

Adopting the Innovated Jigs and Fixtures for Pipe Welding Process

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Abstract:

This research adopting the innovated jigs and fixtures for pipe welding process for students and teachers of General Climaco National High School, in Toledo City, during the school year 2023-2024 as basis for technology adoption. For the technical requirements, all the domains were none rated. These were the design, bill of material, fabrication process, and functions. These implies that the technical requirements adhered the facts of its usefulness as to adopting more innovations that emphasize the creativity of the design, uphold to the availability and low cost of the materials, ease of fabrication process by the used of welding process through shielded metal arc welding and its functions that has a user's manual way easy to understand. The acceptability level of performance of the innovated jigs and fixtures for pipe welding process approved by the respondents in performing the activity device. The respondent highly accepted the acceptability level of performance of the innovated jigs and fixtures for pipe welding process on its serviceability, durability, performance, and safety. Meanwhile, the aesthetic and features of innovated jigs and fixtures for the pipe welding process were acceptable. This implies that the respondent groups accept and appreciate the purpose and importance of the device to education and output. It is recommended that innovated jigs and fixtures for the pipe welding process be used, and the User's Manual be adopted.

Keywords: Industrial Technology, User's Manual, Adopting Innovated Jigs and Fixtures For Pipe Welding Process, Toledo City

Introduction:

Welding is one of the most common methods for joining two metal parts into one. The procedure is straightforward: apply heat to each metal component. When the pieces have melted sufficiently, they will fuse. The result is a strong bond. Due to its effectiveness, it has been used in various

industries, including shipbuilding, automotive, aerospace, and building construction. It has also been used to join pipes in power plants, refineries, and pipelines by fusing metals.

The applications of welding in various industries underscore its profound importance. In shipbuilding, for instance, welding techniques are used to assemble the intricate framework of vessels, ensuring their strength and durability against the rigors of the open sea (Shields, et al. 2023). In the automotive sector, welding plays a pivotal role in constructing the chassis and body of vehicles, guaranteeing passenger safety and structural integrity (Zhou, et al., 2023). The aerospace industry relies on welding for the assembly of aircraft components, where precision and reliability are paramount (Daneshmand, et al., 2023). Similarly, welding is essential in building construction, where it is used for tasks ranging from attaching structural steel beams to fabricating custom architectural elements (Zhou et al., 2020).

Beyond these applications, welding holds a critical role in the energy sector, particularly in power plants and refineries. In these facilities, pipelines are the arteries that transport fluids and gases essential for electricity generation and fuel production. The welding of pipes is a meticulous process, as the resulting joints must withstand extreme temperatures, pressures, and corrosive environments. Failures in these pipelines can have catastrophic consequences, making the quality and reliability of welds paramount (Hussain, et al., 2023). Therefore, welding is instrumental in ensuring the safe and efficient operation of power plants and refineries.

Shielded Metal Arc Welding (SMAW), commonly known as stick welding, is a prominent welding technique with unique characteristics that set it apart from other methods. SMAW employs an arc welding approach while shielding the weld through the use of a coated metal electrode. During the SMAW process, the welding electrode is enveloped in a flux coating, which, when melted, generates a protective gas to safeguard the weld from contamination.

Proficiency in SMAW necessitates a skilled touch from welders. Achieving a robust weld requires the welder to strike and maintain the arc at the correct angle and speed consistently. SMAW is fundamental to welding, serving as a foundational skill. Mastering this technique provides the groundwork for comprehending and excelling in other welding processes, making them easier to grasp through practice and experience. Consequently, SMAW plays a pivotal role in shaping the skillset of welders and serves as a stepping stone for broader proficiency in the welding craft.

Shielded Metal Arc Welding has some advantages and disadvantages when used. While SMAW is a versatile welding technique, it is only appropriate for specific welding projects. Shielded Metal Arc Welding is a labor-intensive process. It may take longer than other, more modernized, automated welding processes because it must be done by hand. Deposition rates are frequently used to evaluate welding projects and are defined as "the amount of welding material deposited per unit of time." Deposition rates for SMAW projects are lower than for other welding projects. As previously stated, SMAW requires a deft touch. Some processes are easier to understand than others.

A few metals, such as titanium, columbium, and zirconium, are also reactive with the process. Finally, the procedure can become disorganized. When the materials are finished, they may splash

and require additional cleaning. There are several advantages to using the SMAW process. For one thing, the equipment required is simple enough.

