ASSESSMENT OF THE APPROPRIATE SPECIFIC TASKS IN GAS TUNGSTEN ARC WELDING AND GAS METAL ARC WELDING FOR INCLUSION IN THE INSTRUCTIONAL PACKAGE FOR TECHNICAL COLLEGES IN AKWA IBOM STATE

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ABSTRACT

The study investigated the appropriate specific tasks in gas tungsten arc welding and gas metal arc welding for inclusion in the instructional package for technical colleges in Akwa Ibom State. The objective of the study is to determine appropriate specific tasks in Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW) for inclusion in the instructional package for Technical Colleges in Akwa Ibom State. Two specific objectives, two research questions and two hypotheses guided the study. The research design was Research and Development design (R&D), population of the study consisted of 145 respondents from the nine Government Technical Colleges in Akwa Ibom State, National Business and Technical Education Board and Mechanical Engineering or relevant field. Using the Krejcie and Morgan sample size determination of 1970, the sample size of this study comprised of 128 respo ndents out of the 145 respondents from the nine Government Technical Colleges in Akwa Ibom State, National Business and Technical Education Board and Mechanical Engineering or relevant field. The researcher developed an instrument titled: called "Argon Welding Instructional Package Checklist" (AWIPC). To analyze the data, mean and standard deviation were used to answer the research questions while the hypotheses were tested with analysis of variance (ANOVA) in conjunction with the content validity ratio at 0.05 probability level. The study concluded that that all the specific tasks in the identified areas of Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW) are highly appropriate for inclusion in Instructional Package for Teaching Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW) in Technical Colleges in Akwa Ibom State. The study therefore recommended that Technical Colleges in Akwa Ibom State should adopt the developed and validated instructional package for the teaching of c in Technical colleges in Akwa Ibom State.

KEYWORD: Instructional Package, Gas Tungsten Arc Welding (GTAW) And Gas Metal Arc Welding (GMAW)

INTRODUCTION

Technical College is one of the institutions established by the Federal Government of Nigeria to provide individuals with practical skills, basic scientific knowledge and attitude to enable the individual participate successfully in the world of work. Technical colleges are integral part of Technical Vocational Education Training (TVET). Technical and Vocational Education and Training (TVET) is a comprehensive term referring to those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life (Federal Republic of Nigeria (FRN, 2013).

"Instructional" is simply an adjective from instruction, while instruction is simply an order, direction, the process or act of imparting knowledge by teaching in a formal or non-formal educational sector (Hank et al., 2016). Package on the other hand is defined as a complete unit consisting of a number of component parts sold or taught separately or a group of separate items put together as a single unit. Packaging is equally seen as the act or process of packing (Hank et al., 2016). Therefore, instructional package in education is a complete group of separate items put together as a single unit to be used for teaching in order to impart knowledge. Based on this, instructional package is needed in the teaching of argon welding in Akwa Ibom State Technical College.

Tungsten Inert Gas (TIG), also known as Gas Tungsten Arc Welding (GTAW) is an arc welding process that uses a non-consumable tungsten electrode to produce weld. The weld area and electrode is protected from oxidation or other atmospheric contamination by an inert shielding gas and a filler metal is normally used. A constant current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionised gas and metal water vapours known as plasma (American Welding Society, 2016). Gas Tungsten Arc Welding (GTAW) uses tungsten rods to create a well-defined and neat weld that is usually appealing. According to Dingson (2019), the metal surface needs to be cleaned thoroughly to produce a high-quality weld. Gas tungsten arc welding is a welding process performed using the heat of an arc established between a non-consumable tungsten electrode and the workpiece.

Gas Metal Arc Welding (GMAW) or Metal Inert Gas (MIG) welding process uses a consumable electrode. The electrode is driven through the same type of collect that holds a tungsten electrode by a set of drive wheels. The consumable electrode in the MIG process acts as a source of the arc column as well as the supply for the filler material (Ashutosh, 2010). Gas metal arc welding uses an arc between a consumable constant filler metal electrode and the weld pool (Tawekal, 2016). Gas metal arc welding is an arc welding process that uses the heat of an electric arc established between a consumable metal electrode and the work to be welded. Gas metal arc welding uses a gun that is continuously fed with a consumable electrode. This method uses an external gas to shield the welded metal from various environmental factors like oxygen, therefore, making the welding process quick and continuous. Argon welding can be used in stainless bar, pipe and indoor welding.

