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Mentor-Based Learning to Enhance SMAW Welding Outcomes in Vocational Entrepreneurship Education

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Abstract: Vocational education must ensure that students acquire not only technical competence but also the confidence and critical thinking needed for real-world tasks. This study investigates the effectiveness of a mentor-based instructional model in enhancing student performance in Shielded Metal Arc Welding (SMAW) practices within the subject of Creativity, Innovation, and Entrepreneurship at SMK Negeri 1 Singosari, Indonesia. Using a descriptive quantitative approach, data were collected from 70 eleventh-grade mechanical engineering students through structured performance assessments and Likert-scale questionnaires. The results show a high average performance score of 84.04 with a standard deviation of 3.18, where 89% of students were categorized as "High" and 11% as "Very High." Performance scores increased progressively across assessment stages, and students reported improved confidence, motivation, and procedural accuracy. These findings suggest that structured mentoring significantly supports technical mastery, reduces skill disparities, and cultivates reflective learning habits. It is concluded that mentor-guided learning should be integrated more widely in vocational curricula. It is also recommended that future research explore the long-term impact of mentoring on work readiness, creativity, and entrepreneurial mindset across other technical fields.
Keywords: vocational education; welding; performance improvement; mechanical engineering.

Pembelajaran Berbasis Mentor untuk Meningkatkan Hasil Praktik Las SMAW di Pendidikan Kewirausahaan SMK

Abstrak: *Pendidikan vokasi harus memastikan bahwa siswa tidak hanya memperoleh kompetensi teknis, tetapi juga kepercayaan diri dan kemampuan berpikir kritis yang diperlukan untuk tugas-tugas di dunia nyata. Studi ini menyelidiki efektivitas model pembelajaran berbasis mentor dalam meningkatkan kinerja siswa dalam praktik Las Busur Logam Terlindung (SMAW) dalam mata pelajaran Kreativitas, Inovasi, dan Kewirausahaan di SMK Negeri 1 Singosari, Indonesia. Menggunakan pendekatan kuantitatif deskriptif, data dikumpulkan dari 70 siswa kelas XI jurusan teknik mesin melalui penilaian kinerja terstruktur dan kuesioner skala Likert. Hasil menunjukkan skor kinerja rata-rata tinggi sebesar 84,04 dengan simpangan baku 3,18, di mana 89% siswa dikategorikan sebagai "Tinggi" dan 11% sebagai "Sangat Tinggi." Skor kinerja meningkat secara bertahap melalui tahap-tahap penilaian, dan siswa melaporkan peningkatan kepercayaan diri, motivasi, dan ketepatan prosedural. Temuan ini menunjukkan bahwa bimbingan terstruktur secara signifikan mendukung penguasaan teknis, mengurangi kesenjangan keterampilan, dan menumbuhkan kebiasaan belajar reflektif. Disimpulkan bahwa pembelajaran yang dibimbing oleh mentor seharusnya diintegrasikan secara lebih luas dalam kurikulum vokasi. Disarankan pula agar penelitian masa depan mengeksplorasi dampak jangka panjang bimbingan terhadap kesiapan kerja, kreativitas, dan mindset kewirausahaan di bidang teknis lainnya.*
Kata kunci*: pendidikan kejuruan; pengelasan; peningkatan kinerja; teknik mesin.*

1. Introduction

Vocational education is increasingly positioned as a catalyst for preparing technically competent, industry-ready graduates. In mechanical engineering programs, Shielded Metal Arc Welding (SMAW) stands out as a core technical skill that demands high levels of accuracy, safety awareness, and process discipline. However, recent studies have revealed persistent learning gaps in welding performance across various vocational institutions. Z. Ahmad & Rofiq (2020) observed that the limited availability of individualized guidance contributed significantly to suboptimal student

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outcomes, while Chakradhar *et al*. (2022) found that technical mastery often stagnates in classrooms using conventional, passive instructional approaches. Orji (2025) identified that traditional teacher-centered learning often neglects students' diverse cognitive and psychomotor development. These limitations are especially concerning in subjects like Creativity, Innovation, and Entrepreneurship (CIE), where technical execution must be integrated with problem-solving and value-creation processes. In this regard, Nabi *et al*. (2025) emphasize the necessity of transforming workshop learning into a more responsive and interactive space that aligns with both technical demands and entrepreneurial goals, a view also supported by Yani *et al*. (2024) through their work on vocational innovation models.

One emerging solution that has gained traction is the mentor-based learning model, which offers a structured, context-rich, and student-centered approach. Unlike conventional demonstrations, this model allows students to engage directly with experienced mentors who guide them through complex procedures while providing personalized feedback. Kelley (2025) demonstrated that mentoring builds student autonomy and enhances task ownership in metal-fabrication training, whereas Kyew (2023) confirmed its positive impact on welding workshop outcomes through real-time performance corrections. Furthermore, mentoring models have been linked to the development of entrepreneurial competencies in vocational settings. Zuo *et al*. (2025) found that structured mentoring enhances students' entrepreneurial orientation when embedded into CIE subjects. Hartati *et al*. (2022) also observed notable improvements in soft skills such as collaboration, creativity, and initiative among mentored learners. These findings are supported by Srinatriyo *et al*. (2023), who showed that systematic mentor feedback significantly improves the technical quality and safety of welding products. Meanwhile, project-based mentoring has been proven superior to traditional methods in enhancing vocational performance, as documented by Rahim *et al*. (2024). Complementary insights from Ting *et al*. (2017) reveal that mentoring also promotes critical thinking and innovation, thus amplifying its relevance in technical-entrepreneurial instruction.

