection; it was validated by two research experts. The data collected were analyzed using mean, standard deviation and t-test statistics. From the findings of the study, it was revealed that students were, to a high extent, exposed to all the listed items on good fit and proper clearance. Based on the findings of the study, it was recommended among other things, that the government should encourage students of mechanical engineering craft-practice who have acquired brazing skills to go into small-scale businesses after graduation, as this will enhance self-employment in Rivers State.

Keywords: technical, skills, self-employment, brazing

1. Introduction

The word skill is commonly used to describe the potential to perform a task acceptably. Skill refers to the knowledge, competencies, and abilities required to perform operational tasks (Zhang, 2019). Skills are acquired not only through learning, but through life and work experience. In comparison to concepts that actually indicate just the capacity to develop some capabilities — such as innate talent, competence or intellectual capacity — the word skill generally implies the physical capabilities gained through practice, education, or practical experience (García-Pérez, García-Garnica, & Olmedo-Moreno, 2021). The term skill is used in several fields of study, notably psychology, business management, technology and education, and it has several interpretations, used for a variety of purposes and situations. In psychology, the concept of skill is considered as the extent to which an individual is able to carry out an activity, in terms of proficiency and the rate at which the task is being accomplished. Thus, this notion of skill explains the capabilities possessed by a person, for instance a self-employed, which encompasses mental capacity, physical abilities, understanding and interpersonal competencies. Similarly, researchers in the field of business management consider the term skill as the potentials necessary for accomplishing a given piece of work — in the sense of the extent and the difficulty in accomplishing the work in context, the degree of accuracy shown and time used to accomplish the given task and the know-how and training required to master the work. Lately, the definition of skill has further been expanded. The significance of "skill set" is emphasized in conjunction to soft skills — communication skills, innovation, adaptability, management, and teamwork. The difference among basic as well as easily adaptable or crucial skill sets and vocational, job-specific, or technical ability, has equally been highlighted. While generic skills are valuable in a variety of industries, technical skills, such as brazing, are required for self-employment in a specific sector or industry. In contrast to personal skills, that are connected to one's character, technical ability are easily measurable. The latter are skills that can or are evaluated and may require some specialized technical certification. They are any abilities related to a particular task or activity. It entails comprehension, strategies, processes, practices and competency in particular tasks such as brazing.

Thus, brazing is a metal-joining method that entails heating up and running a filler material through the work-piece, with the wire having a smaller melting temperature than the brazed work-piece (Way, Willingham, & Goodall, 2019). It is therefore a broad term that encompasses a wide variety of processes, skills, and facilities for joining objects of different shapes, from huge ships to light engine components and precious ornaments. Contemporary brazing businesses are equipped with a wide range of specialist and multi-purpose tools able to produce extremely accurate and robust results (Weis, Fedorov, Elssner, Uhlig, Hausner, Wagner, & Wielage, 2017).

Brazing has been practiced since by the ancient Egyptians and basic brazing methods started in 2975 BC (Way, Willingham, & Goodall, 2019). At this time, new techniques were introduced and improved upon by the Sumerians, Greeks, and Romans. Before the Eighteenth Century, the Europeans had used the techniques to produce magnificent objects (Way, Willingham, & Goodall, 2019). Precious metals, bronze, and copper were among the most prevalent materials.

Brazing has significant advantages above all other metal-joining methods, like welding (Daly, 2013). Because brazing cannot soften the metal parts to be joined, it permits for very much stricter accuracy regulation and generates a good quality joint without any need for intermediate completion. Dissimilar metals and non-metals for example, sintered metal ceramic materials, can also be brazed. Due to the uniform heating of a brazed item, brazing provides less thermal deformation than welding. Dynamic and multi arrangements can be brazed at a low cost. Welded joints must be ground flush at key moments, which is an expensive supplementary task that brazing somehow does not involve since it provides a smooth joint. A further benefit is that brazing can be completely covered or clad for protection. Finally, because the independent process variables are less susceptible to problems, brazing is readily applied to mass manufacturing and quick to optimise.

Brazing is different from other metal joining techniques due to its operation at very high temperatures (above the melting point of the filler metal), does not soften the metal parts to be joined and parts are better closely fitted than in most methods, such as soldering and welding. When brazing operation is carried out, the filler metal — by capillary action — runs into the space between the substrates to be joined. Obviously, this is achievable when the filler metal is heated beyond its melting point under controlled conditions, especially in an atmosphere of flux. The key feature of brazing is its capacity to join similar or dissimilar metals with appreciable mechanical strength. Ultra quality parts joined by means of brazing require proper cleaning of parts by techniques such as pickling and, the parts be also closely fitted (Daly, 2013). Pan, and Zhao (2017), recommended joint clearance of 0.032 – 0.08 mm for good capillary actions, high joint strength and better quality. However joint clearances of up to 0.6 mm are common in most brazing operations.

