

Teaching Factory Engagement, Entrepreneurial Knowledge, Social Relationships, and Vocational Students' Entrepreneurial Mindset

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Abstract

This study examined the relationships among student engagement in the Teaching Factory (TEFA), entrepreneurial knowledge, social relationships, self-efficacy, and entrepreneurial mindset among vocational high school students in East Java, Indonesia. A quantitative, cross-sectional ex post facto design was employed. The participants were 210 Grade 12 students enrolled in TEFA classes within Welding Engineering programs at public and private vocational high schools, selected through proportional random sampling. Path analysis based on multiple regression was used to test the proposed relationships. TEFA engagement ($\beta = .360$, $p < .001$), entrepreneurial knowledge ($\beta = .115$, $p = .023$), and social relationships ($\beta = .410$, $p < .001$) were positively associated with self-efficacy and jointly explained 54.4% of its variance. TEFA engagement ($\beta = .162$, $p = .005$), entrepreneurial knowledge ($\beta = .187$, $p < .001$), social relationships ($\beta = .126$, $p = .037$), and self-efficacy ($\beta = .499$, $p < .001$) were positively associated with entrepreneurial mindset and jointly explained 63.6% of its variance. Social relationships were the strongest predictor of self-efficacy, whereas self-efficacy was the strongest predictor of entrepreneurial mindset. These findings indicate that TEFA programs should integrate authentic production activities, practical entrepreneurship instruction, and sustained support from teachers, peers, and industry professionals to strengthen students' confidence and entrepreneurial orientation. Because indirect effects were not formally tested, the results should not be interpreted as evidence of statistical mediation or definitive causality.

Keywords: Teaching Factory Engagement; Entrepreneurial Knowledge; Social Relationships; Self-Efficacy; Entrepreneurial Mindset

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INTRODUCTION

Twenty-first-century education has undergone profound changes in response to increasing uncertainty, complexity, ambiguity, and rapid technological and economic transformation. Contemporary educational systems are consequently shifting from knowledge-centred instruction toward learning models that emphasize creativity, collaboration, adaptability, critical thinking, and problem-solving (Chalkiadaki, 2018; González-Pérez et al., 2022; González-Salamanca et al., 2020). This transformation is particularly important in vocational education because vocational institutions must equip students not only with occupation-specific competencies but also with the transferable capabilities required to respond to changing labour-market conditions.

In Indonesia, Vocational High Schools (Sekolah Menengah Kejuruan [SMK]) are expected to prepare graduates to enter employment or establish their own businesses

through the acquisition of practical and entrepreneurial competencies (Abiltarova et al., 2022; Borisova et al., 2016; Mack et al., 2019). However, this objective has not been fully achieved. According to the 2020 data reported by the Indonesian Central Bureau of Statistics, vocational high school graduates accounted for approximately 8.49% of the unemployed population. This condition indicates a continuing mismatch between the competencies developed through formal vocational education and those required by rapidly changing industries (Oviawe et al., 2017). Technical preparation alone may therefore be insufficient when students have limited opportunities to apply their competencies, solve authentic problems, and develop confidence in their capacity to work or undertake entrepreneurial activities.

One educational response to this gap is the Teaching Factory (TEFA), an industry-oriented learning model that reproduces selected production processes, work standards, and professional practices within the school environment. TEFA provides students with opportunities to participate in project-based learning, production simulations, authentic problem-solving, and collaboration with industry partners (Ahmad et al., 2024; Meinokat & Wagner, 2025; Wahjusaputri et al., 2024). Related learning-factory research indicates that authentic production environments can support the development of technical, personal, interpersonal, methodological, and action-oriented competencies (Liao et al., 2024; Roll & Ifenthaler, 2021). Factory-based and immersive learning environments may also enrich students' understanding of industrial processes and support the soft skills required for sustainable workforce development (Netland et al., 2024; Yohana, 2020).

Empirical findings further suggest that TEFA and project-based product development can support entrepreneurial outcomes when students actively participate in designing, producing, evaluating, and improving market-relevant products. Among Indonesian vocational students, TEFA, entrepreneurship education, and product innovation have been positively associated with entrepreneurial interest (Nugroho et al., 2024). Project-based final-product development has also been associated with stronger entrepreneurial motivation, while evaluations of TEFA and creative-product learning indicate that their effectiveness depends on student motivation, teacher competence, time allocation, and adequate institutional support (Dhani & Kristiani, 2021; Murniati et al., 2022). These findings support the educational value of authentic production experience but also indicate that TEFA participation alone may not automatically generate entrepreneurial readiness.

TEFA is expected to develop more than technical competence. Through teamwork, communication, problem-solving, feedback, and responsibility for production outcomes, students may also develop the soft skills needed to adapt to contemporary workplaces (Bouhout et al., 2024; Clark et al., 2024). Such learning experiences may strengthen confidence, adaptability, and readiness to work or engage in entrepreneurship, particularly when teachers function as facilitators and entrepreneurial role models (Brush et al., 2024). Critical thinking, creativity, and problem-solving are also relevant to entrepreneurial development because they enable students to identify problems, generate alternatives, and respond to uncertain conditions (Hadley, 2025; Iddris, 2025).

A central psychological factor connecting educational experience with entrepreneurial readiness is self-efficacy. In this study, self-efficacy refers to students' confidence in their ability to perform tasks and overcome challenges relevant to entrepreneurial activity. From a social-cognitive perspective, confidence develops

when learners successfully complete meaningful tasks, observe competent models, receive constructive feedback, and obtain support from their social environment. Entrepreneurial self-efficacy has accordingly been identified as an important predictor of entrepreneurial readiness, intention, persistence, and behaviour (Duong & Vu, 2025; Guo et al., 2025; Taneja et al., 2024). Evidence from Technical and Vocational Education and Training settings shows that entrepreneurial self-efficacy is closely related to students' readiness to create and manage business activities (Adeniyi et al., 2022). Similarly, perceived entrepreneurship education has been positively associated with entrepreneurial self-efficacy and entrepreneurial intention among students in higher vocational education (Zheng & Islam, 2021).

Entrepreneurial knowledge constitutes another important component of students' entrepreneurial development. It includes an understanding of opportunity identification, business planning, marketing, financial management, resource organization, innovation, and risk management. This knowledge can provide students with cognitive resources for evaluating opportunities and making informed decisions, although knowledge is more likely to influence entrepreneurial outcomes when learners are able to apply it in practical contexts. Previous research has shown that entrepreneurship education can develop entrepreneurial skills and intentions, but its effects vary according to instructional methods, learning environments, and students' psychological readiness (Chaker & Dellagi, 2023; Darnell & Gopalkrishnan, 2024; Gassol, 2025). Studies in higher vocational education similarly indicate that both theoretical and practical entrepreneurship education are associated with entrepreneurial intention, with creativity representing one possible explanatory pathway (Huang et al., 2024). School-level evidence also suggests that entrepreneurship-related curricula are more likely to encourage entrepreneurial intention when students develop self-efficacy and perceive entrepreneurship as desirable and attainable (Nepal et al., 2021).

The effects of TEFA engagement and entrepreneurial knowledge may also depend on the quality of students' social relationships. Relationships with teachers, peers, school leaders, and industry professionals provide access to feedback, role models, information, encouragement, and professional networks. Teachers' readiness and confidence in teaching entrepreneurship are particularly important because teachers design learning activities, guide reflection, and help students connect theoretical knowledge with practical opportunities (Ranta et al., 2022). School management teams also contribute through curriculum development, mentoring systems, resource allocation, community partnerships, and connections with external entrepreneurial networks (Nwosu et al., 2023). In addition, industry involvement can strengthen the perceived relevance of learning through curriculum alignment, renewed pedagogical practices, career mentoring, and direct exposure to professional expectations (Ehiobuche et al., 2022). Peer groups may further reinforce entrepreneurial attitudes by providing social encouragement and opportunities to exchange ideas.

These social and institutional conditions are important because entrepreneurial education has not consistently translated into entrepreneurial behaviour. Although innovative teaching approaches can strengthen entrepreneurial competencies, their outcomes remain dependent on curriculum quality, opportunities for authentic application, educator preparedness, and the surrounding entrepreneurial ecosystem (Chaker & Dellagi, 2023; Darnell & Gopalkrishnan, 2024; Gassol, 2025). Educational

institutions can support this process by functioning as entrepreneurship hubs that connect students with mentors, resources, industry partners, and opportunities to develop entrepreneurial ideas (Huang et al., 2025; Wong & Chan, 2024). Evidence from a school-based entrepreneurial project also indicates that authentic business-development activities can improve secondary students' growth mindset, metacognition, and career-choice readiness (Brausch-Böger & Förster, 2024).

Despite the growing literature on TEFA, entrepreneurship education, social support, and self-efficacy, the relationships among these factors remain insufficiently integrated in secondary vocational education research. Chaker and Dellagi (2023), for example, examined the relationship between teaching methods and entrepreneurial skills but did not incorporate industry-based learning or self-efficacy into their model. Ganefri et al. (2024) included self-efficacy and entrepreneurial mindset but focused on university students rather than secondary vocational learners. Hulyadi et al. (2025) examined project-based TEFA in the chemical-cleaning context, whereas Wahjusaputri et al. (2024) investigated the development of an artificial-intelligence-supported TEFA. These studies demonstrate the increasing diversity of TEFA applications but do not simultaneously examine TEFA engagement, entrepreneurial knowledge, social relationships, self-efficacy, and entrepreneurial mindset among students in Welding Engineering programs.

The research gap is particularly relevant because TEFA studies frequently emphasize program implementation, technical competence, soft skills, or entrepreneurial intention as separate outcomes (Ahmad et al., 2024; Hulyadi et al., 2025; Liao et al., 2024; Yohana, 2020). Evidence concerning the combined relationships of authentic industrial learning, entrepreneurial knowledge, and students' social environment with entrepreneurial self-efficacy and mindset remains fragmented. Furthermore, studies that examine self-efficacy as an explanatory mechanism have predominantly involved higher education populations (Duong & Vu, 2025; Ganefri et al., 2024; Zheng & Islam, 2021), limiting their direct applicability to secondary vocational students.

This study addresses this gap by integrating educational, cognitive, and social factors within one path model. It examines whether students' engagement in TEFA, entrepreneurial knowledge, and social relationships are associated with self-efficacy and whether these variables, together with self-efficacy, are associated with entrepreneurial mindset. The study does not assume that participation in TEFA independently determines entrepreneurial outcomes. Instead, it proposes that authentic production experience operates alongside entrepreneurial knowledge and supportive social relationships in explaining differences in students' confidence and entrepreneurial orientation.

The study's contribution lies in its integrated examination of these constructs within Grade 12 Welding Engineering TEFA programs in public and private vocational high schools in East Java. Path analysis is used to estimate the direct relationships among the observed variables and the proportion of variance explained in self-efficacy and entrepreneurial mindset. Although self-efficacy is positioned as an intervening variable in the proposed model, the statistical significance of indirect effects was not formally tested. Therefore, the analysis does not establish mediation and should not be interpreted as evidence of definitive causal processes.

The constructs are operationalized in accordance with their entrepreneurial and vocational contexts. Self-efficacy represents students' confidence in completing

entrepreneurship-related tasks and addressing associated challenges (Taneja et al., 2024). Entrepreneurial mindset reflects an orientation toward recognizing opportunities, acting proactively, responding creatively, persisting through difficulties, and managing calculated risks (Ganefri et al., 2024). This distinction enables the study to examine students' confidence in their capabilities separately from the broader cognitive orientation through which they evaluate and respond to entrepreneurial opportunities.

Accordingly, the study hypothesizes that engagement in TEFA, entrepreneurial knowledge, and social relationships are positively associated with students' self-efficacy. It further hypothesizes that TEFA engagement, entrepreneurial knowledge, social relationships, and self-efficacy are positively associated with entrepreneurial mindset. By testing these relationships, the study seeks to provide evidence for the development of TEFA programs that combine authentic production experience, practical entrepreneurship learning, and sustained support from teachers, peers, school leaders, and industry professionals. Such integration may help vocational schools formulate more responsive educational practices while supporting broader objectives related to graduate adaptability, entrepreneurship, decent work, and sustainable economic growth.

METHOD

Research Design

This study employed a quantitative, cross-sectional ex post facto design. The independent variables were not experimentally manipulated because the relevant educational experiences and social conditions had occurred before data collection. The cross-sectional design enabled the researchers to examine the characteristics and relationships among the study variables at a single point in time (Creswell, 2014; Emzir, 2013). Accordingly, the findings were interpreted as statistical associations rather than definitive causal effects.

Population and Sample

The study population comprised Grade 12 students enrolled in Teaching Factory (TEFA) classes within the Welding Engineering Expertise Program at public and private vocational high schools (SMK) in East Java. Proportional random sampling was used to select students according to their representation within the population. This procedure produced a final sample of 210 students.

Research Variables and Proposed Model

The study examined five variables. Student engagement in TEFA (X1), entrepreneurial knowledge (X2), and social relationships (X3) were specified as exogenous variables. Self-efficacy (Y) was positioned as an intervening endogenous variable, while entrepreneurial mindset (Z) was specified as the final endogenous variable.

The proposed model consisted of two substructures. The first substructure examined the relationships of TEFA engagement, entrepreneurial knowledge, and social relationships with self-efficacy. The second substructure examined the relationships of TEFA engagement, entrepreneurial knowledge, social relationships, and self-efficacy with entrepreneurial mindset. The proposed relationships among the variables are presented in Figure 1.

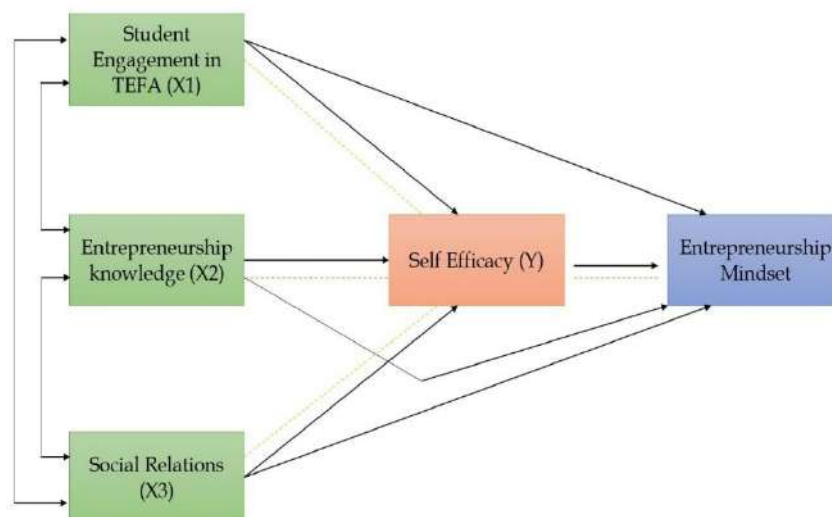


Figure 1. Proposed path model of the relationships among the study variables. Note. X1 = student engagement in TEFA; X2 = entrepreneurial knowledge; X3 = social relationships; Y = self-efficacy; Z = entrepreneurial mindset.

Data Analysis

Path analysis based on multiple regression was used to estimate the relationships between the exogenous and endogenous variables. Path analysis is appropriate for examining the magnitude and statistical significance of relationships among variables specified in a theoretically developed model (Riduwan & Kuncoro, 2014).

The analysis was conducted in two stages. First, self-efficacy was regressed on TEFA engagement, entrepreneurial knowledge, and social relationships. Second, entrepreneurial mindset was regressed on TEFA engagement, entrepreneurial knowledge, social relationships, and self-efficacy. Standardized regression coefficients, significance values, multiple-correlation coefficients, and coefficients of determination were used to evaluate the proposed relationships and the proportion of variance explained in each endogenous variable.

Before hypothesis testing, the data were examined for normality, linearity, multicollinearity, heteroscedasticity, and autocorrelation. Self-efficacy was positioned as an intervening variable in the conceptual model; however, the statistical significance of indirect effects was not formally tested. Therefore, the analysis did not establish mediation or estimate statistically verified indirect and total effects.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1 presents the descriptive statistics for student engagement in the Teaching Factory (TEFA), entrepreneurial knowledge, social relationships, self-efficacy, and entrepreneurial mindset. All variables were measured for 210 students.

Table 1. Descriptive Statistics for the Study Variables

Variable	N	Mean	Median	Mode	SD	Min	Max	Range
Student engagement in TEFA	210	84.00	83.53	82	9.636	60	112	52

Variable	N	Mean	Median	Mode	SD	Min	Max	Range
Entrepreneurial knowledge	210	54.77	53.13	53	12.144	30	78	48
Social relationships	210	54.47	54.00	54	6.336	39	72	33
Self-efficacy	210	64.51	62.96	59	7.090	48	84	36
Entrepreneurial mindset	210	77.64	78.00	81	8.313	53	96	43

Student engagement in TEFA had a mean score of 84.00 (SD = 9.636), with scores ranging from 60 to 112. Entrepreneurial knowledge had a mean score of 54.77 (SD = 12.144), while social relationships had a mean score of 54.47 (SD = 6.336). The mean self-efficacy score was 64.51 (SD = 7.090), and the mean entrepreneurial mindset score was 77.64 (SD = 8.313). The complete interval-based frequency distributions are provided in Supplementary Table S1.

Assumption Testing

Before conducting the path analysis, the data were examined for normality, linearity, multicollinearity, heteroscedasticity, and autocorrelation. The complete SPSS outputs are provided in the appendix.

Normality, Linearity, and Autocorrelation

The normality of the residuals was assessed using the one-sample Kolmogorov-Smirnov test. Residuals were considered normally distributed when the significance value exceeded .05. Linearity was evaluated using the test for linearity, while autocorrelation was examined using the Durbin-Watson statistic.

The residual significance values were .058 for Model 1 and .075 for Model 2, indicating that the residuals were normally distributed. All proposed relationships met the linearity criterion because their significance values were below .05. The Durbin-Watson values for Model 1 and Model 2 also fell within the specified decision ranges, indicating no evidence of autocorrelation.

Table 2. Summary of Normality, Linearity, and Autocorrelation Tests

Test	Model or relationship	Statistic	Significance	Interpretation
Normality	Model 1 residuals	Kolmogorov-Smirnov	.058	Normally distributed
Normality	Model 2 residuals	Kolmogorov-Smirnov	.075	Normally distributed
Linearity	TEFA engagement and self-efficacy	—	$p < .001$	Linear
Linearity	Entrepreneurial knowledge and self-efficacy	—	$p < .001$	Linear
Linearity	Social relationships and self-efficacy	—	$p < .001$	Linear
Linearity	TEFA engagement and entrepreneurial mindset	—	$p < .001$	Linear
Linearity	Entrepreneurial knowledge and	—	$p < .001$	Linear

Test	Model or relationship	Statistic	Significance	Interpretation
Linearity	entrepreneurial mindset	—	$p < .001$	Linear
	Social relationships and entrepreneurial mindset			
Linearity	Self-efficacy and entrepreneurial mindset	—	$p < .001$	Linear
Autocorrelation	Model 1	DW = 2.053	$1.75483 < DW < 2.20674$	No autocorrelation
Autocorrelation	Model 2	DW = 1.974	$1.74513 < DW < 2.19696$	No autocorrelation

Multicollinearity

Multicollinearity was assessed using tolerance and variance inflation factor (VIF) values. Tolerance values above .10 and VIF values below 10 were interpreted as indicating an absence of problematic multicollinearity.

Table 3. Multicollinearity Diagnostics for the Two Path Models

Model	Predictor	Tolerance	VIF
Model 1	Student engagement in TEFA	.633	1.581
Model 1	Entrepreneurial knowledge	.876	1.141
Model 1	Social relationships	.603	1.658
Model 2	Student engagement in TEFA	.536	1.865
Model 2	Entrepreneurial knowledge	.854	1.170
Model 2	Social relationships	.493	2.027
Model 2	Self-efficacy	.456	2.194

All tolerance values exceeded .10, and all VIF values were below 10. Therefore, the predictor variables did not exhibit problematic multicollinearity in either model.

Heteroscedasticity

Heteroscedasticity was assessed by examining scatterplots of the standardized residuals and predicted values. In both models, the residual points were distributed above and below zero without forming a clear systematic pattern. These results indicated no substantial evidence of heteroscedasticity.

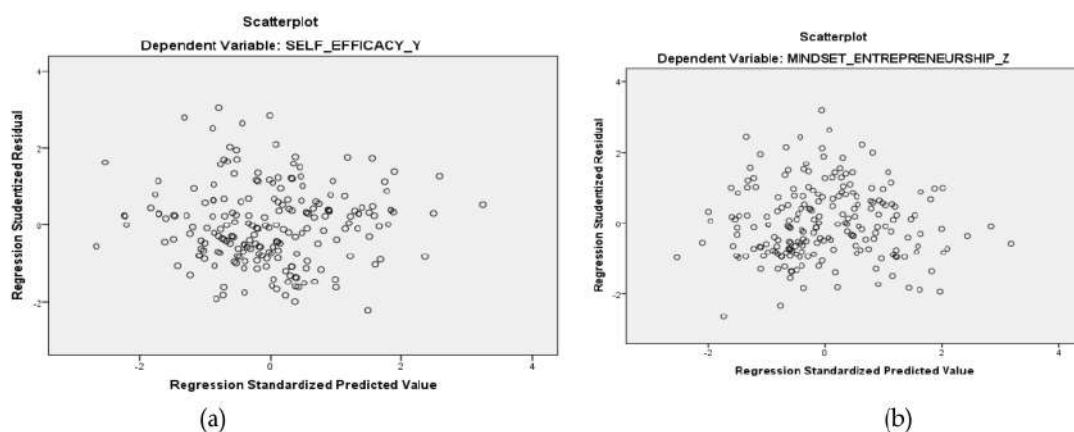


Figure 2. Heteroscedasticity test results for (a) Model 1 and (b) Model 2

Path Analysis and Hypothesis Testing

Path analysis based on multiple regression was conducted in two stages. Model 1 examined the relationships of student engagement in TEFA, entrepreneurial knowledge, and social relationships with self-efficacy. Model 2 examined the relationships of the three exogenous variables and self-efficacy with entrepreneurial mindset.

Table 4. Path Coefficients and Model Summaries for Self-Efficacy and Entrepreneurial Mindset

Model	Outcome	Predictor	β	p	R	R ²	Adjusted R ²
1	Self-efficacy	Student engagement in TEFA	.360	< .001	.738	.544	.538
1	Self-efficacy	Entrepreneurial knowledge	.115	.023	—	—	—
1	Self-efficacy	Social relationships	.410	< .001	—	—	—
2	Entrepreneurial mindset	Student engagement in TEFA	.162	.005	.798	.636	.629
2	Entrepreneurial mindset	Entrepreneurial knowledge	.187	< .001	—	—	—
2	Entrepreneurial mindset	Social relationships	.126	.037	—	—	—
2	Entrepreneurial mindset	Self-efficacy	.499	< .001	—	—	—

Model 1: Predictors of Self-Efficacy

Model 1 was statistically significant, $R = .738$, $R^2 = .544$, adjusted $R^2 = .538$, $p < .001$. Student engagement in TEFA, entrepreneurial knowledge, and social relationships jointly explained 54.4% of the variance in self-efficacy. The residual path coefficient was calculated as the square root of one minus R^2 (Asra et al., 2017; Bachrudin & Tobing, 2017), resulting in a residual coefficient of .675.

$$Y = .360X_1 + .115X_2 + .410X_3 + e_1$$

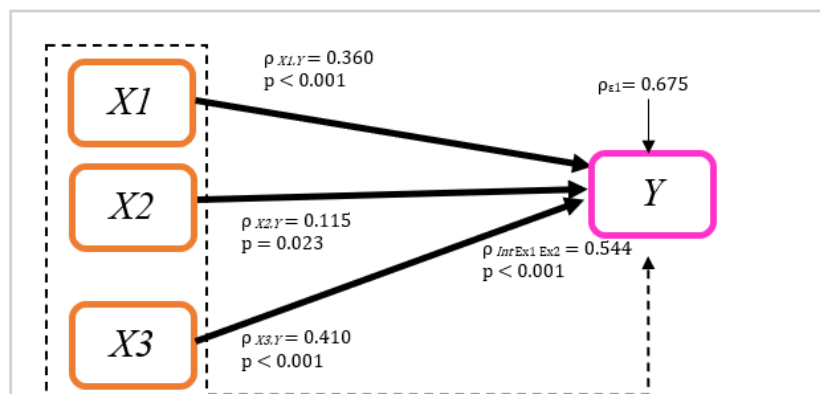


Figure 3. Standardized path coefficients and significance values for Model 1 (predictor of self-efficacy)

Student engagement in TEFA was positively associated with self-efficacy ($\beta = .360$, $p < .001$). Entrepreneurial knowledge also showed a positive association with self-efficacy ($\beta = .115$, $p = .023$). Social relationships had the strongest direct

association with self-efficacy ($\beta = .410$, $p < .001$). Therefore, H1, H2, and H3 were supported.

Model 2: Predictors of Entrepreneurial Mindset

Model 2 was statistically significant, $R = .798$, $R^2 = .636$, adjusted $R^2 = .629$, $p < .001$. Student engagement in TEFA, entrepreneurial knowledge, social relationships, and self-efficacy jointly explained 63.6% of the variance in entrepreneurial mindset. The residual coefficient for Model 2 was .603.

$$Z = .162X1 + .187X2 + .126X3 + .499Y + e2$$

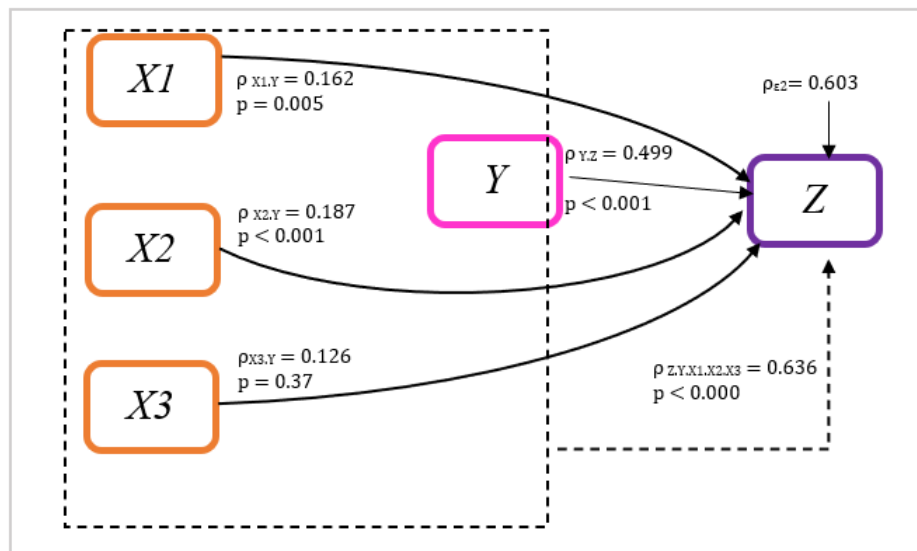


Figure 4. Standardized path coefficients and significance values for Model 2 (predictor of Entrepreneurial mindset)

Student engagement in TEFA was positively associated with entrepreneurial mindset ($\beta = .162$, $p = .005$). Entrepreneurial knowledge also showed a positive association with entrepreneurial mindset ($\beta = .187$, $p < .001$), as did social relationships ($\beta = .126$, $p = .037$). Self-efficacy had the strongest direct association with entrepreneurial mindset ($\beta = .499$, $p < .001$). Therefore, H4, H5, H6, and H7 were supported.

Although self-efficacy was positioned as an intervening variable in the conceptual model, the statistical significance of the indirect effects was not formally examined. Consequently, the findings reported in this section are limited to the model-level explanatory power and the direct standardized relationships among the study variables.

Discussion

This study examined the relationships of student engagement in the Teaching Factory (TEFA), entrepreneurial knowledge, and social relationships with self-efficacy and entrepreneurial mindset among vocational high school students in East Java. The first model explained 54.4% of the variance in self-efficacy, with social relationships emerging as the strongest direct predictor. The second model explained 63.6% of the variance in entrepreneurial mindset, with self-efficacy showing the strongest direct association. Because the study used a cross-sectional ex post facto design and did not formally test indirect effects, these findings represent statistical associations rather than confirmed causal or mediation processes.

Student Engagement in the Teaching Factory

Student engagement in TEFA was positively associated with self-efficacy ($\beta = .360, p < .001$) and entrepreneurial mindset ($\beta = .162, p = .005$). These findings indicate that students who participate more actively in authentic production activities tend to report greater confidence in completing work- and entrepreneurship-related tasks. TEFA allows students to apply classroom knowledge to production processes, use industry-relevant equipment, address practical problems, and assume responsibility for the quality of their work. Such experiences may help students evaluate their occupational capabilities more positively.

This interpretation is consistent with the view that self-efficacy develops through successful task completion, observation of competent models, social encouragement, and performance feedback. Work-based vocational research shows that authentic tasks can increase students' cognitive engagement and motivation, particularly when teachers, workplace trainers, and experienced workers provide guidance and constructive feedback (Pylväs et al., 2022). