

Development and evaluation of plate and pipe welding positioner

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Abstract

This study aimed to develop a *Plate and Pipe Welding Positioner* as an instructional innovation to enhance students' welding competencies in the course *Fundamentals of Welding Design and Facilities*, specifically within the domain of welding and fabrication technology. The objectives of the study were threefold: (1) to design and fabricate a low-cost, functional welding positioner; (2) to assess its level of acceptability in terms of design, functionality, cost-effectiveness, and safety as evaluated by both students and industry/academic experts; and (3) to determine whether a significant difference exists between the evaluations of students and experts regarding the developed instructional device. The study utilized a quantitative descriptive research design and involved two groups of respondents—15 faculty experts and 15 welding students. Data were collected through a researcher-developed questionnaire and analyzed using weighted mean and independent sample t-test. Results revealed the following mean scores: 3.79 for design, 3.80 for functionality, 3.68 for cost-effectiveness, and 3.83 for safety—yielding a grand mean of 3.78, which falls under the *highly acceptable* category. Statistical analysis showed no significant difference between the evaluations of the two respondent groups, suggesting a consistent level of acceptability across perspectives. The findings support the practical value of the welding positioner as a low-cost, efficient instructional tool that can enhance technical skills development. This innovation contributes meaningfully to welding and fabrication technology education by addressing the shortage of instructional equipment and promoting hands-on, experiential learning.

Keywords: development, instructional equipment, pipe, plate, welding positioner

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1. Introduction

In light of the rapidly evolving trends and increasing complexities in technological education, there is an urgent need to upgrade instructional equipment, tools, and devices. This is essential to ensure that students attain globally competitive standards and acquire the technical competencies necessary to thrive in the professional, scientific, and technological fields. These developments align with the broader mission of the educational system, which is to deliver quality education that promotes the holistic development of individuals, thus contributing to the eradication of illiteracy and the upliftment of human life.

The 1987 Philippine Constitution establishes education as a fundamental right, mandating the state to make quality education accessible to all. Article XIV, Section 1, explicitly states: *“The State shall protect and promote the right of all citizens to quality education at all levels and shall take appropriate steps to make such education accessible to all.”* Furthermore, the Constitution encourages the development of financial support systems—such as scholarships and student loans—especially for learners from underprivileged sectors (1987 Philippine Constitution).

A key legislative framework supporting technical-vocational education and training (TVET) is Republic Act No. 7796, also known as the Technical Education and Skills Development Act of 1994. This act created the Technical Education and Skills Development Authority (TESDA) by consolidating workforce development agencies including the National Manpower and Youth Council (NMYC), the Bureau of Technical and Vocational Education (BTVE), and the Bureau of Local Employment (BLE). TESDA is tasked with planning, standard-setting, policy coordination, and resource allocation for TVET institutions (RA 7796, 1994). TESDA continues to play a pivotal role in enhancing the Philippine workforce by promoting collaboration among industry partners, labor groups, local governments, civil society, and technical institutions. It ensures that skills development programs remain relevant, inclusive, and responsive to the demands of both local and international labor markets (TESDA, n.d.).

Technology education is a cornerstone of national development. As noted by Pagatpatan (2022), it fosters innovation, creativity, productivity, and the application of scientific knowledge—skills that are vital in today’s globalized economy. However, many technical-vocational schools and state universities face persistent shortages in tools, equipment, and instructional resources. According to Guyong (2015), these shortages can be addressed through local innovation and the development of improvised instructional devices, which are often as effective as costly, imported equipment in conveying core scientific and technical principles. Instructional materials—ranging from multimedia to print—play a critical role in enriching learning experiences. Gregorio (2000, in Guyong, 2015) emphasized that effective teaching must go beyond lectures. Learning is most impactful when students engage their senses through hands-on experiences, particularly in science and technology education.

As a leading institution in education, innovation, and sustainable development, Nueva Vizcaya State University (NVSU) strives to meet global standards by preparing graduates to serve local, national, and international industries. NVSU remains committed to quality education by promoting access, innovation, research, training, and extension services. It continues to enhance its Quality Management System, aligning with its vision and core values while addressing learners’ needs (NVSU, n.d.). NVSU offers a course in Welding and Fabrication Technology under the College of Industrial Technology (CIT). However, the absence of sufficient instructional materials has posed significant challenges to effective skills development. In response, this research focuses on the development and evaluation of a plate and pipe welding positioner, a teaching device designed to improve students' hands-on learning experiences and technical proficiency.