DepEd includes SMAW study for students in grades 7-8. While grades 9 to 12 focus on the major that leads to a Shielded Metal Arc Welding National Certificate Level II, this is an exploratory and introductory course (NC II). It covers four common competencies that all Grade 7 and 8 Technology and Livelihood Education students should have: using tools, equipment, and paraphernalia; measuring and calculating; practicing Occupational Health and Safety (OHS) procedures; and interpreting technical drawings and plans. This TVL specialization course led to a SMAW Certificate Level I. It focuses on one core competency every high school student should have: fillet welding on carbon steel plates. The preliminary of this introduction that leads to specialization includes a discussion of the course's relevance, an explanation of key concepts related to the course, and an exploration of career options.

Toledo City is one of the divisions introducing the SMAW subject of the region. In adherence to the DepEd Order, selected schools offer SMAW to their learners. One of these schools is the Gen. Climaco National High School. All grade levels had SMAW in exploratory, specialization, and even senior high school studies. It was observed that the equipment/ materials used, supply, and availability were limited. Traditional practices were introduced and used, but it was observed that it takes more time and burdens for teachers and learners to set up the pipe in preparation for NC2 certification.

In response to this situation, the researcher conceptualizes and fabricates the modernized jigs for NCII at Gen. Climaco National High School, which can produce a good starting point, a more straightforward, easy to operate/set up, and more effective tool to do the job in the context of safe fabrication of the device in the school /classroom shops. Hence this study was developed.

Theoretical Background:

The realm of learning theories, spanning over the past century and a half, has been integral in shaping educational practices and instructional environments (kilag, et al., 2023). These theories, initially developed in a time when digital technology was not yet a factor, continue to play a pivotal role in modern education. However, contemporary educational settings, especially those offering Technical-Vocational courses (TVL), face unique challenges and opportunities, necessitating a critical examination of existing teaching methods and the incorporation of innovative approaches (Kilag, et al., 2023).

Technical-Vocational courses in grades K-12, as regulated by Training Regulations (TR) set by the Technical Education and Skills Development Authority (TESDA) in collaboration with the Department of Education (DepEd), offer learners a pathway to acquire practical skills and competencies. Upon successful completion, students receive Certificates of Competency (COC) or National Certificates (NC) that enhance their employability in fields such as Agriculture, Electronics, Trade, and Construction. This approach not only provides students with the option of entering the workforce but also empowers them to pursue further education or entrepreneurial ventures.

Despite the evident benefits of the K-12 TVL system, there remain areas for improvement. To address these challenges effectively, educational institutions must conduct thorough reviews of their programs, specifically focusing on issues encountered by Grade 12 students in TVL programs like Shielded Metal Arc Welding (SMAW). Such reviews should be informed by needs assessments to allocate resources effectively based on student requirements and availability.

This investigation draws inspiration from Skill Acquisition Theory, which builds upon the Adaptive Control of Thought model (ACT). According to this theory, adults initiate the learning process through explicit processes, followed by adequate practice and exposure, ultimately leading to implicit processes (Adeolu, 2022). Niekum (2015) further emphasizes that the learning of various skills follows a pattern, starting from initial knowledge representation and culminating in effortless, highly skilled behavior. This systematic approach to skill development can be applied to the context of SMAW and TVL programs, allowing educators to understand the progression of skills and tailor instruction accordingly.

Moreover, the integration of Six Sigma methodology is pertinent in the context of TVL programs. Developed by engineer Bill Smith in 1986, Six Sigma offers a comprehensive set of tools and techniques to enhance manufacturing quality by identifying and mitigating sources of defects and minimizing process variability. In educational settings, adopting Six Sigma principles can help standardize and improve the delivery of technical skills training. By implementing empirical and statistical quality management methods, educational institutions can ensure consistent and high-quality instruction, thereby enhancing the learning experience for students.

Technology acceptance, as outlined in the Technology Acceptance Model (TAM) proposed by Silva (2015), plays a critical role in modern education. TAM focuses on the processes that underlie the acceptance of technology, predicting behavior and offering a theoretical framework for successful technology implementation. This model highlights the importance of perceived ease of use and perceived usefulness in shaping individuals' attitudes toward technology adoption. Educational institutions must consider these factors when implementing innovative teaching tools and digital resources, ensuring that they align with students' needs and preferences.

Furthermore, the Diffusion of Innovation (DOI) Theory by Rogers (1962; Cheng, et al., 2004) provides insights into how new ideas, behaviors, or technologies spread through a population or social system. In the context of educational innovation, understanding the factors influencing the adoption of new teaching methods, tools, or curricula is essential. Factors such as relative advantage, compatibility, complexity, trialability, and observability can guide educators and policymakers in promoting the adoption of innovative approaches in TVL programs.