Thus, there are basic mechanical engineering craft skills, such as brazing sills, which all trainees of mechanical engineering craft-practice in technical colleges in Rivers State are expected to master to ensure quality joint finishes, consistency, hermeticity and reliability (Isaac & Obed, 2020). Some of the skills, as outlined by Daly (2013), include good fit and proper clearance, cleaning of metal, assembling parts for brazing, brazing the assembled parts and cleaning the brazed joint.

Good fit and proper clearance are essential requirements for efficient brazing operations. They are necessary for the free flow (capillary action) of the hot, liquid filler metal that joins the base metals. In order to disseminate the hot liquid filler material between the layers of the base metals, brazing uses the capillarity principle. The tensile strength of the brazed junction varies with the distance between the components being attached (Etemadi, *et al* 2012). The strength of the joint is, however, almost reduced to that of the filler metal if the gap is wider than is necessary. According to Daly (2013), capillary action can function at different levels of clearance. How much room there needs to be for expansion and contraction depends on the kind, size, and design of the metals being joined as well as the joint itself. To create a brazed junction that is extremely durable and strong, the work-pieces must be carefully cleaned before brazing. Cleaning the work-piece is essential for the capillary activities of the filler metal, which are necessary for efficient brazing. The impurities serve as a barrier between the brazing materials and the base metal surface when they are utilised without being cleaned. Cleaning the part to be brazed is an activity that does not require much to carry out, though, it must be carried out in the right manner. Different techniques of cleaning are applied in different conditions.

After brazing, a workpiece needs to be cleaned. The post-brazing cleaning procedure involves two steps: removing flux residues and pickling to get rid of any oxide scale that formed during the brazing process. Flux may be able to endure pressure testing, but it might not be able to seal pinholes in a braze joint under pressure. But as soon as they were used, the joints would leak. Any remaining flux will pull any water from the environment that is present because some fluxes have the capacity to absorb water, which will result in the work-piece rusting. Flux after brazing can be difficult to remove because it creates a surface that is hard and glass-like.

2. Statement of the Problem

Students in mechanical engineering craft practice are expected to be self-employed and employers of labour upon graduation (Ehimen & Ezeora, 2018). However, the reverse seems to be the case. This is clear from the fact that 44.1% of technical and commercial graduates are still out of work, neither employed nor self-employed (Nigerian Economic Alart, 2020). As noted by Mgaiwa (2021), however, this is due to several factors, notably the lack of practical training necessary for the acquisition of practical skills required for self-employment. Thus, graduates from technical colleges acquire little knowledge and practical skills that can enable them, on graduation, to practise what they have learned in school, create jobs for themselves, and participate in economic development (Okafor, in Ubele & Okwelle, 2020).

Obviously, this is a defect in academics, and the effects have been proven to be increasingly damaging economically, politically, socially, etcetera (Audu, Kamin, & Balash, in Ubele & Okwelle, 2020). As Essien & Onukwubiri (2015) pointed out, unemployed graduate youths have become vulnerable to illegal activities and anti-social behaviour. Their female unemployed graduates are the hardest hit, as many of them have turned to illegal activities such as prostitution and circumstantial marriages to make ends meet. On the other hand, their male counterparts are forced by circumstance to engage in illegal activities in order to survive.

Therefore, addressing this issue will provide Rivers State Technical Colleges with much-needed insights to enable them to improve their policies, strategies, and curriculum to incorporate more of the technical skills required to encourage self-employment among Students. Hence, the problem of the study is: what are the technical skills required to enhance self-employment in brazing among engineering craft practise students in technical colleges in Rivers State?

2.1 Purpose of the Study

The purpose of the study was to ascertain the extent to which students were exposed to technical skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State. In terms of objectives, the study sought to ascertained;

1) The extent to which good fit and proper clearance skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
2) The extent to which metal pre-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
3) The extent to which parts assembly skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
4) The extent to which brazing operation skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
5) The extent to which brazed joint post-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

2.2 Research Questions

The following questions were posed to guide the study;

1) To what extent do good fit and proper clearance skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
2) To what extent do metal pre-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
3) To what extent do parts assembly skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
4) To what extent do brazing operation skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
5) To what extent do brazed joint post-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

2.3 Hypotheses

The following null hypothesis were formulated and tested at .05 level of significance.

