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ASSESSMENT OF METALWORK INSTRUCTIONAL MATERIALS FOR DESIGN THINKING IMPLEMENTATION AS INNOVATIVE APPROACH IN TECHNICAL COLLEGES IN KWARA AND NIGER STATES, NIGERIA

[1*]Shefiu Abdulrauf, Aede Hatib Musta'amala Jamal, Muftau Kayode Raji, & Alhassan Ndagi Usman

[1*]Metalworks Department,
School of Technical Education,
Kwara State College of Education (Technical), Lafiagi.
Email: shefiuabdulrauf@utm.my

[2]School of Education,
Faculty of Social Science and Humanities,
University Tecknologi Malaysia
Email: aede@utm.my

[3]Electical/Electronics Depaetment,
School of Technical Education, Kwara State College of Education (Technical), Lafiagi.
Email: rajimuftaukayode@gmail.com

[4]Department of Technical and Vocational Education,
Abdulkadir Kure University, Minna
Email: algogogius@gmail.com

Abstract

In an attempt for Nigeria to be on the same page with the global trend in technology, it is imperative to have in place an active and meaningful instructional method like the Design Thinking in order to produce students that can withstand the 21st century industrial and economics demands and to implement this there is need to have required and adequate tools and equipment. It is on this backdrop that this study was carried out to assess metalwork instructional materials for design thinking implementation as innovative approach in technical colleges in Kwara and Niger states, Nigeria. A descriptive research methodology was therefore employed for the study of a population consisting of 45 metal work teachers and heads of departments from 10 technical colleges offering metal work subject in Kwara and Niger states. One research question was postulated to guide the study. Data for the study were collected by means of a structured questionnaire which comprised 51 items. The statistical tools employed for data analysis were frequency and simple percentage. The results revealed that there are quite few equipment and hand tools in the technical colleges under study. Based on the findings of the study, it was recommended among others that both states and federal government should provide for the technical colleges in Nigeria with the required tools and equipment in metalwork to aid easy implementation of design thinking approach for skill acquisition in metalwork trade. By implication, making teaching and learning impactful by the teachers and more practical and be learner-centred for the students.

Keywords: Assessment, Instructional materials, Design thinking, Metalwork, Availability

Introduction

Technical and Vocational Education in the view of Okoye and Okwelle (2013), and Okwelle and Ikedi (2020) advocates for the development of the head (knowledge), training of the hand (dexterity) and enriching the heart (consciousness and painstaking). If TVE is properly managed it will provide saleable skills necessary for gainful employment and self-reliance to technical college graduates (Okwelle & Tambari, 2017; Okwelle and Ikedi 2020). That is why provision of necessary instructional materials that could cater for the needed skills in metalwork subject is important. Hence, funding of the programme needs to be of great concern to the government in order to produce students with high problem-solving skills needed to succeed in the 21st century (Razzouk & Shute, 2012). Shehu and Ibrahim (2014) noted that availability of the resources herald meaningful conclusion in the teaching and learning in technical college.

Technical college is an institution of learning where students acquire both practical and theoretical knowledge in a particular trade. Technical college as described by NPE (2013) is a level of education of 3years duration after the upper basic (JSS 3) and before tertiary levels which provide trained manpower at craft, advance craft and technical levels. The beneficiary of this type of education can as well upon completion secure employment or proceed on further education in tertiary institutions such as polytechnics, colleges of education (technical) and universities. Technical college is an institution designed to train people for work to reflect the modern trends and development in occupations and skills requirement (Ayonmike, 2011). These acquired skills cater for many national challenges such as poverty reduction and unemployment among youths. Thus, technical college has major roles to play in the development of skillful personnel who can solve complex problems as result of acquiring the 21st century skills. Therefore, it is important to assess metalwork instructional materials available for implementing the design thinking in technical colleges as an innovative approach to the teaching and learning.