Incorporating these theories and concepts into the educational landscape not only improves the quality of TVL programs but also enhances the overall learning experience for students. By addressing the specific challenges faced by Grade 12 students in TVL courses like SMAW, educational institutions can better prepare learners for success in the workforce, further education, or entrepreneurship. As the landscape of education continues to evolve, embracing innovative teaching and learning strategies is essential to meet the demands of a rapidly changing world.

Methodology:

This section presented the method and design used, the flow of the study, the research locale, the research respondents, the research instruments, the data collection procedure, the statistical treatments of data, the scoring procedure, and the definition of terms.

Design

The study used the Quasi-experimental method of research to gather facts regarding the details in planning, designing, and innovated jigs and fixtures for pipe welding process. A time-efficient research method, descriptive survey design engages the people at the center of the research objective.

In this research, the technical requirements of the fabrication innovated jigs and fixtures for pipe welding process and the extent of acceptability level of performance of the device were determined from the sample's perspective through the prepared survey. The data was treated with the appropriate statistical tools to test the research hypothesis.

	Respondents from General Climaco National High School	
Teachers	5	9.09%
Learners	50	90.91%
Total	55	100%

After the respondents utilized the innovated jigs and fixtures for pipe welding process made by the researcher, results have been expressed. Two sets of questionnaires have been utilized and administered to the Shielded Metal Arc Welding (SMAW) teachers and learners of General Climaco National High School of Toledo City Division. Data were analyzed and interpreted based on the perception of the respondents.

Respondents

The five teachers of Shielded Metal Arc Welding and 50 students in General Climaco National High School were the respondents in the said study. They were chosen through purposive sampling in data collection and answering the questionnaires administered to them.

Table 1 shows the distribution of respondents.

Instrument

This research utilized the modified standardized questionnaire of Hansen and Fern (1993) regarding "Industrial Product Quality: An Empirical Test of Garvins Eight Quality Dimensions". Instruments were adopted in this research and distributed among students and teachers with some modifications. The questionnaire consists of 3 sections. The first section refers to the development requirements such as technical requirement, design, bill of materials, process in fabrication, and it was followed by functions as none rated. Second section referred to the acceptability level of performance of the innovated jigs and fixtures for pipe welding process. The last section refers on the findings of what innovated jigs and fixtures can be adopted.

Data Gathering Procedure

For the gathering of data, the first step was to pass an approval letter addressed to the School Principal of General Climaco National High School of Toledo City Division to seek approval to conduct the study.

After the letter was approved, the questionnaire was personally distributed to the respondents. The respondents were given ample time, preferably 15-20 minutes to answer the questionnaire. If they prefer to answer the questionnaire through their preferred online platforms, questionnaires were given through it.

Data was collected and submitted to the statistician for statistical treatment. It was then subjected to further presentation, analysis, and interpretation with the guidance of the research adviser. A final draft was submitted for finalization and corrections.

Statistical Treatment of Data

The responses of the respondents were statistically treated with the use of several non-parametric metrics:

Weighted Mean. This statistical treatment was used to assess the development requirements of the fabrication of the innovated jigs and fixtures for pipe welding process for the preparation NCII certification and the acceptability level of performance of the innovated jigs and fixtures for pipe welding process for pipe weld preparation NCII certification.

Scoring Procedures

The participants were required to use a Likert scale to determine the level of acceptability level of performance of the innovated jigs and fixtures for pipe welding process through its serviceability, aesthetics, safety, durability, performance and feature. They rated each item on a 4-point Likert scale.

Weight	Range	Category	Verbal Description
4	3.26 – 4.00	Highly Acceptable	If the device aligned the pipe perfectly and served its purpose all the time
3	2.51 – 3.25	Acceptable	If the device aligned the pipe frequently
2	1.76 – 2.51	Less Acceptable	If the device aligned the pipe on an occasional basis.
1	1.00 – 1.75	Not Acceptable	If the device did not aligned the pipe

Results and Discussion:

This section managed the development requirements of adopting the innovated jigs and fixtures pipe welding process as to technical requirements, design, bill of materials, process in fabrication and its functions.

Technical Requirements

Technical requirements are the elements necessary for a system to deliver the desired behavior or function to meet the expectations and needs of a user. Bill of materials and design are included in this.

Design

Creating a system, component, or process to fulfill desired needs is known as design. Design is the preparation of a rough sketch or a set of plans for (an executed work), particularly to plan the form and structure.