1) There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which good fit and proper clearance skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
2) There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which metal pre-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
3) There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which parts assembly skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
4) There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which brazing operation skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.
5) There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which brazed joint post-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

3. Conceptual Review

3.1 Good Fit and Proper Clearance Skills

The effectiveness of brazing depends on maintaining proper joint clearance, as capillary action is optimized when the gap between workpieces is around 0.0015 (0.038 mm) (Etemadi et al., 2012). Deviations from this clearance — whether too tight or too wide — reduce joint strength (Estrella, 2021). Additionally, thermal expansion coefficients must be considered, especially for dissimilar metals, to ensure dimensional stability during heating (Daly, 2013). Joint designs, such as butt and lap joints, influence strength, with lap joints offering greater bonding surfaces for heavier loads (Sharma et al., 2016). Electrical conductivity and pressure-tightness requirements may also dictate joint design and filler metal selection (Wu et al., 2021).

3.2 Metal Pre-Cleaning Skills

Proper cleaning is essential for successful brazing, as contaminants like oil, grease, rust, and scale hinder filler metal flow (Nawfel, 2020). Cleaning should follow a sequential process: degreasing first, followed by oxide removal via mechanical or chemical methods (Baranowski et al., 2019). Flux application immediately after cleaning prevents recontamination and oxide formation during heating (Winiowski & Majewski, 2012). The choice of flux depends on brazing conditions, with boron-modified fluxes enhancing high-temperature performance (Way et al., 2019).

3.3 Parts Assembly Skills

Proper assembly ensures alignment during brazing, with gravity or fixtures used to maintain joint clearance (Wang et al., 2021). Fixtures should minimize heat conduction and use materials like stainless steel or ceramics (Muhammad et al., 2018). Self-supporting designs, such as crimping or riveting, reduce fixture dependency (Weis et al., 2017). Sharp edges should be softened to facilitate filler metal flow (Jayesh & Harshwardhan, 2017).

3.4 Brazing Operation Skills

Brazing involves heating the assembly to filler metal flow temperature, with torch brazing being common for separate assemblies (Kay, 2018). Uniform heating is critical, and filler metal should be applied near the joint to ensure capillary flow (Rocha & Handerson, 2019). Safety measures include using proper regulators, check valves, and flashback arrestors (Ngai & Ngai, 2020). Ventilation is necessary to mitigate toxic fumes from fluxes and filler metals (Zhang et al., 2013).

3.5 Brazed-Joint Cleaning Skills

Post-braze cleaning removes corrosive flux residues and oxide scale, typically via hot water quenching or chemical pickling (Wojdat et al., 2019). Residual flux compromises joint inspection, promotes corrosion, and hinders coatings (Savill & Eifion, 2021). Mechanical or ultrasonic cleaning may be used for stubborn residues (Zhao et al., 2021). Acid baths should be carefully selected to avoid damaging the joint (De Prado et al., 2016).

3.6 Review of Related Empirical Studies

For over two decades, the Nigerian government has emphasized skill development as a strategy to enhance youth self-employment and reduce unemployment (Oluwajodu et al., 2015). Research has explored the relationship between skill acquisition and entrepreneurial intentions, particularly among technical and vocational students. Oluwajodu et al. (2015) investigated this link among undergraduate students in Nigeria's north-central region, finding a strong positive correlation between skill development and entrepreneurial intent. The study recommended equipping students with entrepreneurial skills to foster self-employment.

Similarly, Edmond et al. (2014) examined strategies for empowering individuals through Technical, Vocational Education, and Training (TVET). Their survey highlighted the importance of public-private partnerships in funding and managing TVET programs to enhance self-employment opportunities. The study underscored the need for adequate training resources and institutional support.

Ehijele and Ugochukwu (2018) focused on metalworking skills among technical college graduates in Edo and Enugu States. Their findings revealed that graduates required competencies in interpreting technical drawings, using measurement tools, and operating machinery. The study advocated for improved workshop facilities and qualified instructors to bridge skill gaps.

Odinaka (2017) expanded on this by assessing entrepreneurial skills for metalwork students in Northeast Nigeria. The research identified 40 essential skills and called for government investment in infrastructure and curriculum development to integrate these competencies.

Bala et al. (2022) explored welding and fabrication skills in Jigawa State, noting deficiencies in practical abilities like torch handling and metal joining techniques. The study recommended enhanced training and provision of modern welding equipment to improve craftsmanship.

Lastly, Ubele and Okwelle (2020) analyzed machining skills for metalwork students in Rivers State, emphasizing the role of teachers in communicating skill relevance and encouraging small-scale entrepreneurship post-graduation. Their findings supported government interventions to promote self-employment among graduates.

Collectively, these studies highlight the critical role of skill development in reducing unemployment, stressing the need for institutional support, updated curricula, and public-private collaboration to foster youth entrepreneurship in Nigeria.

4. Methodology

The descriptive survey research design was adopted for the study. The study was carried out in Rivers State. Rivers is one of the states in southern Nigeria. The population for the study was technical colleges in Rivers State. There were four government approved Technical Colleges (GTC) in Rivers State: GTC Port Harcourt, GTC Tombia, GTC Ele-Ogu and GTC Ahoada. However, only GTC Port Harcourt, GTC Tombia, and GTC Ahoada offered mechanical engineering craft practice, with trainers and workshop attendants populations of; GTC Port Harcourt (4, 1), GTC Tombia (1, 1) and GTC Ahoada (2, 1), which summed-up to 10 (Records Unit, Rivers State Secondary School Board, 2022). The mechanical engineering craft practice trainers were considered suitable as part of the population for the study because they are experts in teaching concepts on brazing and related topics in technical colleges. Similarly, the workshop attendants were used as part of the population for the study because they are qualified personnel with a wealth of experience on the trade, and more so, they are vast on the skills essential for maintenance of brazing equipment and preparation of materials for the students (NBTE, 2014).

The study was a census because the entire population was studied. The questionnaire was used as research instrument. The tool was expressly validated by two research experts. Thus, the reliability index was established using Cronbach Alpha coefficient formula which yielded a reliability coefficient of .83. Descriptive and inferential statistics were used to answer the research questions and also test the hypotheses. Specifically, the mean and standard deviation were used to answer the research questions and the results obtained were utilized to make decisions. The decision rule on any weighted mean was as follows;

2.5 and above	Agree
Below 2.5	Disagree

Similarly, the students t-test was used to test the hypotheses at .05 level of significance and the results obtained were used to make decisions based on the following decision rules;

Reject the null hypothesis (Ho) in favour of the alternate hypothesis (Ha), if the calculated value (tc) is greater than the table value (t-crit), otherwise accept the null hypothesis.

5. Results

Research question 1

To what extent do good fit and proper clearance skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 1. Mean responses of trainers and workshop attendants on the extent to which good fit and proper clearance skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

S/N	**Good Fit and Proper Clearance Skills**	**Trainers**			**Workshop Attendants**		
		Mean	**SD**	**Decision**	**Mean**	**SD**	**Decision**
1.	Selecting, cutting and fitting work-pieces considering their thermal expansivities.	4.14	0.38	Agree	4.29	0.53	Agree
2.	Maintaining a clearance of 0.038mm between work-pieces before brazing.	4.71	0.49	Agree	3.77	0.53	Agree
3.	Making a lap joint three times as long as the thinner member's thickness.	4.57	0.79	Agree	4.89	0.32	Agree
4.	Constructing butt joints for brazing works that require high tensile strength.	4.14	0.69	Agree	4.37	0.64	Agree
5.	Holding tubular joints in the correct alignment for brazing, by nesting one tube inside the other.	4.14	0.90	Agree	4.30	0.73	Agree
6.	Increasing joint area by using lap joint.	4.57	0.53	Agree	4.88	0.32	Agree
7.	Using filler wires that contain very good conductors of electricity such as silver, for work-pieces that are intended for use with electricity.	4.29	0.49	Agree	4.53	0.61	Agree
	Grand Mean and SD	**4.37**	**0.61**	**Agree**	**4.43**	**0.53**	**Agree**

Source: Field Survey 2022.

The results of the analysis from research question 1, as presented in Table 1, show that the respondents Agree with items 1-7. However, since the grand means of 4.37 and 4.43 are above the criterion mean of 2.50, therefore it implies that the trainers and workshop attendants Agree that the students were, to a high extent, exposed to the seven items. The standard deviations of 0.61 and 0.53 show high homogeneity or closeness in their responses.

Research question 2

To what extent do metal pre-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 2. Mean responses of trainers and workshop attendants on the extent to which metal pre-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

S/No	**Metal pre-cleaning skills**	**Trainers**			**Workshop Attendants**		
		Mean	**SD**	**Decision**	**Mean**	**SD**	**Decision**
8.	Removing oil or grease by dipping the parts into a suitable degreasing solvent, vapour degreasing or by alkaline or aqueous cleaning.	5.00	0.00	Agree	4.94	0.24	Agree
9.	Removing rust by acid pickle treatment.	4.29	0.49	Agree	4.91	0.29	Agree
10.	Cleaning heavy rust/hard scales by mechanical/ abrasive cleaning using emery cloth, grinding wheel, file or grit blast.	5.57	0.53	Agree	4.33	0.64	Agree
11.	Choosing the right acid and combining same with distilled water in the right proportion, considering the nature of the metal in context.	4.50	0.76	Agree	4.33	0.78	Agree
12.	Neutralizing the leftover acid with appropriate alkaline solution to ensure that no acid traces remain in crevices or blind holes.	4.00	0.58	Agree	4.30	0.48	Agree
13.	Using the right abrasive wheel for cleaning to	4.14	0.69	Agree	4.46	0.54	Agree

	ensure proper surface roughness.						
14.	Using alkaline pickle solution such as sodium hydroxide, for non-ferrous metals and alloys.	4.00	0.82	Agree	4.13	0.87	Agree
	Grand Mean and SD	**4.36**	**0.55**	**Agree**	**4.49**	**0.55**	**Agree**

Source: Field Survey 2022.

