IMCC Journal of Science 2024, 4, 209-215
https://myjournal.imcc.edu.ph/

Exploring the Mechanism of Square Bars Steel for Groove Welding as Training Materials in Shielded Metal Arc Welding

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ABSTRACT
This qualitative study explores the use of square bar steel as an alternative training material for groove welding in Shielded Metal Arc Welding (SMAW) and examines its impact on the welding skill development of Grade 12 Technical-Vocational-Livelihood (TVL) students at Manticao National High School. Through in-depth interviews with experienced welders, classroom observations, and visual and non-destructive testing methods, the study investigates the interplay between welding parameters, material characteristics, and joint integrity. Findings suggest that the use of square bar steel promotes better joint precision, bevel angle formation, enhanced penetration, and reduced material waste, all of which contribute to improved weld quality. Teachers observed increased learner engagement, better alignment of welds, and greater mastery of groove and root pass welding tasks. The study underscores the potential of alternative materials in enhancing vocational instruction and highlights the need for institutional support, targeted training, and flexible curriculum adaptation to promote effective, resource-sensitive welding education.

KEYWORDS: alternative materials, groove welding, SMAW, welding education

ARTICLE INFO: Received: 11 November 2024; Revised: 07 December 2024; Accepted: 15 December 2024; Published Online: 27 December 2024; Volume: 04; Issue: 03; Type: Original Article

1. Introduction

Groove welding plays a critical role in the metal fabrication industry by joining the edges of two metal parts through melting and fusion. This process is widely used across sectors such as construction, shipbuilding, and oil pipeline manufacturing. Recognizing its practical relevance, Manticao National High School offers Technical-Vocational-Livelihood (TVL) training in Shielded Metal Arc Welding (SMAW) to Grade 12 students, following the TESDA Competency-Based Curriculum and Training Regulations. This collaborative effort between DepEd and TESDA seeks to equip learners with the necessary skills to obtain National Certification (NC I/II) and meet workforce demands.

The TVL track, as part of the Philippine K–12 education system, is designed to prepare students with trade-specific competencies. Manticao National High School remains the only public school in the Manticao District offering SMAW under the TVL track. Its implementation is grounded in national legislation, including Republic Act No. 10533 (Enhanced Basic Education Act of 2013) and Republic Act No. 7796 (Technical Education and Skills Development Act of 1994), which mandated the establishment of TESDA and the integration of technical education under one governing body. Currently, the school has 42 teachers and one school head supporting this vocational endeavor.

This study aims to explore the potential of square bar steel as a training material for groove welding in SMAW. Due to the rising cost and scarcity of standard welding materials such as steel plates and pipes, the research investigates the viability of using square bars to address the gap in consumable materials. Additionally, the study examines how the use of square bar steel may alleviate financial strain on students and provide teachers with alternative instructional strategies in light of limited resources and institutional support.

While prior research has underscored the significance of TVL programs in bridging the workforce skills gap (Nabuya, 2019), most studies focus on theoretical implementation or are situated in urban or resource-rich settings. There remains a lack of research on alternative materials and localized innovations in rural areas like Manticao. This study contributes to addressing that gap by examining how non-traditional materials can enhance skill acquisition, support curriculum delivery, and prepare students for TESDA certification assessments.

This study investigates the use of square bar steel as a training material in groove welding among TVL-SMAW learners at Manticao National High School. Specifically, this research seeks to answer the following questions:

- What are the experiences of Grade 12 students in their training on groove welding using square bar steel in SMAW?
- What are the success stories of the Senior High School TVL-SMAW graduates?

2. Methodology

This study employed a qualitative case study design to examine how the use of square bar steel as an alternative training material influences groove welding instruction and skills development among Senior High School learners enrolled in the Technical-Vocational-Livelihood (TVL) Shielded Metal Arc Welding (SMAW) strand at Manticao National High School in Misamis Oriental. The case study design was chosen to explore the participants' experiences and success stories as they engaged in hands-on SMAW training using non-traditional materials in a real classroom setting. This design allowed for a contextualized understanding of how alternative training materials, such as square bar steel, influence students' technical skill acquisition, employment outlook, and career readiness in a rural public school context (Alipio & Torres, 2023; Torres et al., 2021).