Persistent gaps in students' welding competence continue to pose challenges within vocational education, particularly in SMAW practices that demand high levels of precision, procedural discipline, and adherence to safety standards. Many vocational schools still report inconsistencies in weld quality, frequent procedural errors, and uneven skill acquisition among students problems often linked to limited individualized guidance and conventional, teacher-centered instructional approaches. These issues are aligned with broader empirical findings indicating that students tend to struggle when instruction lacks structured feedback and personalized correction. Supporting this problem identification, Prasetya *et al*. (2024) and Mustaffa *et al*. (2024) highlight that mentor involvement directly improves product quality through targeted and continuous feedback, while Azman *et al*. (2025) reported notable improvements in observed significant gains in students' persistence, confidence, and retention of complex welding procedures when mentoring systems are integrated. Similarly, A. R. Ahmad *et al*. (2024) demonstrated that mentor-guided sessions effectively reduce technical errors in both machining and welding contexts, thereby minimizing performance disparities across learners. These consistent findings indicate that the absence of structured mentoring contributes to skill stagnation and widens competency gaps, underlining the urgency of exploring alternative pedagogical models that better address individual learning needs in welding practice.

In response to this problem, the present study aims to investigate the extent to which mentor-based learning can enhance SMAW welding performance by providing structured, context-rich, and personalized instructional support. The study also seeks to examine whether mentoring can simultaneously foster broader entrepreneurial competencies attributes such as initiative, creativity, and innovation-oriented thinking which are central to the Creativity, Innovation, and Entrepreneurship (CIE) curriculum. Existing literature substantiates this dual objective, Rofa & Ngah (2024) argue that structured mentoring not only promotes entrepreneurial potential but also strengthens cognitive engagement and reflective learning, demonstrating its relevance beyond technical mastery. By integrating these insights, the present study is expected to generate meaningful benefits for vocational education institutions. Specifically, its findings may offer empirical evidence of how mentoring enhances technical accuracy, promotes procedural consistency, and supports more equitable performance outcomes. At the same time, mentoring has the potential to cultivate entrepreneurial mindsets that align welding practice with real-world problem-solving

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and value-creation processes. Through these contributions, mentor-based learning can serve as a replicable and scalable pedagogical model capable of strengthening vocational learning ecosystems and aligning instructional practices with industry expectations as well as the holistic learning goals of the CIE curriculum.

2. Materials and Methods

This study employed a descriptive quantitative approach to evaluate the effectiveness of a mentor-based learning model in improving student outcomes in SMAW welding practice. The research was conducted at SMK Negeri 1 Singosari, Malang Regency, involving 70 students from the eleventh-grade Mechanical Engineering program. The sampling technique used was total sampling, where all students in the population were selected as research subjects. Data were collected through two main instruments: a structured performance assessment rubric to measure students' welding competencies and a Likert-scale questionnaire to capture student perceptions of the mentoring process. The rubric covered aspects of accuracy, weld quality, safety compliance, and task completion, while the questionnaire assessed mentoring experience, engagement, and motivation. Data were analyzed using descriptive statistics, including mean scores and frequency distributions, to interpret the effectiveness level of the mentoring model. The results were then categorized into predefined levels ranging from very low to very high effectiveness.

3. Result and Discussion

The progression of students' welding competence during the implementation of the mentor-guided learning model revealed a compelling and consistent pattern of improvement that reinforces the model's pedagogical value. As shown in Table 1, which presents descriptive statistics across the initial, mid, and final assessment phases, students demonstrated steady growth throughout the intervention. The overall mean performance score reached 84.04, with values ranging from 80.67 to 93.33, indicating that the majority of learners operated comfortably within a high-competency band. The relatively low standard deviation of 3.18 further suggests a homogeneous distribution of achievement, implying that individual performance gaps gradually narrowed as the mentoring process progressed. Quartile distribution also supports this stability, with Q1 at 82.33, the median at 82.67, and Q3 at 84.33, highlighting tightly clustered outcomes across students.

These statistical patterns demonstrate that the mentoring model not only elevates overall performance but also fosters consistency across different stages of assessment. The upward trajectory from the initial mean of 79.31 to 87.57 in the final phase shows that students were able to internalize feedback, refine their welding techniques, and progressively improve procedural accuracy. This aligns with the assertions of Mwesigwa & Nakato (2025), who explain that structured mentoring contributes to instructional stability by ensuring that learners receive timely corrections and individualized guidance, ultimately reducing disparities in vocational skill acquisition. The tight clustering of quartile values reflects this effect, signaling that even students who initially performed below the cohort average were able to reach comparable levels of competence through the sustained support embedded in the mentor-guided framework.