The findings from research question 2 are shown in Table 2, which demonstrates that all the respondents Agree with items 8 through 14. The grand means of 4.36 and 4.49, however, are higher than the criterion mean of 2.50, which suggests that the trainers and workshop attendants both Agree that the students were, to a high extent, exposed to the seven items. High homogeneity or closeness in their responses is indicated by the standard deviations of 0.55 and 0.55.

Research question 3

To what extent do parts assembly skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 3. Mean responses of trainers and workshop attendants on the extent to which parts assembly skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

S/No	**Parts Assembly Skills**	**Trainers**			**Workshop Attendants**		
		Mean	**SD**	**Decision**	**Mean**	**SD**	**Decision**
15.	Producing the right type of joint for any given brazing operation.	4.00	0.58	Agree	3.73	0.80	Agree
16.	Selecting, producing and combining two kinds of joints to improve brazed-joint strength.	4.43	0.79	Agree	4.57	0.63	Agree
17.	Aligning work-pieces for proper/accurate brazing operation.	4.71	0.49	Agree	4.03	0.65	Agree
18.	Producing fixtures for various shapes/sizes of work-pieces.	4.43	0.53	Agree	4.57	0.65	Agree
19.	Identifying intricacies in work-pieces and building fixtures to accommodate them.	4.43	0.79	Agree	4.55	0.75	Agree
20.	Identifying appropriate parts and creating vents in tubular work-places.	3.86	1.07	Agree	4.06	0.87	Agree
21.	Maintaining the right clearance (gap) for effective capillarity of the molten filler metal.	4.86	0.66	**Agree**	4.34	0.67	**Agree**
	Grand Mean and SD	**4.39**	**0.66**	**Agree**	**4.34**	**0.67**	**Agree**

Source: Field Survey 2022.

Table 3 shows that all the respondents Agree with items 15-22 in response to research question 3. However, because the grand means of 4.39 and 4.34 are greater than the criterion mean of 2.50, it means that the trainers and workshop attendants Agree that the students were, to a high extent, exposed to the seven items. The standard deviations of 0.66 and 0.67 indicate a high uniformity or closeness in their responses.

Research question 4

To what extent do brazing operation skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 4. Mean responses of trainers and workshop attendants on the extent to which brazing operation skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

S/No	Parts Assembly Skills	Trainers			Workshop Attendants		
		Mean	SD	Decision	Mean	SD	Decision
22.	Flowing the molten filler wire into a tubular work piece until it runs out through the veins.	4.57	0.79	Agree	4.54	0.73	Agree
23.	Placing the filler mental at the appropriate position for efficient brazing operation.	3.86	0.69	Agree	4.52	0.60	Agree
24.	Moving the touch continuously to evenly heat up the work piece.	4.44	0.79	Agree	4.27	0.89	Agree
25.	Heating the assembly to the flow point of the brazing filler mental.	4.86	0.38	Agree	4.77	0.56	Agree
26.	Applying the flux from 51 mm to 76 mm to facilitate the flow of molten filler wire into the workpiece.	4.29	0.76	Agree	3.92	0.91	Agree
27.	Wearing the right safety gear before commenting brazing operation.	3.86	1.07	Agree	4.25	0.80	Agree
28.	Connecting the gases only when they are needed to be used.	3.86	0.69	**Agree**	4.59	0.52	**Agree**
29	Opening acetylene before lighting the touch followed by oxygen after the touch has been lit.	4.86	0.38	**Agree**	4.67	0.85	**Agree**
	Grand Mean and SD	**4.32**	**0.69**	**Agree**	**4.44**	**0.73**	**Agree**

Source: Field Survey 2022.

All of the respondents Agree with items 22 through 29, according to the research question 4 result shown in Table 4. The fact that the grand means of 4.32 and 4.44 are higher than the criterion mean of 2.50, however, suggests that the trainers and workshop attendants both Agree that the students were, to a high extent, exposed to the eight items. A high degree of homogeneity or closeness in their responses can be seen in the standard deviations of 0.69 and 0.73.