The research was conducted at Manticao National High School (MNHS), a public secondary school located in Purok 10, Pagawan, Manticao, Misamis Oriental. The school occupies approximately 1.2 acres of land and serves as the only institution in the district offering the TVL-SMAW strand. As a mid-sized school with 42 teaching personnel and one school head, MNHS provided an appropriate environment for investigating innovations in vocational training. The school's unique position as the sole SMAW provider in the district, along with the financial constraints on training material procurement, made it a fitting site for exploring cost-effective alternatives to traditional groove welding consumables. The researcher, a subject teacher of the participants, had an existing rapport with the school community, which facilitated participant cooperation and trust during the data collection process.

Participants in this study included ten Grade 12 students currently enrolled in the SMAW strand and two Senior High School TVL-SMAW graduates from MNHS. All participants were purposively selected to ensure they had sufficient exposure to groove welding using square bar steel. The inclusion of graduates provided additional insight into the long-term value of SMAW training using alternative materials and its influence on post-graduation employment opportunities. The selection criteria followed the guidance of Creswell (2013) and Polkinghorne (1989), which recommend focused sampling in qualitative studies to enhance depth and data richness.

Data were collected through semi-structured interviews guided by open-ended questions, allowing participants to share their insights on welding experiences, training materials, skill acquisition, and career outlooks. The interview guide was developed by the researcher and informed by existing literature on vocational training and skills development. After securing approval from the Schools Division Superintendent of DepEd–Misamis Oriental, interviews were scheduled at times convenient to the participants and conducted in quiet, familiar school settings to ensure focus and comfort. With participants' full consent, audio recordings were made, and non-verbal cues were documented through field notes. When necessary, explanations and responses were translated into the local vernacular (Bisaya) to ensure clarity and participant ease. Interview data were transcribed, translated into English where applicable, and subjected to thematic analysis. Braun and Clarke's (2006) six-phase framework was employed, as referenced in Mihas (2023).

3. Results

Experiences of Grade 12 Students in Groove Welding Training Using Square Bar Steel

Six key themes emerged in response to the first research question on how Grade 12 students experienced training on groove welding using square bar steel in SMAW: (1) Better Precision and Alignment, (2) Skill Versatility, (3) Boosting Confidence, (4) Fostering Teamwork, (5) Affordability for Practice, and (6) Practical Investment.

Better Precision and Alignment. Participants emphasized that the consistent dimensions of square bars allowed for improved alignment and joint preparation, which are critical for mastering groove welding skills. These features helped them achieve clean and precise welds essential in professional practice. One student shared:

> *"Square bars' consistent dimensions aid in better piece alignment, making it easier to prepare joints for groove welding. This consistency allows us to practice creating clean and precise welds, which are essential for professional work." (S3)*

Skill Versatility. Participants shared that square bars allowed them to practice multiple welding positions and angles, which made them more adaptable to real-world welding challenges. The shape also helped in preparing bevel angles efficiently. One student expressed:

> *"The square shape enables us to practice different welding positions and angles, which enhances our ability to tackle various scenarios in real-world applications." (S6)*

Boosting Confidence. Students reported increased confidence as a result of frequent and focused practice with square bar steel. The chance to refine their skills and correct mistakes in a low-pressure environment contributed to their growth. One student shared:

> *"Regular practice with square bars increases confidence because it provides us with the chance to perfect our techniques without pressure. It's a great way to build a strong foundation." (S2)*

Fostering Teamwork. Some students explained that the affordability of square bars encouraged group work, which enhanced teamwork and communication skills. These collaborative efforts made the learning process more engaging. One student stated:

> *"Square bars are affordable, so they allow multiple students to work together on collaborative projects without worrying about financial constraints. It's a great way to learn from one another." (S10)*

Affordability for Practice. Many students appreciated that square bars were inexpensive, which encouraged frequent experimentation and skill development. One student shared:

> *"Because square bars are less expensive, we can experiment with different welding techniques without worrying about wasting costly resources. It gives us the freedom to practice more and learn better." (S3)*

Practical Investment. Students viewed square bars as a wise investment, offering long-term benefits that outweighed their initial cost. One student said: *"Compared to other materials, square bars are reasonably priced, making them the perfect choice for students like us who need to practice frequently." (S4)*

Success Stories of Senior High School TVL-SMAW Graduates

Two major themes emerged in response to the second research question on the success stories of Senior High School TVL-SMAW graduates: (1) Persistence Amid Hardship, and (2) Discipline and Service.