STATEMENT OF PROBLEM

The students lack training in other forms of welding like TIG and MIG welding that employ argon gas. This trend has left the students unskillful in argon welding that would have added to their advantages of maximizing their practical potential and skills in different sections of fabrication and welding engineering craft practice. Technical education is meant to equip the students with saleable skills for self-reliant and gainful employment. In situation where the students are not exposed to argon welding method, the job opportunities for students in the modern technological era would be limited. This has called for the development of instructional package in argon welding in Technical Colleges in Akwa Ibom State. Hence, this study seeks to develop and validate an instructional package in argon welding for Technical Colleges in Akwa Ibom State.

OBJECTIVES OF THE STUDY

1. What are the appropriate specific tasks in Gas Tungsten Arc Welding (GTAW) for inclusion in the instructional package for Technical Colleges in Akwa Ibom State?

2. What are the appropriate specific tasks in Gas Metal Arc Welding (GMAW) for inclusion in the instructional package for Technical Colleges in Akwa Ibom State?

HYPOTHESES

1. There is no significant difference among the mean responses of fabrication and welding teachers, fabrication and welding examiners and argon welding practitioners with at least HND or BSc in Mechanical Engineering or in relevant field on the appropriate specific tasks in Gas Tungsten Arc Welding (GTAW) for inclusion in the instructional package for Technical Colleges in Akwa Ibom State.

2. There is no significant difference among the mean responses of fabrication and welding teachers, fabrication and welding examiners and argon welding practitioners with at least HND or BSc in Mechanical Engineering or in relevant field on the appropriate specific tasks in Gas Metal Arc Welding (GMAW) for inclusion in the instructional package for Technical Colleges in Akwa Ibom State.

THE CONCEPT OF DEVELOPMENT AND VALIDATION OF INSTRUMENTS

The term development means having something done through a gradual process (West et al., 2018). It entails evolution or progression from a simpler or lower state to a more advanced, mature or more complex form or state. In education, several things can be developed, including an instrument. Instrument is defined as a generic term representing a variety of data collection devices that are used in education for measurement (Udo and Joseph, 1999) cited in Udoudo, 2014). According to Ogwo and Oranu (2016), educational measurement is a data and information gathering process which involves the assignment of numerical values to outcomes according to specific rules. According to this source, educational measurement is characterized by its tendency to focus on specific trait and to calculate with accuracy the degree to which an individual student possesses that trait.

Researchers such as Trochim (2016) and Effiong (2016) identified many types of validity namely; face, content, predictive, concurrent, construct, convergent and discriminant validities. According to Okoro (2018), predictive and concurrent validity are sometimes referred to as criterion related validity. Criterion related validity refers to the effectiveness of a test in measuring a construct or an individuals' behaviour in relation to his behaviour in another specified situation called criterion (Nkemakolam, 1997) cited in Udoudo (2014). Predictive validity refers to the extent to which a students' present performance in a test can predict his or her future behaviour or performance in some future tasks. In other words, it is concerned with the degree to which success or failure in a particular test can be used to predict success or failures in a future test or activity (Okoro, 2018). Okoro added that predictive validity often have more relevance in comparing performance on a test with actua

On the other hand, concurrent validity is the extent to which present performance in a given activity or test estimates accurately present performance in another test or related behaviour. It is similar to predictive validity except that the two test are administered at the same time in quick succession and it is most useful when a given instrument is evaluated for the purpose of using it to substitute for a more cumbersome instrument or process (Nkemakolam, 1997) cited in Udoudo (2014).

CONCEPT OF GAS TUNGSTEN ARC WELDING (GTAW)

Gas Tungsten Arc Welding (GTAW), also known as Tungsten Inert Gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce weld. The weld area and electrode is protected from oxidation or other atmospheric contamination by an inert shielding gas (argon or helium), and a filler metal is normally used, though some welds, known as autogenous welds, do not require it. A constant-current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionised gas and metal vapours known as a plasma (American Welding Society, 2016). Gas Tungsten Arc Welding uses tungsten rods to create a well-defined and neat weld that is usually appealing. To produce a high-quality weld, the metal surface needs to be cleaned thoroughly. It is also important to choose the smallest electrode possible when performing the weld so as to minimise the chances of contamination. Different arc lengths must be used for different metals when it comes to using the TIG welding technique (Dingson, 2019).