According to Gepila (2012), developing instructional devices is a product of educational research and development. These tools are especially crucial for students in programs like the Bachelor of Science in Industrial Technology (BSIT), where acquiring manipulative skills is essential. A welding positioner is a mechanical device that allows welders—particularly trainees—to work with consistency and precision. It holds workpieces such as pipes or flat bars at ideal angles, using a rotating and overturning mechanism. Welding processes involve complex techniques and potential hazards, including issues like incomplete fusion or excessive penetration, often caused by poor heat control or incorrect handling (Cary & Helzer, 2005).

To address these concerns, the study also proposes an ergonomically designed welding table with multiple swivel arms. This setup allows pipe welding in a 1G flat position with rotation, providing stability and improving both the safety and quality of student projects. As emphasized by TESDA (n.d.), well-designed welding fixtures and workstations are vital in minimizing fatigue and ensuring high-quality output. This initiative stems from the researcher's commitment to improving instructional delivery and advancing student competencies in welding and fabrication. The development of the plate and pipe welding positioner directly supports the National Research Agenda for Teacher Education (NRATE) 2019–2023, which underscores the need for qualified educators and innovative teaching strategies. Globally, the right to education includes the right to be taught by competent and well-prepared teachers.

In higher education institutions such as NVSU, the College of Teacher Education implements research initiatives focused on localized knowledge, teaching effectiveness, and product development, including instructional tools and devices. This research also aligns with the College of Industrial Technology's research agenda and contributes to the United Nations Sustainable Development Goal (SDG) 4, which advocates for inclusive, equitable, and quality education, while promoting lifelong learning opportunities for all (United Nations, 2015).

This research on the development and evaluation of a plate and pipe welding positioner is anchored in national laws, institutional mandates, and global education goals. It responds to the pressing need to enhance students' technical knowledge, skills, and values, particularly in the field of welding and fabrication. Through innovation and dedication, the study aims to contribute meaningfully to the improvement of instructional practices and workforce readiness, empowering future professionals to meet both local and global standards.

2. Related Literature

This study on the development of a *Plate and Pipe Welding Positioner* is classified as a utility model and instructional innovation, grounded in Instructional Theory. As explained by Mergel (1998, as cited in Pagatpatan, 2022), instructional theory offers clear guidance for enhancing learning and development. It highlights expected learning outcomes and their rationales, and proposes effective assessment strategies. Instructional designers are therefore responsible for organizing content and instructional strategies in a manner that enhances learners' educational experiences. Aligned with this view, Batasan (2023) emphasized the crucial role of higher education institutions (HEIs), as recognized by the Philippine Association of Colleges and Universities of Industrial Technology (PACUIT), in providing quality education and hands-on training. These HEIs are expected to produce graduates who are competent in various industrial roles—technical, managerial, research, and entrepreneurial. Achieving this goal requires setting high standards in terms of curriculum goals, components, and implementation strategies in industrial technology programs.

Technical education, in this context, is designed to prepare individuals for self-employment and professional careers that demand values, advanced technical knowledge, and competencies beyond the level of skilled technicians. Pagatpatan (2022) noted that the Philippine government's mission for global competitiveness and holistic human development is anchored on producing a world-class skilled Filipino workforce—productive, adaptable to emerging technologies, and responsive to evolving market opportunities. Special emphasis is placed on marginalized and disadvantaged sectors, aiming to improve access to and efficiency in skills development

programs.

Despite this national thrust, technical-vocational institutions continue to struggle with a persistent challenge: the lack of adequate tools, equipment, and instructional materials. As Gepila (2012) pointed out, instructional tools and equipment play a vital role in skill development, particularly in cultivating students' manipulative abilities. This supports the principle of "learning by doing," which Rexford (1997, as cited by Abalos, 2023) regarded as the most effective instructional method. He asserted that true learning occurs not through passive methods like lectures or demonstrations, but through active, hands-on experiences. The instructional design process underscores this principle across its key phases: analysis, design, development, and implementation. In the analysis phase, instructional problems are clarified, learning goals are set, and the learners' current knowledge and skill levels are assessed. Educators must consider who the learners are, what learning outcomes are targeted, which knowledge, skills, and attitudes are required, and what resources are available.