However, literature revealed that in most of the colleges, teaching is at the mercy of the method or approach employed by the teacher especially in teaching metalwork. Therefore, one important modern tool that has been advocated by scholars is design thinking, an approach which allows for more creative and student-centered approach to teaching and learning (Crites & Rye, 2020).

The Design Thinking

Design thinking is a kind of special method to solve complex (wicked) problems (Rittel, 1972; Buchanan, 1992; & Thoring & Müller, 2011) and to generate innovative solutions, based on a user-centered approach with multi-disciplinary teams (Thoring & Müller, 2011). Sarah (2016) noted that the design thinking ideology asserts that a hand-on, user-centric approach to problem solving can lead to innovation and innovation can lead to differentiation and a competitive advantage. The aim of design thinking is getting to the root of problem be it social or technological, and generate a lasting solution. Design Thinking is one promising way to extend the creative potential of both students and professionals (Lembcke, 2016). It is thus a right peg in the right hole if used in the teaching and learning of metalwork subject in technical colleges in Nigeria. As important as this approach may seem, however, availability of instructional materials is an important prerequisite. The desire in this paper, therefore, is to investigate the availability

of these important instructional materials for the implementation of the design thinking in technical colleges in Nigeria.

Razzouk and Shute (2012) defined design thinking as an analytical and creative process that engages a person in opportunities to experiment, create and prototype models, gather feedback, and redesign. The design thinking revolves around three related process or phases that may be non-sequential and iterative namely; inspiration phase; ideation phase; and implementation phase (Sharief, Nailah, Tania, & Tinashe, 2018). There is no doubt that over the last few decades, the design thinking process has been widely accepted as a method for innovation (Dolata & Schwabe, 2016; Hager & Uflacker, 2016; Wrigley, Mosely & Tomitsch, 2018; Albay & Eisma, 2021). Meanwhile, as design thinking is a simple approach to problem solving, it as well increases the probability of success and breakthrough innovation especially in metalwork subject (Sarah, 2016).

In technical education there is need to look beyond the traditional method of handling the entire process in teaching and learning as technology is fast growing across the globe. As the traditional approaches in teaching may no longer work effectively (Luka, 2014; Albay & Eisma, 2021), educational institutions should endeavor to look for new instructional methodologies of enhancing student learning (Albay, 2019; Retna, 2016; Albay & Eisma, 2021). That is why De Sena, Bento, Matias and Silva (2021) suggested that the methodology of Design Thinking should be explored as a protagonist of the change of focus of the teaching process, focus on the student and their learning process. Therefore, to move in the direction of the globe, novelty is required to be infused into the educational system, particularly in the technical education.

Instructional Materials for Teaching Metalwork Technology

Metalwork is one of the trades that are being offered in technical colleges. Metalwork is the product of metal materials such as arts, articles and objects, or act of making object out of metal (NBTE, 2001). This act includes a corresponding wide range of skills, process and tools. Metalwork department in technical colleges involves welding and fabrication, mechanical engineering craft-practice, equipment mechanic work, foundry craft practice and instrument mechanic work (NABTEB, 2014). The teaching of any technical subject involves both theory and practical, the practical aspect must be carried out with the required tools and equipment for effective delivery of the instructions to the learners. Ogbu (2007) stated that teaching equipment (instructional materials) are some of the most effective devices, which both teachers and students can use to enhance the quality of teaching. This equipment includes all forms of information carriers that can be used for teaching and learning activities.

Metalwork cannot be taught effectively in the classroom only; it must go be accompanied with workshop experience where some skills are demonstrated with instructional materials. Ogunleye (2007) affirmed that implementation of metalwork programme calls for provision of workshop activities for learners, without which its objectives may not be realized. The author further stated that the provision of these activities of course presupposes the availability of the relevant teaching resources. In other words, instructional materials such as workshop space, tools, machines, equipment, facilities and human resources must be readily available for effective learning to take place. Instructional materials help to facilitate teaching and learning and are used to influence concrete and permanent change in technical behaviour (James, 2015).

According to Ogwa (2002) and James (2015), instructional materials include audio visual aids, educational materials such as charts and ICT instructional resources, tools, equipment, and machines. Nwachukwu (2006) stated that instructional materials in vocational and technical education are all the practical and skills developing resources that would facilitate the processes of teaching, learning and evaluation of vocational and technical skills. Therefore, metalwork instructional materials are those materials employed by metalwork teacher to teach the subject effectively, especially in the practical class such as tools and equipment.

Instructional materials could be already made object that can be imported such as tools and equipment. If too expensive then another means should be explored to get it within the environment to suite the purpose. Umunadi (2009) observed that realization of the objectives of technical college programmes, and their ability to improve the student achievement depends on a number of factors. These include the availability of equipment, tools and materials, and adequate supply of technical education teachers, and proper implementation and usage of technical equipment tools and materials. Ogbuanya, Ogundola, and Ogunmilade (2010) noted that the effective preparation of any caliber of students is dependent on the availability of facilities for the training.

Therefore, for effective learning in technical education to take place, there must be connection between the brain and the hand. It is imperative for technical colleges to take into cognizance the availability of necessary tools, equipment and instructional materials to enable them meet the objectives of their establishment particularly in the area of metalwork trade. Students' attitudes towards technical subject can be improved positively when tools and equipment are available in technical colleges (Okwelle & Ikedi, 2020).

Availability of Metalwork Instructional Materials

In a simple term, availability means the quality of being at hand when needed (Vocabulary.com, 2021). It is noted that instructional materials are essential for effective teaching and learning, and should be made available in all schools (Tuimur & Chemwei, 2015). Moreover, provision of metalwork instructional materials is shouldered by the government through the college principal who request for the materials on behalf of the head of department that makes them available to the teachers. Availability here refers to accessibility of the metalwork instructional materials, tools and equipment that one can find, buy or get to make the design thinking implementation in metalwork trade feasible.

Assessment of Instructional Materials

Assessment is an act of evaluating object, method/procedure or programme to know it's worth and effect or impact. Owolabi and Olasehinde (2007) described assessment as a means of quality control to determine the level of accountability displayed by stakeholders in the industry and of determining the effectiveness of teaching and learning, as well as in finding out student achievement. On the other hand, Ryan (2021) also viewed assessment as an ongoing process of gathering, analyzing and reflecting on evidence to make informed and consistent judgements to improve future students learning. Therefore, to ensure that metalwork students acquire the 21st century skills, there is the need for assessing on the spot or available teaching facilities in technical colleges for the implementation of design thinking approach in metalwork trade. Metalwork trade is supposed to be a practical oriented subject that needed to be taught with tools and equipment. To achieve this, Sarah (2016) affirmed that approaching problem-solving with a hands-on, leads to innovation. Hence in this context, assessment

will be referring to finding out the availability of tools and equipment needed to implement design thinking approach in metalwork trade. This is particularly important when we consider the fact that training in technical education must be accompanied with provision of required tools and equipment to facilitate knowledge and skills to the learners in all the trades, metalwork inclusive.

Research Question

The research question that guided the conduct of the research is:

I. What is the level of availability of instructional materials (equipment) for design thinking implementation in metalwork subject in technical colleges in North-Central Nigeria?

II. What is the level of availability of instructional materials (hand tools) for design thinking implementation in metalwork subject in technical colleges in North-Central Nigeria?

Methodology

The study was carried out in Technical Colleges offering metalwork subject in Kwara and Niger States, Nigeria. A descriptive survey research was adopted for this study, since the researcher sought for the opinions of the respondents as regards the availability of metalwork instructional materials, as well as employed equipment checklist.

The population for the study comprised of all the 45 metalwork teachers in technical colleges in Kwara and Niger states. Total population sampling technique was employed. Therefore, the entire population was used for the study because it is of manageable size.