Gas tungsten arc welding is a welding process performed using the heat of an arc established between a non-consumable tungsten electrode and the work-piece. The electrode, the arc and the area surrounding the molten weld puddle are protected from the atmosphere by an inert gas shield which is ducted directly to the weld zone. The electrode is not consumed in the shielded metal arc welding. If a filler metal is necessary, it is added to the molten puddle as shown in Figure 2.18.

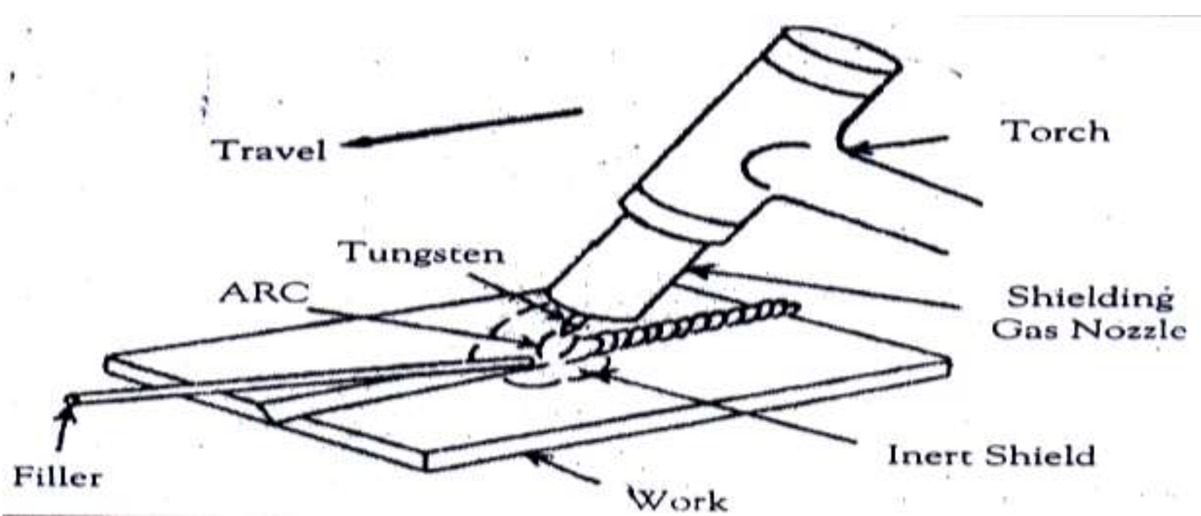

Figure 2.18: Gas tungsten arc welding

Source: Ashutosh (2020)

The major inert gases that are used are argon and helium. Tungsten Inert Gas welds are stronger, more ductile, and more corrosion resistant than welds made with ordinary shield metal arc welding (Ashutosh, 2020).

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In addition, because no granular flux is required, it is possible to use wider variety of weld designs than in conventional shield arc welding or stick electrode welding. The weld bead has no corrosion because flux entrapment cannot occur and because of gas fluxing there is little or no post-weld cleaning operation. There is also little weld metal spatter or weld sparks that damage the surface of the base metal as in traditional shield arc welding. Fusion welds can be made in nearly all commercial metals. The TIG process lends itself ably to the fusion welding of aluminums and its alloy, stainless steel, magnesium, alloys, nickel base alloys, copper base alloys, carbon steel and low alloy steels. Tungsten Inert Gas welding can also be used for combining of dissimilar metals, hard facing and the surfacing of metals.

Gas Tungsten Arc Welding is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminums, magnesium and copper alloys. The process grants the operator greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stinger, higher quality well and difficult to master and furthermore, it is significantly slower than most other welding techniques. Manual gas tungsten arc welding is a relatively difficult welding method, due to the coordination required by the welder. Similar to torch welding, Gas Tungsten Arc Welding normally requires two hands, since most applications require the welder manually feed a filler metal into the weld area with one hand while manipulating the welding torch in the other. Maintaining a short arc length while preventing contact between the electrode and the work piece, is also important (Miller, 2013).

To strike the welding arc, a high frequency generator provides an electric spark. This spark is a conducive path for the welding current through the shielding gas and allows the arc to be imitated while the electrode and the work piece are separated, typically about 1.5 - 3mm (0.06 – 0.12 in) apart. Once the arc is struck, the welder moves the torch in a small circle to create a welding pool, the size of which depends on the size of the electrode and the amount of current. While maintaining a constant separation between the electrode and the work piece, the operator then moves the torch back slightly and tilts it backward about 0 - 5 degrees from vertical. Filler metal is added manually to the front end of the weld pool as it is needed (Lincoln, 2017).

Welders often develop a technique of rapidly alternating between moving the torch forward (to advance the weld pool) and adding filler metal. The filler rod is withdrawn from the weld pool each time the electrode advances, but it is always kept inside the gas shield to prevent oxidation of its surface and contamination of the weld. Filler rods composed of metals with a low melting temperature, such as aluminum, require that the operator maintain some distance from the arc while staying inside the gas shield. If held too close to the arc, the filler rod can melt before it makes contact with the weld paddle. As the weld nears completion, the arc current is often gradually reduced to allow the weld crater to solidify and prevent the formation of crater cracks at the end of the weld (Jeffus, 2017).

CONCEPT OF GAS METAL ARC WELDING (GMAW)

Gas Metal Arc Welding (GMAW) or Metal Inert Gas (MIG) welding or inert gas consumable electrode process, is a requirement of TIG process; however, in this process, the tungsten electrode has been replaced with the consumable electrode. The electrode is driven through the same type of collet that holds a tungsten electrode by a set of drive wheels. The consumable electrode in the MIG process acts as the source of the arc column as well as the supply for the filler material (Ashutosh, 2010). Gas [illegible] is continuously fed with a consumable electrode. This method uses an external gas to shield the welded metal from various environmental factors like oxygen, therefore, making the welding process quick and continuous. This method produces less welding fumes and is easy to learn, requires less heat input and has a high electrode efficiency (Dingson, 2019).

The MIG process is quickly replacing the shield arc stick electrode process because it can easily be applied to an extremely wide range of metals, both ferrous and non-ferrous. This process can also deposit a large quantity of weld metal in a relatively short period of time. It can be done with both semi-automatic and fully automatic operations. Also a large variety of metals can be MIG welded with the same equipment. The only changes are in electrode wire and the shielding gas (Ashutosh, 2010). This method is not effective on thick metals but work well on metals like magnesium, stainless steel, aluminum, silicon, bronze, nickel and copper. It is widely used in construction, automotive repairs, metal fabrication, plumbing, robotics and repairs. To create high-quality welds, the metal has to be cleaned before any welding in metal fabrication takes place (Dingson, 2019). This can easily be done by grinding the metal to remove any paint, mist or solvent that may have accumulated on the metal. If a metal grinder is not available, you can also use a detergent, solvent and water to remove any grease that is present on the metal. Once the metal is clean and the welding begins, it is important to ensure that the welding torch does not touch the metal being welded. A zig zag pattern should be used in this common welding technique to ensure that both sides of the metal joint are being welded (Dingson, 2019).

Gas metal arc welding uses an arc between a consumable constant filler metal electrode and the weld pool. Shielding is provided by an externally supplied shielding gas. This method is also known as metal inert gas (MIG) welding or metal active gas (MAG). GMAW consists of a DC arc burning between a thin bare metal wire electrode and the work piece. The arc and weld area are encased in a protective gas shield. The wire electrode is feed from a spool, through a welding torch which is connected to the positive terminal. The technique is easy to use and fast (high productivity) and there is no need for slag-cleaning since no flux is used. The MAG process is suitable for steel, low-alloy and high-alloy based materials. The MIG process, on the other hand, is used for aluminium and copper materials (Tawekal, 2016).

Gas metal arc welding is an arc welding process that uses the heat of an electric arc established between a consumable metal electrode and the work to be welded. The electrode is a bare metal wire that is transferred across the arc and into the molten weld puddle. The wire, the weld puddle and the area in the arc zone are protected from the atmosphere by a gaseous shield. Inert gases, reactive gases and gas mixtures are used for shielding. The metal transfer mode is dependent on shielding gas choice and welding current level (Ashutosh, 2010).

METHODOLOGY

The research design was Research and Development design (R&D), population of the study consisted of 145 respondents from the nine Government Technical Colleges in Akwa Ibom State, National Business and Technical Education Board and Mechanical Engineering or relevant field. Using the Krejcie and Morgan sample size determination of 1970, the sample size of this study comprised of 128 respondents out of the 145 respondents from the nine Government Technical Colleges in Akwa Ibom State, National Business and Technical Education Board and Mechanical Engineering or relevant field. The researcher developed an instrument titled; called “Argon Welding Instructional Package Checklist” (A[illegible] and standard deviation were used to answer the research questions while the hypotheses were tested with analysis of variance (ANOVA) in conjunction with the content validity ratio at 0.05 probability level.

RESEARCH QUESTION 1

What are the specific tasks in Tungsten Gas Arc Welding (TGAW) appropriate for inclusion in the instructional package for teaching argon welding in Technical Colleges in Akwa Ibom State?

Table 4.1: Mean responses on TGAW welding tasks suitable for inclusion in the instructional package

S/N	Item	$\bar{X}$	SD	Remark
1	Setting up the GTAW welding equipment.	3.67	0.87	HA
2	Using appropriate power supply.	3.80	0.93	HA
3	Holding of the torch properly.	3.67	0.79	HA
4	Directing the arc into the weldjoint.	3.91	0.97	HA
5	Feeding the filler metal into the leading edges of the puddle.	3.25	0.95	MA
6	Adjusting the argon regulator	4.24	0.96	HA
7	Adjustment of the length of electrode.	4.05	0.90	HA
8	Cooling of the torches.	3.91	0.97	HA
9	Selecting appropriate filler metal angle.	3.55	0.95	HA
10	Selecting proper joint designs.	3.88	0.94	HA
11	Appropriate use of the electrode.	3.72	0.91	HA
12	Moving of torch in front of the pool.	4.26	0.98	HA
13	Appropriate tilting of torch when welding.	3.71	0.91	HA
14	Selecting appropriate diameter of electrode for the job.	3.88	0.95	HA
15	Maintaining a constant separation between the electrode and the workpiece.	3.85	0.96	HA

* HA = Highly Appropriate
* MA = Moderately Appropriate

The result in Table 4.1 is a summary of the responses on the specified tasks in Tungsten Gas Arc Welding (TGAW) for inclusion in the instructional package. Table 4.1 shows the mean responses on all the items fall within and above the real limit of 2.50 and 3.49 which indicate that they are highly and moderately appropriate. Item 12 has the highest mean of 4.26 followed by item 6 with the mean of 4.24; while item 5 has the least mean of 3.25. This result implies that all the listed specific tasks in tungsten gas arc welding (TGAW) are highly and moderately appropriate for inclusion in the instructional package for teaching argon welding in Technical Colleges in Akwa Ibom State.

RESEARCH QUESTION 2

What are the specific tasks in Gas Metal Arc Welding (GMAW) appropriate for inclusion in the instructional package for teaching argon welding in Technical Colleges in Akwa Ibom State?

Table 4.2: Mean Responses of the GMAW welding tasks for inclusion in the instructional package

S/N	Item	$\bar{X}$	SD	Remark
1	Choosing the appropriate power supply.	3.34	0.95	MA
2	Operating at the correct wire feeder speed.	3.81	0.91	HA
3	Proper cooling of the nozzle.	3.67	0.79	HA
4	Using argon in proportion of other gases.	3.71	0.81	HA
5	Selecting electrodes with the correct diameters.	3.79	0.87	HA
6	Choosing the correct angle of MIG gun.	3.91	0.97	HA
7	Using the right manipulation pattern.	3.89	0.92	HA
8	Determining the stickout of the electrode.	3.67	0.79	HA
9	Manipulating the weld pool when welding in an overhead position.	3.79	0.91	HA
10	Controlling the shielding gas and the type and size of the electrode.	3.66	0.81	HA
11	Performing a zig-zag pattern while welding.	3.87	0.94	HA
12	Replacing a new consumable bare wire electrode to the torch while welding.	3.76	0.86	HA
13	Directing the electrode and shielding gas to the arc area from the torch.	3.62	0.81	HA
14	Controlling the gun tip-to-work distance (stickout).	3.69	0.89	HA
15	Ability of including consumable tungsten electrode of bare wire on a spool.	3.57	0.97	HA