The design phase involves formulating specific learning goals, assessment tools, lesson content, instructional strategies, and media selection. Lessons must be deliberately structured to address core questions: How will content be delivered and emphasized? What are the intended learning outcomes? Which instructional methods are most effective? And how will student understanding be evaluated? In the development phase, instructional materials are created based on the design plan. This includes the preparation of lesson plans, learning activities, graphics, and, where applicable, digital learning tools. Developers must also determine how to sequence content, facilitate practice, integrate media, and deliver feedback to ensure mastery of skills. The implementation phase focuses on training facilitators and delivering instruction. According to Smith (2021), facilitators must consider course design, instructional procedures, and methods for enhancing engagement and retention. Key considerations include how to introduce new content, stimulate discussion, integrate technology (e.g., PowerPoint), review key points, and manage instructional time.

Given the revolution in educational technology, Batasan (2023) advocates for the development of instructional models and mock-ups that respond to the demands of science and technology. Abalos Jr. (2024) echoed this recommendation, emphasizing the value of low-cost, locally fabricated machines that are user-friendly and instructionally effective. Such innovations can enrich the teaching-learning process, particularly in technology-based disciplines.

In response to the need for cost-effective instructional solutions, this study evaluates a locally fabricated plate and pipe welding positioner designed by the researcher. Constructed from inexpensive and locally available materials, the device was developed to enhance instruction in welding and fabrication courses within the Metal Trades Department. This instructional tool aims to address the scarcity of equipment, foster hands-on learning, and develop students' technical and manipulative skills. Grounded in instructional theory and the principles of experiential learning, this innovation is proposed as a practical solution for improving technical education outcomes. To ensure its instructional effectiveness and appropriateness, the device will undergo a formal evaluation process focused on its acceptability among students and instructors.

3. Methodology

Research Design. This research undertaking utilized the quantitative research design in order to quantify collected data or information and establish the relationship between variables through analytical or statistical method. Moreover, data obtained through quantitative research are by nature comparable and can be represented numerically in the form of tables. In conducting the research study specifically in the development of plate and pipe welding positioner the researcher utilized the process consists of five stages described as follows:

- **Stage 1 Planning Stage** Based from the syllabus, solicited students' ideas on their priority needs for instructional equipment needed in the shop, the researcher was guided on what to develop. The researcher conceptualized the plate and pipe welding positioner, and prepared a detailed plan of the parts to be followed in assembling the project.

- **Stage 2 Development Stage.** All necessary materials, tools, and equipment needed were prepared. The researcher also sought alternative ideas, technical information, knowledge, and expertise to enhance the development of the project and based on the prepared final plan.
- **Stage 3 Testing Stage.** Dry run of the Plate and Pipe Welding Positioner was performed to identify any deficiencies and to simply to test the functionality if all attached parts to ensure they are functioning properly.
- **Stage 4 Evaluation Stage.** All the suggestions and necessary revisions were incorporated for the improvement of the project. Should there still be irregularities found in the developed project, then the whole cycle of the method in making the project will be undone until done perfectly.
- **Stage 5 Revision Stage.** In this stage, the revision and refinement of the finished project based on the feedbacks of the initial set of welding and fabrication students and experts as evaluators was undertaken.

Research Environment. This study was conducted at the Nueva Vizcaya State University-Bambang Campus, specifically the Bachelor of Science in Industrial Technology Program under the College of Industrial Technology. Nueva Vizcaya State University (NVSU) emerged from the integration of two academic institution – Nueva Vizcaya Institute of Technology (NVSIT) and Nueva Vizcaya State Polytechnic College.

Respondents of the Study. The respondents considered in this study were from the Bachelor of Science in Industrial Technology program at the College of Industrial Technology at the Nueva Vizcaya State University composed of students, faculty members who are experts with knowledge, experience, and skills in the field of welding and metal crafts.

Research Instrument. To generate the perceptions of the two groups of respondents on the acceptability of the plate and pipe welding positioner that was developed, the proponent adopted the instrument from the study of Abalos Jr. (2024), and had it validated by selected faculty members. The respondents were asked to respond to the items in the questionnaire to express their level of agreement or disagreement, following the scale:

Statistical Treatment of Data. Data which were gathered from the respondents were statistically treated through the use of the following.

- **Weighted Mean.** This was used for determining the level of acceptability of the proposed project.
- **t-test.** This was utilized to determine even thou there is a significant difference between the mean evaluated scores of by the to two groups of respondents regarding the acceptability of the plate and pipe welding positioner in terms of its design, functionality, cost-effectiveness, and safety.

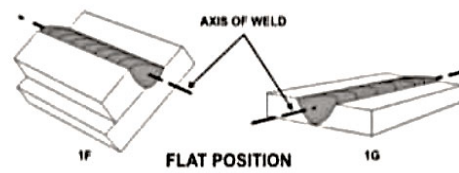
All statistical interferences were based on the five percent (5% or .05) level of significance.

4. Results and Discussion

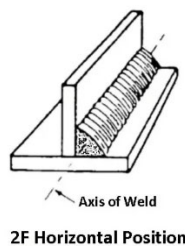
Problem 1. What plate and pipe welding positioner can be developed to enhance the welding competencies of students in Fundamentals of Welding Design and Facilities in welding and fabrication technology?

To answer this problem, the different welding positioner were explained below. Clamping and positioning the metal plates and pipes to be welded to flat, horizontal, vertical, and overhead welding position are here under described.

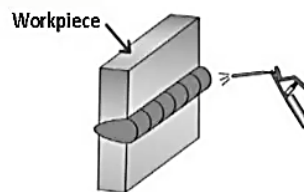
The Flat Welding Position in Plate. When welding in the flat position, the welder works on the top side of the joint, but the actual weld face is in a nearly horizontal position. The type of weld is commonly known as the “flat position” but can also be referred to as the “downhand position.”



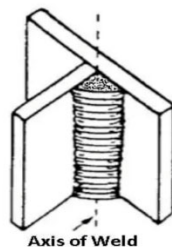
The Horizontal Welding Position in Plates. During horizontal welding, the plates to be joined are placed vertically, and the weld bead is applied horizontally. This method is considered more difficult compared to flat welding. It is important to carefully select welding parameters for horizontal welding to ensure easy manipulation and proper positioning of the weld material in the intended spot.



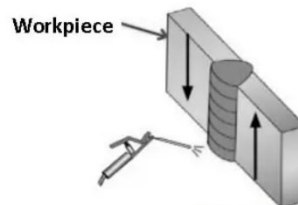
2F Horizontal Position



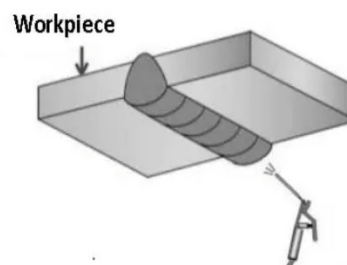
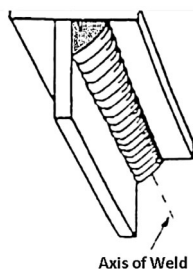
The Vertical Welding Position in Plates. When welding in vertical position, the plate is positioned on the vertical plane, and the welder can weld it from bottom to top. However, this can be challenging because the liquid weld metal tends to fall down due to the force of gravity.



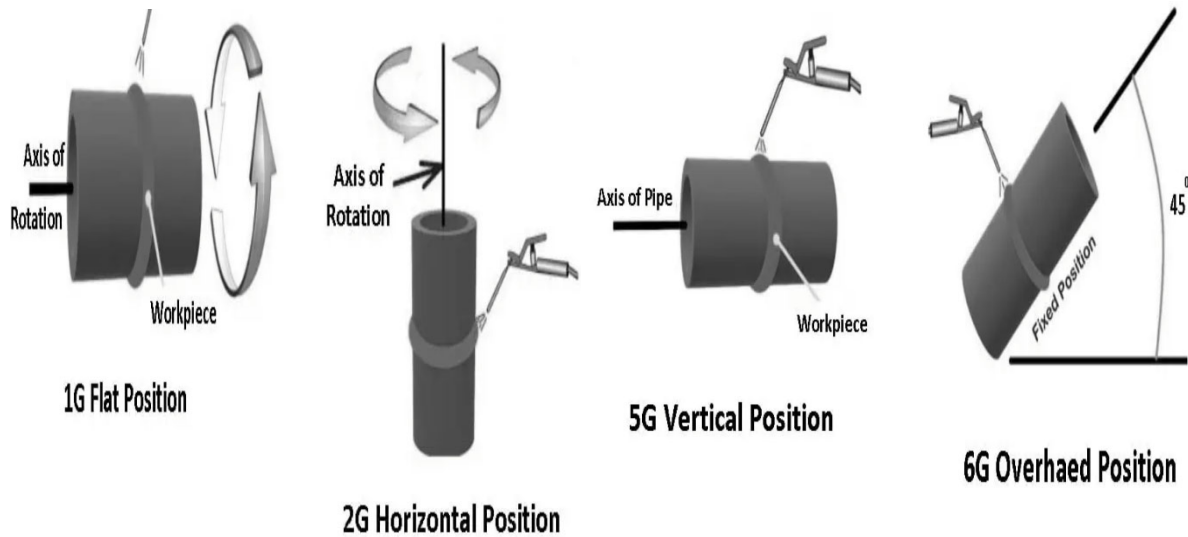
3F Vertical Position



Overhead Welding Position. The overhead welding position, also known as the 4G position, is a welding technique where the welder works from underneath a horizontal workpiece that is positioned above them.



Pipe Welding Position. When welding a pipe, it is similar to welding any structural shape, it can be done in various welding position. When welding pipe flanges with certain joint set-ups, a fillet weld can be used. The joint used for welding one pipe to another resembles a v-groove and typically has an exposed root. Welding pipes demands a greater level of expertise, which they focus in additional information.



As illustrated by Santos (2023), the recognized welding positions include the 1G flat or rolled position, 2G horizontal, 5G vertical, and the 6G fixed position, each with its own application depending on the joint orientation and complexity.

Problem 2. What is the acceptability level of the developed device in terms of design, functionality, cost effectiveness, and safety as evaluated by the students and the experts?

To arrive at the answer to their problem, the mean scores of the two groups of respondents along the criteria, design, functionality, cost effectiveness, and safety were computed to determine the acceptability of the developed plate and pipe welding positioner. The result is reflected on table 2.

Table 2
Respondents' Assessment on the Level of Acceptability of the Developed Plate and Pipe Welding Positioner

Criteria	Students Mean	Qualitative Description	Experts Mean	Qualitative Description	Overall Mean Mean	Qualitative Description
Design	3.78	Very Acceptable	3.80	Very Acceptable	3.79	Very Acceptable
Functionality	3.83	Very Acceptable	3.76	Very Acceptable	3.80	Very Acceptable
Cost Effectiveness	3.55	Very Acceptable	3.82	Very Acceptable	3.68	Very Acceptable
Safety	3.80	Very Acceptable	3.87	Very Acceptable	3.83	Very Acceptable
Overall Mean	3.74	Very Acceptable	3.81	Very Acceptable	3.78	Very Acceptable

It can be gleaned from table 2 that the two groups of respondents evaluated the acceptability of the developed plate and pipe welding positioner as “very acceptable”. This is marked by the overall mean of 3.78.

Specifically, the students rated the design of the device with a mean of 3.78, while the experts gave a mean of 3.80 or an overall mean for design of 3.79, all qualitatively described as “very acceptable”. This emphasizes that the two groups of respondents strongly agree that the design of the plate and pipe welding positioner is simple, durable, and movable. The device is suitable to students at the tertiary level as it could improve their learning performance in metal arc welding. The parts of the device are purposeful, functional, neatly arranged, fastened, and secured, the parts can be easily replaced with the same parts if found defective, and 3 automatic jaw to ensure the workpiece is clamped on the welding positioner. This would be interpreted to mean that the student and the expert respondents are convinced with the simplicity, durability and mobility of the developed as

well as its suitability to the students' level. They acknowledge the fact that the device was well designed as planned in order to create the needs of the students in welding and fabrication. They have the impression that the developer of the device has considered key principles of weld design to come up with a device that facilitate welding and fabrication instruction. These three aspects are: strength, fatigue resistance, and distortion.

According to Daussault System (2024), the aspect of strength means that the weld must be strong enough and reliable; fatigue resistance connotes that the weld must be able to withstand stress over time without cracking; distortion means the weld must remain stable during the heating and cooling process; cost which means that ideal weld joint can handle the loads imposed while still being produced at minimal cost. Mohanty et al. (2022) welding remains a crucial operation in the heavy fabrication industries, although it poses potential hazard. The study aimed to enhance the sustainability of these processes by examining alternatives to traditional multi-pass, multi-layer welding, which can involve over a hundred layers and lead to excessive consumption of time, energy, and material. This research introduced a mathematical model to facilitate resource-efficient process design optimal parameters related to strength, process efficiency, and production performance. The findings highlighted that a single-pass-per-layer narrow gap welding approach could significantly boost melting efficiency and deposition rates while reducing energy and material usage.

The study also established three key design rules for implementing this method: 1) the bead-on-plate width should be approximately 1.5 times the groove width; 2) there exists a maximum threshold for process capability utilization, beyond which productivity declines; and 3) this threshold can only be reached under specific layer thickness conditions. Overall, the approach promises a more sustainable and productive design for material-intensive welding operations. Meanwhile functionality obtained a mean of 3.83 from the students, and 3.76 from the experts or an overall mean of 3.80 with qualitative description of "very acceptable". This denotes that the two groups of respondents strongly agree that the device is suitable to the height requirements of the welder; is effective for different positions and pipes; and can perform simple to complex activities.

It can be deduced from this finding that the respondents are unanimous in their assessment that developed device is useful and practical for the purpose for which it is intended and therefore it calls for ease manipulation and comfort or convenience when using it and as multiple use in simple to complex task performance as well as during teaching-learning process, particularly in welding and fabrication. Quora (2022) shared the concept that a welding machine is a crucial tool in various metalworking processes and it serves several key functions, such as joining metals, generating heat, control of welding parameters, supporting various welding, and other multiple welding processes making them versatile tools for various applications.

Statements that may relate to functionality are those express by Dia's and Victor (2022) highlighted that the emergence of mobile technology has introduced a new wave of educational tools, enabling more dynamic and immediate access to learning materials. While both educators and learners generally view these devices favorably due to their potential to enhance engagement and interactivity, there remain notable challenges in effectively integrating them into educational environments. Dia and Victor (2022) examined the benefits of mobile devices and their challenges in teaching and learning. The students are positive about the impact and significance of these tools on students' motivation, communication, teamwork, and research skills. Effective training and support can assist in addressing the difficulties they encounter.

Garcia et al. (2016) evaluated the statics of welding industries in the province of Biliran. The study discussed the features of welding workshops, their proprietors, challenges faced, upcoming strategies, and the current status of their services throughout the year. They found out that machinery of welding shops was reasonably accessible although "supplies and materials" were accessible, shops "personnel" the availability and convenience of shops were typically quite good. The majority of welding shops typically functioned with a working capital between ₱15,000 and ₱50,000. Labor wages varied significantly, ranging from ₱40 to ₱300, depending on the complexity of the tasks. While all businesses adhered to licensing requirements, none possessed formal accreditation or affiliations. The workforce mainly consisted of individuals with vocational

training, with some holding college degrees and few having completed high school. Although a minority had certifications from institutions like TESDA or the NMYC, most were self-taught and heavily relied on practical experience. Advanced training beyond fundamental welding skills was rare. Operational obstacles included frequent power interruptions, shortages of essential materials in hardware stores, and challenges related to distant material suppliers.

Similarly, cost effectiveness was evaluated as “very acceptable” as signified by the mean of 3.55 from the students and 3.82 from the experts or an overall mean of 3.68. It can be construed that the two groups of respondents strongly agree that the materials used for constructing the device are durable and locally available, the developed device supplement the University’s unavailable equipment, the developed trainer is cheaper than device sold in the market. This is to say that in the development of a device, cost effectiveness should be an essential consideration. Actually, some teacher and manufacturers and producers improve devices because they could not afford commercial devices or tools as they are expensive by. So, they find ways to cut down expenses by using locally available materials but are durable and much cheaper. Sometimes, the users of such devices regard fabricated devices as more economical because fabricators are assumed to make the devices sturdier so that they do not break down easily so they can be used repeatedly and for different task.

In the point of view of Weldmaster (2024), emphasized that the integration of automated welding systems, materials handling tools, and computer-controlled processes has significant transformed the welding industry, offering greater precision and reliability compared to traditional manual methods. However, investing in automated welding systems entails various cost – such as initial acquisition, setup, maintenance, operational expenses, and training – the long-term advantages are considerable. These include enhanced productivity, improved weld consistency, greater safety, and potential long-term cost reductions. So, before making the leap to automated welding, several critical factors must be considered, which include assessment of specific and current processes, identification of particular needs, evaluation of equipment options, and understanding the learning curve. So, before making the leap to automated welding, several crucial factors must be considered, which include assessment of specific and current processes, identification of particular needs, evaluation of equipment options, understanding the learning curve.

Liew et al. (2024) introduced the concept of Equipment Cost Efficiency (ECE) as a more inclusive measure to evaluate the operational and financial performance of manufacturing equipment than the traditional Overall Equipment Effectiveness (OEE), aiming to capture not only operational performance but also financial implications. They explained that ECE provides a benchmark by accounting for cost linked to non-productive yet necessary activities, allowing for more strategic evaluation and improvement planning. Through a case study, they demonstrated how this metric supports decision-making in equipment optimization, ultimately enhancing productivity and financial returns.