The project is intended for Metalworks inside and outside the laboratory. It used the device comfortably during the welding project and design the workpiece and other areas. The Innovated Jigs and Fixtures for Pipe Welding Process comprises the accessories: Angle bar which guide the pipe, Flat bar which the wing nut lies on, Bolt with a wing nut at the top of it so that it easy to turn the bolt by hand that presses the pipe into steady and the Steel plate which is the main base of the jigs and fixtures that support all the load on it. The device has also 5 lines as the output. The users can use the device simultaneously with confidence during workshop operations. The top view has dimensions of 13 inches as width and 12 inches as length with mixed materials and accessories attached. The front view has 11 inches in height fixed.

Design is where a pipe weld's quality is first determined. This is the point at which it is determined what pressures, loads, stresses, and other external forces a pipe welding must be able to withstand. These specifications will specify the pipe's dimensions, the alloys used to make it, and how the pipe is welded. Additionally, designers must balance the project's engineering requirements with the applicable laws and industry norms (Esab, 2020).

Bill of materials

A bill of materials is a detailed list of all the raw materials, assemblies, subassemblies, parts, and components that are required to make a product, along with the quantities of each. It is needed to know if the materials are also available in local areas. It includes things like raw materials, items, parts, subassemblies, interrelated data layers, and other things that affect the product's cost. This gives the parts and instructions needed to make a specific product.

Table 2
List of Materials and Cost

Quantity	Unit	Materials	Price	Price
1	pieces	Steel Plate 12mm x 4" x 12" (Scrap)	150.00	150.00
2	sets	Bolt and nut M10 x 80mm	60.00	120.00
2	pieces	Wing nut M10	20	40.00
1	kilo	Welding electrode (E6012)	150.00	150.00
1	length	Flat bar 2" x 1/8" x 20ft.	700.00	700.00
1	pieces	Angle bar 4" x 3/16" x 10 " (Scrap)	70.00	70.00
		total Cost of Material	Php	1,230.00

Material, Tools, and Equipment Needed for the innovated jigs and fixtures for pipe welding process. For the materials needed it includes the following 1piece steel plate 12mm x 12" x 12", 2pieces bolt and nut with spacer M10 x 80mm, 2pieces wing nut M10, 1piece flat bar 1" x 1/8" x 20 feet and 1 piece angle bar 4" x 3/16" x 20 feet.

Tools includes open wrench, Box Wrench, Combination Wrench, Pliers, Steel Tape Rule, Hack Saw and Flat File. It also needed other equipment like Portable Angle Grinder, Welding Machine, Bench Grinder, Impact Wrench and Hand Drill.

In making and creating this innovated jigs and fixtures, the procedures to be followed are Planning your work, Making a working drawing, Make a quantity survey and canvass the materials and accessories. Set-up all accessories for the pipe welding jigs and fixtures. Attach through welding the angle bar to the steel plate, which is the base. Attach through welding the flat bar of each side of the base. Attach the top portion of the flat bar from each side through welding. Make a through the hole from the top portion of the flat bar. Attach the wing nut to the top portion of the bolt. Install the bolt and nut.

When building a product and ordering replacement parts, a BOM list is essential and helps to avoid problems if product repairs are necessary. Planning for acquisition orders lowers the likelihood of errors. Numerous businesses contract out their manufacturing process to other businesses to lower overhead costs. The bill of materials assists in ensuring that each manufacturer only uses the components required for producing a specific product (Megave, 2019).

Process in Fabrication

The procedures used in fabrication were those that shaped, cut, or mold raw materials into finished products. The construction of products using a combination of typically standardized parts and one or more distinct processes was known as fabrication. The process includes the following. First was preparing all materials needed in making the device. Second was attaching the base plate and angle bar through welding process with the angle of 45 degrees in each of the angle bar, this was to hold the pipe in proper position. Third was to attach the side column welded into the side of the base and connected into the other side. This served as the handle for lifting the devise and at the same time it served as the place for the wing nut to install for the locking purposes of the pipe to be

welded. After this process, the device proceeded in the cleaning process using portable grinder for taking out rust and then painting of the product for finish output.

A panel of experts identified eight crucial metal fabrication knowledge and skill areas that beginning education teachers should have before beginning a career as teachers, according to Swafford 2019. The equipment and production of metal fabrication, as well as student evaluation and laboratory management, were among these knowledge and skill areas.

Function

Functions were advantageous because they minimize effort or enable people to carry out tasks that were outside of their normal scope. This was one of the most important considerations in planning. Its output was the basis of the device if its needs to be modified or to continue. The main function of this device was to hold the pipe from moving and aligning the pipe and its root face before proceeding to welding process. If the pipe is properly aligned, it assured that the output will pass in one of the indicators in assessing the pipe welding process. The device will provide smooth flow of processing because it will help the work target to achieve the correct output or product. It is important that the steps in working the product is accurate from the start to end of the process. If one of the steps or processes is inaccurate then the consequence will be undesirable output which leads to failed grade or project. This device totally performed its function in completing the project. It is essential to help students recognize common device functions. Because many commonly used devices are used so frequently, it can be difficult for students to recognize examples of their functions.