The instrument used for data collection were questionnaire and, tools and equipment checklist developed by the researcher. Face to face administration of questionnaire was employed. Frequency and simple percentage were used to analyze the research question. The cutoff percentage for availability of equipment and hand tools was 55%. This implied that any item with 55% and above was regarded as available, while items with less than 55% were considered not available.

Results and Discussion

Data obtained on the level of availability of instructional materials for implementation of design thinking in metalwork subject in technical colleges were presented in Tables 1 and 2.

Table 1: Level of Availability of Metalwork Equipment in Technical Colleges

S/N	Item	Required Number	Available %/ Frequency	Not Available% /Frequency	Decision
1	Portable electric hand drilling machine	50	(26) 52	(24) 48	A
2	Drilling machine (sensitive, pillar and radial)	10	(9) 90	(1) 10	A
3	Grinding machine (floor and table type)	20	(12) 60	(8) 40	A
4	Bench and rotary shears	20	(4) 20	(16) 80	N/A
5	Guillotine (electric and foot operated)	20	(0) 0	(20) 100	N/A
6	Circular cutting machine	20	(1) 5	(19) 95	N/A
7	Folding machine	10	(2) 20	(8) 80	N/A
8	Bending rolls (floor and table type)	20	(0) 0	(20) 100	N/A
9	Oxy-acetylene welding equipment	20	(7) 35	(13) 65	N/A
10	Arc welding machine (AC or DC)	20	(9) 45	(11) 55	N/A
11	Electric hand grinders	30	(10)33.3	(20)66.67	N/A
12	Power hacksaw machine	20	(3) 15	(17) 85	N/A
13	Furnace	10	(13) 130	(0) 00	A
14	Soldering stove	100	(19) 19	(81) 81	N/A
15	Soldering bits	200	(50) 25	(150) 75	N/A
16	Spot welding machine with accessories	10	(0)0	(10) 100	N/A
17	Forging equipment	20	(11) 55	(9) 45	A
18	Foundry equipment	20	(5) 25	(15) 75	N/A
19	Shaping machine	20	(3) 15	(17) 85	N/A
20	Milling machine (horizontal and vertical)	10	(1)10	(9) 90	N/A

NB: Figures in parentheses indicate number of equipment.
KEY: "A" Available. "N/A" Not Available

The results of the availability and non-availability of equipment in technical colleges are presented in Table 1. The result showed that out of 20 equipment that were expected to be found in the technical colleges, 17 equipment were available which fall within the range of 5-90% whereas, items 5, 8 and 16 were not available with zero percent. Among the equipment that were available, item 13 was found to be more than what was required with 30% increment over the required number. Items 1, 2, 3, and 17 had respective percentage availability of 90, 60, 55, and 52. All other items had percentage availability that was below 50%. In the entire equipment item 6 ranked the lowest with 5% availability.

Table 2: Level of Availability of Metalwork Hand Tools in Technical Colleges

S/N	Item	Required Number	Available %/Frequency	Not Available%/Frequency	Decision
1	Bench vice	300	(61) 20.3	(239) 79.7	N/A
2	Combination square	150	(19)12.7	(131)87.3	N/A
3	Centre punch	300	(64)21.3	(236)78.7	N/A
4	Spirit level	150	(22)14.7	(128)85.3	N/A
5	Protractors	150	(22)14.7	(128)85.3	N/A
6	Mallet (assorted)	200	(49)24.5	(151)76.5	N/A
7	File (assorted)	200	(99)49.5	(101)50.5	N/A
8	Try-square	300	(64)21.3	(236)79.7	N/A
9	Micrometer screw gauge	100	(35)35	(65) 65	N/A
10	Vernier calipers	100	(43) 43	(57) 57	N/A
11	Spring divider	300	(70)23.3	(230) 76.7	N/A
12	Hammers (assorted)	300	(68)22.7	(232)77.3	N/A
13	Anvil	20	(13) 65	(7) 35	A
14	Scribers	300	(89)29.7	(211) 70.3	N/A
15	Tap and wrench, stuck and dies(set)	50	(24) 48	(26) 52	N/A
16	Calipers (inside, outside, odd-leg)	50	(33) 56	(17) 44	A
17	Snip/hand shears/table shears	100	(28) 28	(72) 72	N/A
18	Drill bits (set)	200	(47) 23.5	(153) 76.5	N/A
19	Hacksaw frames	100	(102)102	NIL	A
20	Hacksaw blade (consumable)	200	(138) 69	(62) 31	A
21	Engineer's hand vice	100	(19) 19	(81) 81	N/A
22	Clamps (assorted)	100	(35) 35	(65) 65	N/A
23	Riveting pliers	50	(36) 72	(14) 28	A
24	Hand stake (assorted)	50	(22) 44	(28) 56	N/A
25	Tinman's hand-lever punch	100	(20) 20	(80) 80	N/A
26	Grooving punch	30	(7) 23.3	(23) 76.7	N/A
27	Soldering iron/bit	100	(41) 41	(59) 59	N/A