Cheng and Estrada (2021) conducted a cost-effectiveness evaluation of the 29% increase in cigarette prices implemented through RA 1134 in 2021. Their research used a static, single cohort model on locally available data to assess the outcomes from both public payer and societal perspectives. The former focused on direct healthcare costs and government revenue allocated to the health sector, while the latter also included indirect costs such as lost productivity. With a 7% discount rate was applied, the study estimated that the policy intervention would result in the prevention of approximately 34,571, disability-adjust life year (DALYs). Furthermore, it was found that avoided hospitalization costs and additional health-targeted excise tax revenue would generate around USD 367 million in savings. When broader societal factors such as productivity gains and healthcare spending were included to USD 415 million. The findings indicated that the reform could lead to savings of USD 11,755 for every DALY averted from the public payer’s perspective. This suggest that tax measures like RA 11346 can serves as effective tools not only for reducing Tobacco-related health burdens but also for strengthening public health financing.

On the other hand, the two sets of respondents rated safety with an overall mean of 3.88-3.80 from the

students and 3.87 from the experts. This could mean that the installation of the different parts of the device is safe for demonstration, the materials meet the requirements of accepted technical safety standards, the device can be used by the students or trainees with less supervision or special assistance, and that personal protective equipment (PPE) is always used. It can be deduced that the developer's first consideration is safety as signified by the mean of 3.83 – the highest among the assessed criteria. This means further that the device was meticulously developed to ensure that the users' safety is not compromised, that is he made sure that the parts of the device are assemble carefully and that any part is not loosely attached. In other words, the developer constructed the device with reference to safety and security standards.

Eco Online (2023) safety equipment comprises protective gear and tools that workers utilize to safeguards themselves and avoid accidents during work. This equipment can consist of gloves, helmets, safety glasses, earplugs, high-visibility jackets, and respirators among others items. Eco Online (2023) added that ensuring machine safety begins with proper maintenance and evaluating whether the equipment is suitable for its intended task. The report emphasizes that the user is required to verify that every safety component-including guards, isolators, lockout mechanisms, and emergency stop switches is properly installed and operating as intended. Furthermore, machines should be operated strictly following the manufacturer's guidelines. Eco Online also noted the importance of wearing proper personal protective equipment (PPE), stating that is important to wear safety glasses, ear protection, and steel-toe shoes while using machinery, based on the task at hand. According to Martin (2022), a significant number of health and safety accidents stem from the use of inadequately designed equipment in the workplace or equipment not suited for its intended purpose. Sometimes, tool and equipment were neglected. Even when workplaces are made as safe as possible, risk are still be present in one way or the other. The risks involved in such work operation can damage parts of the body. Hence, Martin (2022) urged employers must guarantee that all equipment supplied to workers must be safe and free from any long-term health risks for the users. Employers also bear the responsibility in ensuring the workers using such equipment all skilled and competent to do the work safely. The equipment must be maintained for safe use; inspected periodically for signs of damage, correctly installed to ensure safety during operations, and treated with care to prevent any mishaps.

In particular, the research of Salvador (2023) conducted a focused investigation on occupational health and safety among welding professionals, analyzing common hazards and effective prevention strategies. Drawing on input from 40 experienced welders, the study identified major risk including exposure to hazardous fumes, intense light radiation, and excessive noise, which may lead to hearing damage. The research emphasized that minimizing these risks requires a combination of engineering controls, the correct use of personal protective equipment (PPE), and consistent, well-structured safety training. Furthermore, Salvador stressed that fostering a strong safety culture-through collaboration among workers, employers, and safety personnel-is key to creating a secure working environment. His findings present critical insights, not only for improving welding safety standards but also for adapting to emerging technologies that enhance workplace safety. The respondents' assessment on the acceptability was "very acceptable" as testified by the overall mean of 3.78. this means that the plate and pipe welding positioner is well designed, functional, cost- effective and safe to use for instructional or even industrial purposes,

Ikpe et al. (2023) examined various forms of welding defects and their impact on structural performance. Their study categorized defects into two broad types: internal, which are not visible on the surface, and the external, which can be detected visually. As they stated internal defects include porosity, hidden blowholes, lack of fusion, and embedded cracks, while external imperfections consist of surface cracks, underfill, undercut, overlaps, excessive penetration, arc strikes, spatter, and visible porosity. The author noted that such defects can lead to serious consequences, including deterioration due to repeated stress, increased susceptibility to corrosion, and a decline in the structural integrity of the material. They emphasized that these flaws, formed during the welding process, are not only determined to safety but also to long-term durability. However, the study concluded that deterioration due to repeated stress, increased susceptibility to corrosion, and a decline in the structural integrity of the material. thereby ensuring greater reliability and service life of welded components,

thereby ensuring greater reliability and service life of welded components.

Problem 3. Is there a significant difference in the evaluation of the two groups of respondents on the plate and pipe welding positioner?

To come up with the answer to this problem, the t-test was run. The result of which is exhibited in table 3.

Table 3

Summary of t-test Computation on the Difference in the Level of Acceptability of the Developed Plate and Pipe Welding Positioner

Criteria	Groupings	Mean	Computed t-Value	p-value	Remarks
Design	Student	3.78	-0.16	0.875	Not Significant
	Experts	3.80			
Functionality	Student	3.83	0.935	0.359	Not Significant
	Experts	3.76			
Cost Effectiveness	Student	3.55	2.246	0.036	Significant
	Experts	3.82			
Safety	Student	3.80	-0.682	0.501	Not Significant
	Experts	3.87			
Overall	Student	3.74	0.988	0.332	Not Significant
	Experts	3.81			

As reflected in table 3, the students assessed cost effectiveness with a mean of 3.55 while the experts rated it with a mean of 3.82. The difference of 0.27 between the two mean ratings was submitted two t-test and it yielded a computed t-value of 2246 and as p-value of 0.036, which is the p-value is lower than 0.05 significance level. This resulted in rejecting the null hypothesis stating there is no significant disparity in how the two groups of participants evaluate the acceptability of the plate and pipe welding positioner in terms of safety. This denotes that the experts gave a higher assessment on safety than the students. This could be accounted on the fact that the experts have more knowledge and experience when it comes prices of goods or material in the local market. They are more experience in improvisation and fabrication because they have to. As instructors, they are very much aware of the need for more instructional materials, so every now and then, the improvise their own instructional materials. With this experience they pay attention to cost effectiveness of such material.

In contrast, the students feel that the device is expensive or not cost effective. They are not aware enough of current market prices, and may be comparing the cost of the device to their school supplies, the result would be different. So, they think that the prices of the raw materials used in the developing the device is high. In relation to their finding, Evans and Popova (2016) emphasized the need for thorough evaluation of both cost and outcomes to facilitate successful evidence-based policy decisions. Their study explored practical strategies for conducting cost-effectiveness analyses and evaluating the efficiency of different programs in the field of education. Adapting development initiatives from one environment to another involves making various assumptions.

Evans and Popova (2016) investigated how errors in estimating program impacts can influence the outcomes of cost-effectiveness analyses, particularly in educational interventions. Using data from 27 students learning initiatives and 16 programs aimed at improving attendance across regions in Africa and Asia, they illustrated the extent of uncertainty in such evaluations. They explained that by utilizing Monte Carlo simulation methods and tailoring key cost factors to match local market rates can significantly minimize uncertainty in evaluating cost-effectiveness. Additionally, they stressed that implementing standardized, detailed templates for reporting costs during the rollout phase of programs helps minimize estimation biases and enhance the reliability of findings.

Design, functionally, and safety of the developed plate and pipe welding positioner did not vary with the respondents. The computed t-value of design with the p-value of 0.875; functionally with a computed t- value and p-value of 0.359; and safety with a computed t-value of 0.682 and p-value of 0.501 implies that the respondents were in consensus with the acceptability of the device in these criteria because their p-value are higher than the 0.05 level of significance

5. Conclusions

Based on the significant findings, the following conclusions were drawn.

- A plate and pipe welding positioner were developed for teaching.
- The developed plate and pipe welding positioner was evaluated as very acceptable.
- The assessment of the student respondents and the assessment made by the faculty/expert respondents on the acceptability differed significantly along cost-effectiveness, as the faculty/expert respondents are more familiar with the prices of materials needed in developing the device compared to the students.

Recommendations

- Having found out that the developed device is very acceptable, this may be used in the teaching of welding and fabrication instead of using conventional or traditional methods.
- Instructors may be encouraged or inspired to develop similar or other welding devices to enhance students' competencies in welding.
- The University's management may initiate an award/incentive scheme to motivate faculty members to develop more low-cost but useful devices/equipment for instructional purposes.
- The production of the developed device may be considered to increase the ratio between students and availability or accessibility of welding and fabrication tools/equipment.
- Hydraulic for easy lifting, ensuring smooth and adjustable height control better welding efficiency may be used.
- Locking mechanism on the rotating table to prevent any movement or rotation when using the plate positioner may be installed.
- Tiller gearbox mechanism may be used for the tilting angle of the plate and pipe welding positioner to ensure smooth and controlled adjustments.

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