ACCEPTABILITY LEVEL OF PERFORMANCE OF THE INNOVATED JIGS AND FIXTURES FOR PIPE WELDING PROCESS

This section presented the extent of the acceptability level of performance of the innovated pipe welding process utilizing jigs and fixtures as to serviceability, aesthetics, safety, durability, performance, and feature.

Serviceability

Serviceability was a metric and a collection of features that support how quickly and easily a system can undergo corrective maintenance and preventive maintenance. When a product breaks down, its serviceability depends on how quickly it can be repaired and how competent and professional the repair person is. Table 2 shows the results on serviceability of the respondents. The indicator with the highest weighted mean from the respondent groups was “easy to maintain” with an average of 4 and 3.62, interpreted as Highly Acceptable. This implied that acceptability of the innovated jigs and fixtures for pipe welding process as to serviceability was very functional.

Table 3
Serviceability

	HA	A	LA	NA	Weighted Mean	Verbal Description
Easy to maintain	37	17	1	0	3.81	Highly Acceptable

Dependable, competent installation	25	18	11	1	3.21	Acceptable
Speed of repair service	26	23	6	0	3.47	Highly Acceptable
Average					3.50	Highly Acceptable

Legend:	3.26 – 4.00	Highly Acceptable
	2.51 – 3.25	Acceptable
	1.76 – 2.51	Less Acceptable
	1.00 – 1.75	Not Acceptable

The supports how quickly and easily a system can undergo corrective thanks to serviceability. Serviceability is a metric and a collection of features that support how quickly and easily a system can undergo corrective maintenance and preventive maintenance. Corrective maintenance (CM) refers to all steps taken to fix and return a malfunctioning system to an operational or usable state. A good product's serviceability is a crucial component. Too many products are created with the cost as the primary consideration. Industrial products should always be repairable and, t can be repaired with standard parts to the greatest extent possible.

The indicator with the lowest weighted mean was “dependable, competent installation” with an average of **3.62** and **3.22** interpreted as **Highly Acceptable** and **Acceptable**. Teachers and learners were doubtful with their competence in utilizing the product. With these terms dependable, competent installation, there is no guarantee that they will adhere to the most recent health and safety regulations and will undergo regular evaluations to confirm their ongoing competence. They still lack of confidence that they can complete the work both safely and under all legal requirements.

The average weighted mean of the domain serviceability was **3.50**, interpreted as **Highly Acceptable**. This implied that both the respondent groups appreciated the acceptability of the innovated pipe welding process utilizing jigs and fixtures in terms of serviceability. Thanks to serviceability, the system's availability and dependability are increased during its useful life. A good product's serviceability is a crucial component. Too many products were created with the cost as the primary consideration. Service design provided in-depth understanding of the needs and motivations of customers, which lead them to use particular types of services. Industrial products should always be not only serviceable but with standard parts to the greatest extent possible. This enabled businesses to create emotionally engaging services that increase client loyalty (Hellon, 2020).

Aesthetics

The nature of art and the framework for interpreting and evaluating works of art are the subjects of aesthetics. A fundamental design principle, aesthetics, determines what makes a design appealing. Aesthetics in the visual realm includes elements like balance, color, movement, pattern, scale, shape, and visual weight. Designers enhanced functionality with aesthetically pleasing

layouts to complement the usability of their designs. Table 3 revealed the results of aesthetics on the survey based on the respondent's views.

	HA	A	LA	NA	Weighted Mean	Verbal Description
Compatibility with existing design	28	16	11	0	2.99	Acceptable
Compatibility of existing tools	40	14	1	0	3.84	Highly Acceptable
Variety of style and colors	14	27	14	0	2.73	Acceptable
Adjusted goodness of fit	20	18	17	0	2.85	Acceptable
Average					3.50	Highly Acceptable

Table 4
Aesthetics

The indicator with the highest weighted mean among the respondent groups was “Compatibility of existing tools” with an average of **4** and **3.68**, interpreted as **Highly Acceptable**. This implied that the skill was always implemented and it was observed every time that tools were compatible and present.

Choosing the appropriate welding consumables, such as electrodes and wire, is essential for high-quality and long-lasting welds. These comparatively insignificant parts greatly impact the final weld's strength, integrity, and appearance during the welding process. The supplies used to make a weld, such as electrodes and filler wire, are known as welding consumables. While filler wire is used in MIG (Metal Inert Gas) and TIG (Tungsten Inert Gas) welding, electrodes are used in arc welding processes. These consumables help to improve the weld's overall performance and quality.