* HA = Highly Appropriate
* MA = Moderately Appropriate

The results in Table 4.2 is a summary of the responses on the specific tasks in gas metal arc Welding (GMAW) for inclusion in the instructional package. Table 4.2 shows the mean responses on all the items fell within and above the real limit of 2.50 and 3.49 which indicate that they are highly and moderately appropriate. Item 6 has the highest mean of 3.91 followed by item 7 with a mean of 3.89; while item 1 has the least mean of 3.34. This result implies that all the listed specific tasks in gas metal arc welding (GMAW) are highly and moderately appropriate for inclusion in the instructional package for teaching argon welding in Technical Colleges in Akwa Ibom State.

HYPOTHESIS 1

There is no significant difference among the mean responses of fabrication and welding teacher, fabrication and welding examiners and argon welding practitioners with at least HND or BSc. in Mechanical Engineering or in relevant field o UKPONG, Paulinus Happy-Day, Ph.D Gas Tungsten Arc Welding (GTAW) for inclusion in the instructional package for Technical Colleges in Akwa Ibom State.

Tasks 4.10: Analysis of variance of the responses of fabrication and welding experts on specific tasks in Gas Tungsten Arc Welding (GTAW)

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig. P	Decision
Between groups	2.868	2	1.434			
				2.112	0.125	NS
Within groups	84.878	125	0.679			
Total	87.746	127				

NS = Not significant at P > 0.05

The data in Table 4.10 is a summary of the analysis of variance of the responses on the specific tasks in Tungsten Gas Arc Welding (TGAW) for inclusion in the instructional package. Table 4.10 shows that the value of F-cal is 2.11 while the P-value is greater than the stipulated level of significance of 0.05, the null hypothesis is upheld. This implies that there is no significant difference in the mean responses of fabrication and welding teachers, fabrication and welding examiners and argon welding practitioners with at least HND or BSc. in Mechanical Engineering or in relevant field on the appropriate specific tasks in Gas Tungsten Arc Welding (GTAW) for inclusion in the instructional package for Technical colleges in Akwa Ibom State.

HYPOTHESIS 2

There is no significant difference among the responses of fabrication and welding teachers, fabrication and welding examiners and argon welding practitioners with at least HND or BSc. in Mechanical Engineering or in relevant field on the appropriate specific tasks in Gas Metal Arc Welding (GMAW) for inclusion in the instructional package for Technical Colleges in Akwa Ibom State.

Table 4.11: Analysis of variance of the responses of fabrication and welding experts on specific tasks in Gas Metal Arc Welding (GMAW)

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig. P	Decision
Between groups	2.429	2	1.215			
				2.018	0.137	NS
Within groups	75.236	125	0.602			
Total	77.666	127				

NS = Not significant at P > 0.05

The data analysis in Table 4.11 is a summary of the analysis of variance of the responses on the specific tasks in Gas Metal Arc Welding (GMAW) for inclusion in the instructional package. Table 4.11 shows that the value of F-cal is 2.0 the obtained P-value is greater than the stipulated level of significance of 0.05, the null hypothesis is upheld. This implies that there is no significant difference in the mean responses of fabrication and welding teachers, fabrication and welding examiners and argon welding practitioners with at least HND or BSc. in Mechanical Engineering or in relevant field on the appropriate specific tasks in Gas Metal Arc Welding (GMAW) for inclusion in the instructional package for Technical Colleges in Akwa Ibom State.

CONCLUSION

Based on the findings and discussion of findings, it is concluded that all the specific tasks in the identified areas of Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW) are highly appropriate for inclusion in Instructional Package for Teaching Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW) in Technical Colleges in Akwa Ibom State. The instructional package has been developed for teaching Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW) in Technical Colleges in Akwa Ibom State. The content validity Ratio indicated that all the tasks in each of the identified task areas are appropriate for inclusion in the instructional package for teaching Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW) in Technical Colleges in Akwa Ibom State.

RECOMMENDATION

1. Technical Colleges in Akwa Ibom State should adopt the developed and validated instructional package for the teaching of c in Technical colleges in Akwa Ibom State.

2. The State Government should employ Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW) experts in Technical Colleges to teach argon welding.

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