Research question 5

To what extent do brazed joint post-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 5. Mean responses of trainers and workshop attendants on the extent to which brazed joint post-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

S/No	Parts Assembly Skills	Trainers			Workshop Attendants		
		Mean	SD	Decision	Mean	SD	Decision
30.	Quenching a workpiece in hot water at 120°F (50°C) to remove brazing Flux.	4.29	0.49	Agree	4.50	0.62	Agree
31.	Brushing the assembly (joint) while it is still hot.	4.57	0.53	Agree	4.46	0.59	Agree
32.	Selecting and using water-based Flux for easier post brazing cleaning.	4.86	0.38	Agree	4.93	0.26	Agree
33.	Changing workpiece cleaning solution occasionally.	4.14	0.69	Agree	4.10	0.80	Agree
34.	Sandblasting work piece to remove debris from it.	4.00	0.82	Agree	4.12	0.87	Agree
35.	Dissolving tough Flux residues in 25% hydrochloric and bath at 140°F to 160°F (60°C to	4.00	0.58	Agree	4.71	0.45	Agree

	70° C).						
36.	Removing phosphate slag through prolonged pickling in sulfuric acid.	4.14	0.69	**Agree**	4.34	0.68	**Agree**
	Grand Mean and SD	**4.29**	**0.60**	Agree	**4.34**	**0.61**	Agree

Source: Field Survey 2022.

The findings from research question 5 are shown in Table 5, which reveal that all respondents Agree with items 30 through 36. The fact that the grand means of 4.29 and 4.34 are higher than the criterion mean of 2.50, however, suggests that the trainers and workshop attendants both Agree that the students were, to a high extent, exposed to the seven items. A high degree of uniformity or closeness in their responses is shown in the standard deviations of 0.60 and 0.61.

6. Test of Hypotheses

Hypothesis 1

There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which good fit and proper clearance skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 6. T-test Analysis of the Difference Between the mean responses of trainers and workshop attendants on the extent to which good fit and proper clearance skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

	N	**X**	**SD**	**DF**	**T-Cal**	**T-Crit.**	**Decision**
Trainers.	7	4.37	0.61				
				8	0.16	1.96	Accept
Workshop attendants.	3	4.43	0.53				

Source: Field Survey.

The data in Table 6 show the calculated T-value (T-cal) of 0.16 at 0.05 level of significance, while T-critical is 1.96. Since the calculated T-value (T-cal) of 0.16 is less than the T-critical value (T-crit) of 1.96, the null hypothesis is accepted. This indicates that there is no significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to good fit and proper clearance skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

Hypothesis 2

There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which metal pre-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 7. T-test Analysis of the Difference Between the mean responses of trainers and workshop attendants on the extent to which metal pre-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

	X		**DF**	**T-Cal**	**T-Crit.**	**Decision**
Trainers.	4.36	0.55				
			8	0.34	1.96	Accept
Workshop attendants.	4.49	0.55				

Source: Field Survey.

The data in Table 7 indicate that the calculated T-value (T-cal) at the 0.05 level of significance is 0.34, while T-critical is 1.96. The null hypothesis is upheld because the calculated T-value of 0.34 is less than the T-critical value of 1.96. This suggests that there is no statistically significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to metal pre-cleaning skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

Hypothesis 3

There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which parts assembly skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 8. T-test Analysis of the Difference Between the mean responses of trainers and workshop attendants on the extent to which parts assembly skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

	N	X	SD	DF	Z-Cal	Z-Crit.	Decision
Trainers.	7	4.39	0.66				
				8	0.11	1.96	Accept
Workshop attendants.	3	4.34	0.67				

Source: Field Survey.

The data in Table 8 show a calculated T-value (T-cal) of 0.11 at 0.05 level of significance, while T-critical is 1.96. The null hypothesis is accepted because the calculated T-value (T-cal), which is 0.11, is lower than the T-critical value (T-crit), which is 1.96. This suggests that there is no statistically significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to metal pre-cleaning skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

Hypothesis 4

There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which brazing operation skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 9. T-test Analysis of the Difference Between the mean responses of trainers and workshop attendants on the extent to which brazing operation skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

	N	X	SD	DF	T-Cal	T-Crit.	Decision
Trainers.	7	4.32	0.69				
				8	0.24	1.96	Accept
Workshop attendants.	3	4.44	0.73				

Source: Field Survey.

Table 9 shows the calculated T-value (T-cal) of 0.24 at the 0.05 level of significance, while the T-critical is 1.96. The null hypothesis is accepted because the calculated T-value (T-cal) of 0.24 is less than the T-critical value (T-crit) of 1.96. This indicates that there is no significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to brazing operation skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

Hypothesis 5

There is no significant difference between the mean responses of trainers and workshop attendants on the extent to which brazed joint post-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State.