The indicator with the least weighted mean from the respondent groups was “Variety of style and colors”, with an average of **2.40** and **3.06**, interpreted as **Acceptable**. For the respondents, variety and color is less prioritize, the color of the device won't matter greatly, what matter most is the output of the device. Any coloring of the weld or its surroundings is a sign of oxidation. The colors range from colorless chrome (minimal corrosion risk), to straw, gold, blue, or purple (maximum corrosion risk). The level of oxidation is thicker the darker the color.

Other problems than cross-contamination can benefit from color-coding. For instance, color-coding can be useful for maintaining order in the workplace because it reduces confusion. Color-coding can make it easier to keep track of the tools in a particular work area for a facility with lots of employees.

The average weighted mean of the domain aesthetic was **3.04**, interpreted as **Acceptable**. This implied that the skills in this domain do not need so much attention. Concerning the beautification of the device its just a plus factor what matters most to them is its function and contribution to the field.

Safety

Safety refers to not experiencing or causing harm, injury, or loss. a tool or machine intended to stop unintentional or dangerous operations. A safe product is one that, while considering the normal or reasonably foreseeable use of the product and the requirement to maintain a high level of protection for consumers, offers either no risk or a minimum acceptable level of risk. Table 4 reveals the results of safety.

From the teacher respondents, the indicator with the highest weighted mean were “Safety habits is being applied, Preparation of tools, machines, materials and accessories and Adequate ventilation of the working area”, with an average of **4**, interpreted as **Highly Acceptable**. This implies that teachers always believed that safety during the activity is very important, from the preparation of the materials and tools to the working area and to the learners who performed the task and always make safety a habit for them. For the students respondents, the

Table 5
Safety

	HA	A	LA	NA	Weighted Mean	Verbal Description
Safety habits is being applied	38	17	0	0	3.83	Highly Acceptable
Preparation of tools, machines, materials and accessories	34	21	0	0	3.79	Highly Acceptable
Adequate ventilation of the working area	17	17	2	19	3.22	Acceptable
Proper housekeeping of the working area	26	25	4	0	3.49	Highly Acceptable
Average					3.50	Highly Acceptable

indicator with the highest weighted mean was “Safety habits is being applied” with an average of **3.66**, interpreted as **Highly Acceptable**. This implies that learners also believed that making safety

a habit is a priority. They believed that 100 percent of safety can always give them a better performance.

Welders may sustain various physical injuries without the appropriate PPE (personal protective equipment), such as eye damage, cuts, burns, or even crushed fingers and toes. Since these wounds may occasionally prevent a welder from working, they should be taken seriously. UV radiation and metal fume exposure are two health risks associated with welding, cutting, and brazing operations. The risks associated with these procedures include burns, eye damage, electrical shock, cuts, and toe and finger crushing. Safety is a must.

The indicator with the lowest weighted mean from the teacher respondents was “Proper housekeeping of the working area” with an average of **3.6**, interpreted as **Highly Acceptable**. This implies that they are always seen as proper housekeeping of the area can always affect safety. This may be the lowest but it was observed it was still implemented all the time. From the learner’s view, the indicator with the lowest weighted mean was “Adequate ventilation of the working area”, with an average of **2.44**, interpreted as **Acceptable**. For them, a good ventilation must be given attention. This is for Health reasons. For some classroom or laboratories for welding, they lack some of ventilation for air and light.

The average weighted mean for safety was **3.58**, interpreted as **Highly Acceptable**. This implies that the respondent groups viewed and observed that school welding laboratories and applications always follow the safety guidelines and policies in the work environment and also satisfies the health concerns of the teacher and learners doing the welding.

If safety procedures are not followed, a welding arc can produce extremely high temperatures, posing a fire and explosion risk. The most frequent reason for fire, despite the arc itself reaching temperatures of up to 10,000 degrees Fahrenheit, is when sparks and spatter come into contact with combustible substances nearby the work area. Without welding, you wouldn't have a car or any other electrical equipment at home.

Durability

The ability of a physical product to continue functioning under normal operating conditions for the duration of its design life without needing extensive maintenance or repair is known as durability. Durability is the capacity to withstand repeated use without noticeably degrading. Durable materials benefit the environment by preserving resources, minimizing waste, and minimizing the environmental effects of repair and replacement. Table 5 showed the results of durability for the innovated jigs and fixture.

Table 6
Durability

	HA	A	LA	NA	Weighted Mean	Verbal Description
Service life	32	2	16	5	3.51	Highly Acceptable
Structural Integrity	17	1	20	17	2.81	Acceptable

Resistance to wear	39	3	8	5	3.48	Highly Acceptable
Average					3.27	Highly Acceptable

The indicator with the highest weighted mean was “Service life” with an average of **4**, interpreted as **Highly Acceptable**. This implied that teachers believed that the jigs and fixtures are very durable in operation and processes.

A jigs and fixture's main function is to increase accuracy and make it possible for the welder to repeatedly replicate a design's manufacturing. A jigs and fixtures, however, stands still while permitting the workpiece to move, in contrast to a fixture, which offers a stable mounting for the workpiece and moves in relation to it. From the learner's point of view, the indicator with the highest weighted mean was “resistance to wear” with an average of **3.36**, interpreted as **Highly Acceptable**. This implied that learners because they always use it especially in performing their NC II. There was no other device that can correctly perform the alignment specially setting-up pipe.

The indicator with the lowest weighted mean was “structural Integrity” from the respondent groups with an average of **3.10** and **2.22**, interpreted as **Acceptable**. This implied that the skill was not familiar to them. The device was not very exposed to learners and in terms of its positioning and set -up they were not that best performed by them. Since it was newly introduced to them, they don't ha sufficient knowledge to properly position and set up the device.

The average weighted mean of the domain under durability was **3.27**, interpreted as **Highly Acceptable**. This suggested that the device's structure was well-planned and in line with its intended function, which is to prevent the six ways of freedom in a workpiece setup, according to teachers and students.

Performance

Performance is a product's response to outside actions in each working environment. A product's response actions in its working environment were referred to as product performance. A product's performance is realized through the performance of each of its individual parts. Numerous definitions implied that product performance is a gauge of its functional qualities. Table 6 presented the results for performance.

Table 7
Performance

	HA	A	LA	NA	Weighted Mean	Verbal Description
Effect of workers productivity	34	16	5	0	3.65	Highly Acceptable
Ability to enhance status of the user	22	26	7	0	3.33	Highly Acceptable

Multi-functionality of product	11	28	14	2	3.20	Acceptable
Average					3.39	Highly Acceptable

The indicator with the highest weighted mean among the respondent groups was “Effect of workers productivity”, with an average of **3.80** and **3.50**, interpreted as **Highly Acceptable**. This implied that both respondent groups thought the result could have a significant impact. If they set up for the activity, there is a very good chance that they had fewer back jobs and less downtime working the workpiece because the equipment aligned with the flow of the work smoothly without achieving any mistakes, especially in the finished output.

The most recent information on the new techniques and goods that have elevated welding to the status of a high-tech industry can be found at Welding Productivity. If it's new and increases welding productivity, it should be used, from training and software to controls, robotics, and materials. If they are given the opportunity to set and achieve attainable goals, they will be more productive. Setting goals assists workers in becoming more self-motivated and self-assured in their capacity to succeed (Ottawa, 2020).

The indicator with the lowest weighted mean from the teachers was “Ability to enhance status of the user “ with an average of **3.40** interpreted as **Highly Acceptable**. This suggested that some TLE teachers may have had some exposure to the sector. They were already proficient in using tools like this newly developed pipe welding process that makes use of jigs and fixtures. Additionally, they found it simple to manipulate because the procedures were standard in the classroom, particularly for shielded metal arc welding. From the students view, the lowest mean among the indicators was **2.80**, interpreted as **Acceptable**. This was “Multi-functionality of product”. This implied that the students acceptability of the product was lesser. Because of the new device introduced the familiarity of using the device was somewhat considered as a little problem. Learners need to be oriented very well as to what and how to use the product. The must knew the value of the functionality of the device.

Product feature established the brand and aids in starting the company from scratch so that, in the long run, it can start concentrating on the design. Even if a product doesn't have a good design, it can still be used as long as it has the necessary features. Product function rather than product form is essential to succeed as a brand.

The average weighted mean of the domain was **3.39**, interpreted as **Highly Acceptable**. This suggested that the device's performance influences the output of the product. It was thoughtfully constructed to encourage proper alignment, which is one factor to consider when welding. It is very beneficial for both teachers and students to perform activity-based learning and earn NCII certificates with ease and comfort. It includes the ability to produce quick, accurate, and high-quality output that can help the user become a great employee.

Feature

Feature is a product's traitor attributes that deliver value to the end-user and differentiate a product in the market. Table 7 showed the results of the feature of the product.