Furthermore, the uniform improvement visible across statistical indicators suggests that mentoring played a significant role in cultivating procedural discipline and technical confidence—two essential components of effective SMAW practice. Students appeared to benefit not only from the direct modelling of correct welding techniques but also from the formative feedback cycles that encouraged reflective adjustments and self-regulated learning. Such outcomes resonate with broader findings in vocational pedagogy, where consistent mentor interaction is linked to improved skill mastery, reduced error rates, and heightened learner motivation. Collectively, these results reaffirm the instructional merit of mentor-based learning and demonstrate its capacity to enhance the quality, consistency, and equity of welding performance in vocational education settings.

Table 1. Descriptive Statistics of Student Performance in SMAW Welding Practice

Statistics	Initial Test	Mid Test	Final Test	Overall Average
Minimum	75.00	82.00	84.00	80.67
Quartile 1 (Q1)	78.00	82.00	85.00	82.33
Median	80.00	84.00	85.00	82.67
Mean (Average)	79.31	85.24	87.57	84.04
Quartile 3 (Q3)	80.00	88.00	90.00	84.33
Maximum	90.00	95.00	95.00	93.33
Standard Deviation	3.26	3.96	3.48	3.18

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The data reveal a clear and progressive improvement in student achievement, beginning with an initial mean score of 79.31 that increased steadily across assessment stages until reaching 87.57 in the final evaluation. This upward shift demonstrates that students not only assimilated the foundational welding concepts but were also able to refine their performance through repeated practice and targeted mentor feedback. Such a trend aligns with the cumulative learning benefits highlighted by Yunus *et al*. (2025), who emphasize that structured mentoring enhances retention, supports skill consolidation, and facilitates gradual mastery of complex technical tasks. The relatively low performance variance observed in this study further reinforces the idea that mentoring contributes to balanced and equitable learning development. Chine *et al*. (2022) similarly argue that sustained mentor–learner interaction cultivates more uniform achievement distribution by minimizing instructional gaps and ensuring that all students receive adequate support throughout the learning process. This consistency across assessment phases illustrates that the mentoring model played a substantive role in stabilizing student performance and enabling learners with diverse initial skill levels to reach comparable proficiency.

A deeper understanding of the learning impact is reflected in the categorization of student performance presented in Table 2. From a total of 70 participants, 8 students (11.4%) achieved the Very High category, while 62 students (88.6%) were classified into the High category, and importantly, no students fell into either the Low or Very Low categories. This distribution strongly indicates that the majority of learners were able to perform at consistently elevated levels, suggesting that the mentor-based approach effectively narrowed achievement disparities and supported uniformly positive outcomes. These findings resonate with the leveling effects described by Smith-Ruig (2014) and Idiaghe & Deters (2024), who documented similar patterns in guided project-based environments, where structured mentoring reduced variation in learner performance and promoted more inclusive mastery. The absence of lower-tier classifications in this study underscores the potential of mentor-driven instruction to lift the performance floor while simultaneously supporting high-end achievement, ultimately contributing to a more equitable and competency-oriented learning environment within vocational welding education.

Table 2. Distribution of Students by Effectiveness Category

Effectiveness Category	Number of Students	Percentage
Very High	8	11.4%
High	62	88.6%
Low	0	0%
Very Low	0	0%
Total	70	100%

Student reflections gathered via Likert-scale responses support the positive impact of mentoring on confidence, motivation, and task ownership. These psychological benefits have been emphasized by Horváth-Csikós *et al*. (2023) and López *et al*. (2023), who found that mentor interaction enhances self-efficacy and critical thinking in vocational learners. Students in this study consistently reported increased ability to assess their own performance, adapt techniques, and apply safety measures. This behavior aligns with findings from Carvalho & Santos (2022), who linked mentoring to the development of procedural independence. Furthermore, students' outputs in the Creativity, Innovation, and Entrepreneurship subject reflected not only technical proficiency but also innovation in design and execution, resonating with claims made by Napieraj (2022).

Finally, these results illustrate the broader potential of mentoring to transform vocational education. It operationalizes principles of individualized instruction, formative evaluation, and competency-based progress. The consistent improvements and high motivation observed in this study echo the mentorship models described by Varianytsia *et al*. (2022), all of whom emphasize the role of mentor involvement in fostering deeper learning and workplace readiness. Accordingly, the mentor-guided model used in this study may serve as a replicable reference for integrating skill development with entrepreneurial growth in vocational education.

4. Conclusion and Suggestions

Based on the findings, it can be concluded that the mentor-based learning model is highly effective in improving students' competencies in SMAW welding practice, as evidenced by the high average performance score of 84.04 and the dominance of students in the "High" and "Very High" effectiveness categories. The consistent progression of scores, supported by low variability and positive student perceptions, indicates that structured mentoring fosters both technical mastery and reflective learning. Therefore, it is recommended that vocational

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schools systematically adopt and integrate mentoring approaches within practice-based subjects, particularly those linked to entrepreneurship and innovation. Future research should explore mentor impact across different vocational fields and examine long-term effects on graduate readiness, creativity, and adaptability in real industrial settings.

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