28	Electric hand grinding tools	50	(17) 34	(33) 66	N/A
29	Hand-lever corrugated bench shear	50	(4) 8	(46) 92	N/A
30	Set of screw drivers (assorted)	100	(59) 59	(41) 41	A
31	Vee-block (assorted)	50	(25) 50	(25) 50	N/A

Key: Negative = 1.00 – **NB:** Figures in parentheses indicate number of hand tools available and not available
KEY: "A" Available. "N/A" Not Available

The results of the study on the percentage available and non-available hand tools in the technical colleges are shown in Table 2. All the 31 hand tools that were expected to be found in the technical colleges were available which ranged between 8-72%. Out of 31 hand tools item 19 was found to be more than what was required with 2% increment over the required number. Items 31, 30, 13, 16, 20, and 23 showed respective percentage availability of 50, 59, 65, 56, 69, and 72. All other items had percentage availability that was below 50. In all the hand tools, item 29 was least in availability with 8%. A close look at the results of the available of hand tools in the technical colleges under investigation revealed that the minimum standard that was set is not met (Table 2).

Findings of the study

I. Available equipment in metalwork trade are quite few for consideration of design thinking implementation in the technical colleges under study.

II. Most hand tools are not available to average level and this could hinder design thinking implementation in metalwork trade in the technical colleges under study.

Discussion

The findings of this study with respect to the level of availability of instructional materials in technical colleges indicated that most of the equipment and hand tools were not available at all in some colleges in Kwara and Niger states. The essentiality of availability of instructional materials supposes not to be compromised especially in the technical colleges where learning by doing is desired cum the principles of design thinking that involves physical practice. Provision of tools and equipment is one of the major factors that need to be considered in the accreditation of any technical subject in technical colleges. Equipment such as drilling machine, grinding machine, oxy-acetylene welding equipment, spot welding machine, milling machine, lathe machine, and shaping machine are seriously lacking in most colleges.

However, for student to achieve the right skill, tools and equipment must be available and adequate for effectiveness of the design thinking approach as instructional process.

Conclusion

This paper has assessed the availability of metalwork instructional materials needed for design thinking implementation as innovative approach in technical colleges. The availability of these equipment will in-turn improve the technological and problem-solving skills of the students. It contributes to the advancement of the nation in the area of

technology and reducing the high rate of unemployment in the society. It is hoped that following the recommendation will go a long way in equipping the technical colleges with the required and necessary tools and equipment in metalwork trade.

Recommendations

The following recommendations are suggested as a way of enhancing efficiency on human capacity and effective metalwork instruction;

I. Technical colleges in Nigeria should be provided with the required tools and equipment in metalwork to aid easy implementation of design thinking approach for skill acquisition.

II. The tools and equipment to be supplied for metalwork trade should be modern types that will be in conformity with 21st century and make the design thinking implementation achievable.

III. Practical measure should be put in place to create synergy between industries and the government in the provision of metalwork tools and equipment for the colleges.

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