Table 10. T-test Analysis of the Difference Between the mean responses of trainers and workshop attendants on

the extent to which brazed joint post-cleaning skills enhance self-employment among mechanical engineering craft-practice students in technical colleges in Rivers State

	N	X	SD	DF	T-Cal	T-Crit.	Decision
Trainers.	7	4.29	0.60				
				8	0.39	1.96	Accept
Workshop attendants.	3	4.45	0.61				

Source: Field Survey.

Table 10 shows the calculated T-value (T-cal) of 0.39 at the 0.05 level of significance, while T-critical is 1.96. For the fact that the calculated T-value (T-cal) of 0.39 is less than the T-critical value (T-crit) of 1.96, the null hypothesis is upheld. This indicates that there is no significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to brazed-Joint cleaning skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

7. Discussion of Findings

The results or findings of the study are discussed here under one after the other. The findings from research question 1, which sought to assess the extent to which students were exposed to good fit and proper clearance skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, indicated that selecting, cutting and fitting work-pieces considering their thermal expansivities, maintaining a clearance of 0.038mm between work-pieces before brazing, making a lap joint three times as long as the thinner member’s thickness, constructing butt joints for brazing works that require high tensile strength, holding tubular joints in the correct alignment for brazing, by nesting one tube inside the other. And increasing joint area by using lap joint using filler wires that contain very good conductors of electricity such as silver, for work-pieces that are intended for use with electricity were good fit and proper clearance skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State. This finding is in agreement with the view of Ubele and Okwelle (2020) that skills are required by students of metalwork in technical colleges for self-employment in Rivers State. The test of the first hypothesis proves that there is no significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to good fit and proper clearance skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

The findings from research question 2, which sought to assess the extent to which students were exposed to metal pre-cleaning skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, indicated that removing oil or grease by dipping the parts into a suitable degreasing solvent, vapour degreasing or by alkaline or aqueous cleaning, removing rust by acid pickle treatment, cleaning heavy rust/hard scales by mechanical abrasive cleaning using grinding wheel, files or grit blast, choosing the right acid and combining them with distilled water in the right proportion considering the nature of the metal and context, neutralizing the leftover acid with appropriate solution to ensure that no acid remains in crevices or blind holes, using the right abrasive wheel for cleaning to ensure proper surface roughness and using alkaline pickle solution such as sodium hydroxide for non-ferrous metals and alloys were good fit and proper clearance skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State. This finding is in agreement with the view of Odinaka (2017) that skills are essential for a successful metalworking and self-employment. The test of the second hypothesis proves that there is no significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to metal pre-cleaning skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

The findings from research question 3, which sought to assess the extent to which students were exposed to parts assembly skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, indicated that producing the right type of joint for any given brazing operation, selecting producing and combining two kinds of joints to improve brazed joint strength, aligning work-pieces for proper/accurate brazing operation, producing fixtures for various shapes/sizes of work-pieces, identifying intricacies in work-pieces and building fixtures to accommodate them, identifying appropriate parts and creating vents in tubular work-places and maintaining the right clearance (gap) for effective capillarity of the molten filler metal were parts assembly skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice Students in technical colleges in Rivers State. This finding is in agreement with the view of Oluwajodu et al. (2015) that there is a strong correlation between skill development and entrepreneurial intent. That students must possess skills/abilities in order to participate in entrepreneurial endeavours. The test of the third hypothesis proves that there is no significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to parts assembly skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

The findings from research question 4, which sought to assess the extent to which students were exposed to brazing operation skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, indicated that flowing the molten filler wire into a tubular work-piece until it runs out through the vents, placing the filler metal at the appropriate position for efficient brazing operation, moving the touch continuously to evenly heat up the work-piece, heating an assembly to the flow point of the brazing filler metals applying the flux from 51 mm to 76 mm to facilitate the flow of the molten filler wire into the workpiece, wearing the right safety gear before commencing brazing operation, connecting the gases only when they are needed to be used and opening acetylene before lighting the torch, followed by oxygen, after the torch has been lit were brazing operation skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State. This finding is in agreement with the view of Bala, et al. (2022) that there is a need for improvement so that metal workers could develop the skills to hold nozzles securely while working on metal. The test of the fourth hypothesis proves that there is no significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to brazing operation skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

The findings from research question 5, which sought to assess the extent to which students were exposed to brazed-joint cleaning skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, indicated that quenching a workpiece in hot water at 120°F (50°C), to remove brazing flux, brushing the assembly (joint) while it is still hot, selecting and using water-based flux for easier post-brazing cleaning, changing work-piece cleaning solution occasionally, sandblasting a work-piece to remove debris from it, dissolving tough flux residues in 25% hydrochloric acid bath at 140° F-160°F (60°C-70°C) and removing phosphate slag through prolonged pickling in sulphuric acid were brazed-joint cleaning skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State. This finding is in agreement with the view of Ehijele and Ugochukwu (2018), that technical college students required knowledge of symbols, how to use tools, and how to read blueprints, among other things. The test of the fifth hypothesis proves that there is no significant difference between the mean responses of trainers and workshop attendants on the extent to which students were exposed to brazed-Joint cleaning skills during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State.

8. Conclusion

Good fit and proper clearance skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, included selecting, cutting and fitting work-pieces considering their thermal expansivities, maintaining a clearance of 0.038mm between work-pieces before brazing, making a lap joint three times as long as the thinner member's thickness, constructing butt joints for brazing works that require high tensile strength, holding tubular joints in the correct alignment before brazing by nesting one tube inside the other, increasing joint area by using lap joint and using filler wires that contain very good conductors of electricity such as silver, for work-pieces that are intended to be used with electricity.

Metal pre-cleaning skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, were removing oil or grease by dipping the parts into a suitable decreasing solvent, vapour decreasing or by alkaline or aqueous cleaning, removing rust by acid pickle treatment, cleaning heavy rust/hard scales by mechanical abrasive cleaning using grinding wheel, file or grit blast, choosing the right acid and combining it with distilled water in the right proportion considering the nature of the metal in context, neutralizing the leftover acid with appropriate alkaline solution to ensure that no acid remains in crevices or blind holes, using the right abrasive wheel for cleaning to ensure proper surface roughness and using alkaline pickle solution such as sodium hydroxide for non-ferrous metals and alloys.

Parts assembly skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, were the right type of joint for any given brazing operation, selecting producing and combining two kinds of joints to improve brazed joint strength, aligning work-pieces for proper/accurate brazing operation, producing fixtures for various shapes/sizes of work-pieces, identifying intricacies in work-pieces and building fixtures to accommodate them, identifying appropriate parts and creating vents in tubular work-pieces and maintaining the right clearance (gap) for effective capillarity of the molten filler metal.

Brazing operation skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, were flowing the molten filler wire into a tubular work-piece until it runs out through the vents, placing the filler metal at the appropriate position for efficient brazing operation, moving the touch continuously to evenly heat up the work-piece, heating an assembly to the flow point of the brazing filler metal, applying the flux from 51 mm to 76 mm to facilitate the flow of the molten filler wire into the work-piece, wearing the right safety gear before commencing brazing operation, connecting the gases only when they are needed to be used and opening acetylene before lighting the torch, followed by oxygen, after the torch has been lit.

Brazed-joint cleaning skills students were exposed to during training to enhance self-employment in brazing among mechanical engineering craft-practice students in technical colleges in Rivers State, were quenching a work-piece in hot water at 120°F (50°C), to remove brazing flux, brushing the assembly (joint) while it is still hot, selecting and using water-based flux for easier post-brazing cleaning, changing work-piece cleaning solution occasionally, sandblasting a work-piece to remove debris from it, dissolving tough flux residues in 25% hydrochloric acid bath at 140° F-160°F (60°C-70°C) and removing phosphate slag through prolonged pickling in sulphuric acid.

9. Recommendations

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

1) Following the result that selecting, cutting, and fitting work-pieces considering their thermal expansivities, etcetera, are the skills Students are exposed to during training to enhance self-employment in brazing, engineering craft-practice students should be given more access to brazing tools, machinery, and a workshop or lab to enable them to develop the technical skills necessary to enhance self-employment in brazing.

2) Based on the result that all the listed items on metal pre-cleaning skills are the skills Students are exposed to during training to enhance self-employment in brazing, curriculum designers and decision-makers should broaden the scope of the curriculum/scheme to incorporate these and more skill sets.

3) From the result that producing the right joint for any given brazing operation, etcetera, are the skills students are exposed to during training to enhance self-employment in brazing, the government should provide more equipment as well as training on practical brazing, to facilitate the acquisition of the skills.

4) Considering the result that flowing molten filler wire into a tubular work-piece until it runs out through the vents, etcetera, are the skills students are exposed to during training to enhance self-employment in brazing, trainers should be more sensitive to communicating the different practical brazing skills open to students, as well as how these skills will lead to self-employment.

Based on the result that all the items on brazed-joint cleaning skills are the skills students are exposed to during training to enhance self-employment in brazing, the government should encourage students of mechanical engineering craft-practice who have acquired brazing skills to go into small-scale businesses after graduation, as this will aid in reducing unemployment in Nigeria.

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