Table 8

	HA	A	LA	NA	Weighted Mean	Verbal Description
Availability of the design	35	15	5	0	3.57	Highly Acceptable
Sound quality	29	14	11	1	2.98	Acceptable
Affordability	20	12	16	7	3.08	Acceptable
Value	39	9	7	0	3.14	Acceptable
Average					3.39	Highly Acceptable

Feature

The indicator with the highest weighted mean from the teachers responses was “Availability of the design” with an average of **3.60** interpreted as **Highly Acceptable**. It implied that the design had a significant impact on the final product. If someone wants to copy the design of the device to create the desired output in the pipe welding process, it complied with standards and is simple to fabricate. From the students responses the indicator with the highest weighted mean was “Value” with an average of **3.60**, interpreted as **Highly Acceptable**. It means that the tool has significant value for the students because it greatly aids them in completing and adhering to their projects. It is the only thing that would enable them to produce accurate and high-quality projects in less time. It is challenging for them to pass the NCII welding certification without using this type of modernized jig and fixture.

The indicator with the least weighted mean among the teachers was “Value” with an average of **2.60**, interpreted as **Acceptable**. This implied that the users doesn't focused on the value since their they focused more on the design of the devise. It helps you differentiate between asset priorities. The value of the device is only meant for feeling in using while they give emphasize to physical impact of the device.

Additionally, the learners lowest weighted mean was **2.76** interpreted as **Acceptable** on “Affordability”. This implied that learners can tell for their selves that the device is not so affordable for them because most of the learners for now is dependent for their parents or guardian. They cannot produce on their own financial without the help of others for producing such this kind of device. This is the reason why it's the lowest for the indicator.

The average weighted mean of the domain on features was **3.19**, interpreted as **Acceptable**. This implied that the feature of the device is the balance indicator it could be achievable for the standards of the teachers and students in producing this device. It is also important to know what are the capabilities of this device through features.

Summary of Results

Table 8 showed the summary of the acceptability of the innovated jigs and fixtures for pipe welding process.

Table 9
Summary of the Results

Indicators	Average Weighted Mean	Verbal Description
Serviceability	3.50	Highly Acceptable
Aesthetics	3.10	Acceptable
Safety	3.58	Highly Acceptable
Durability	3.27	Highly Acceptable
Performance	3.39	Highly Acceptable
Feature	3.19	Acceptable
Average	3.34	Highly Acceptable

The domain with the highest weighted mean under acceptability of pipe welding process utilizing jugs and fixtures was Safety with an average of **3.58**, interpreted as **Highly Acceptable**. This implied that the safety in working with this device really gave great impact to the user in performing the activity. The number one concern in terms of working physically is safety and this device prove that it considered safety of the user. The device will be forfeited if it cannot pass for safety and here, it was evidently that safety is the most important thing above all.

The domain with the lowest weighted mean was Aesthetics with an average of **3.10** interpreted as **Acceptable**. This implied that aesthetics were not the main point of the device. It gave additional consideration with other indicator to make the device perform well to its function in the process of preparing the setting of for pipe welding but still it gave impact of the device.

The average weighted mean was **3.34** interpreted as **Highly Acceptable**. This implied that the device were visibly doing the target purpose for teacher and students in the field of shielded metal arc welding. It gave the users with comfort and confidence because it's precisely built for this specific functions to give the best output and experience to the user who are engage in this field. It's guaranteed to support the output to pass from the NCII certificates.

Conclusion:

The technical requirements included the design, bill of material, process of fabrication and functions. This innovated Jigs and fixtures with a 45-degree mirror-side were used when welding two pipes together. This innovated Jigs and fixtures were tools that hold the pipe in place so that tack welding can be done. Instead of directing it, this innovated jigs and fixtures hold the work

piece steadily in a fixed position, orientation, or location. This device's primary aimed to stabilize the pipe and align especially the root face before the welding process begins. It will be guaranteed that the output will pass in one of the indicators in evaluating the pipe welding process if the pipe and the root face are properly aligned. The tool will ensure a smooth processing flow because it will assist in achieving the intended result or product. This was approved by most of the respondents. The acceptability level of performance of the innovated jigs and fixtures for pipe welding process as to serviceability, durability, performance, and safety was highly accepted by the respondent. Meanwhile, aesthetics and feature were of the innovated jigs and fixtures for pipe welding process were acceptable. This means that the respondent groups accept and appreciate the purpose and importance of the device to education and output.

Thus, based on the findings and after careful analysis and interpretation of the data gathered, it was concluded that the Innovated Jigs and Fixtures for Pipe Welding process met the standards and was precisely functional in performing each function for Metalworks Instructions and laboratories. The respondent's acceptability level of performance of the innovated jigs and fixtures for the pipe welding process has impact on the adoption.

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