Persistence Amid Hardship. Participant's story is one of perseverance despite financial and personal struggles. While academically average, he worked menial jobs every weekend to support his studies and family. Living 6.5 kilometers from school, he often walked or found ways to save money just to continue learning. One participant narrated: *"I had to walk long distances and skip meals just to survive high school. But I always believed something better was coming." (S1)*

Discipline and Service. Participant also known as Ockim, grew up in difficult family circumstances after his mother passed away and his father remarried. Raised by his grandparents, he remained respectful and active in class. Though academically average, he was praised for leadership and positive character. One participant recalled: *"Even with his struggles at home, Ockim was the one who united our group during activities. He was always calm and focused." (S2)*

4. Discussion

This study revealed six key themes related to the groove welding training experiences of Grade 12 TVL-SMAW students using square bar steel: better precision and alignment, skill versatility, confidence building, teamwork, affordability, and practical investment. These findings align with existing research highlighting how consistent materials, scaffolded practice, and social learning environments contribute to skill acquisition in technical education. Kumar and Singh (2020) emphasized that the use of square bars enhances accuracy in welding, reducing material waste and improving joint quality—an observation echoed by learners who noted that the square bar's structure helped them achieve cleaner, more precise welds.

Skill versatility emerged as another important theme, with students appreciating how square bars allowed them to practice multiple welding positions and joint preparations. Garcia and Patel (2022) supported this by noting that industrial adaptability depends heavily on diverse welding skill sets. This reflects Vygotsky's Sociocultural Theory (1978), which posits that learners develop through interactions with tools and tasks that reflect real-world complexity.

Learners also reported a growing sense of confidence, which they attributed to frequent hands-on practice and the opportunity to refine techniques without fear of material waste. Thompson and Nguyen (2023) found that confidence in welders is cultivated through repeated application and mentorship. Schön's Reflective Practice

Theory (1983) similarly highlights how reflective engagement with technical tasks strengthens both competence and assurance in one's abilities.

Peer collaboration was another notable experience. Students valued teamwork in welding exercises, which promoted communication, shared learning, and task coordination. Miller and Carter (2021) observed that cooperative welding setups improve both productivity and safety outcomes. This resonates with the sociocultural emphasis on learning as a social process where interaction supports deeper engagement.

The affordability of square bars also played a key role in facilitating frequent practice. According to Johnson and Lee (2020), cost-effective material use is crucial in technical training, especially in resource-limited settings. Learners expressed that square bars gave them the freedom to experiment and make mistakes—opportunities that are often limited by the high cost of practice materials.

Finally, the use of square bars was viewed as a practical investment. Kumar and Singh (2022) highlighted that the long-term benefits of affordable, durable materials extend beyond training—they prepare learners for industry requirements. For students, this investment allowed them to develop tangible skills that directly contributed to their post-graduation success.

The study highlights that using square bar steel in TVL-SMAW training supports effective skill development through structured input and reflective, collaborative learning. This approach enhances authenticity, accessibility, and alignment with industry standards, providing students with safe, affordable, and practical experiences. It not only boosts their confidence and competence but also prepares them for real-world success. Future research is encouraged to explore how such hands-on materials impact student motivation, teamwork, and long-term employability.

5. Conclusion

This study concluded that the use of square bar steel in groove welding training effectively enhances the skills, confidence, and teamwork of Grade 12 TVL-SMAW students. Its affordability and versatility provide realistic practice opportunities, making it a practical investment for both learners and institutions. These experiences contribute to students' readiness for real-world welding tasks and future employment.

Acknowledgment

Gratitude is directed to the two peer reviewers for the valuable comments and suggestions that greatly improved this paper.

Conflict of Interest Statement

The authors declare no conflict of interest.

Author Contributions: Both authors have contributed equally. They have approved the final version of this manuscript.

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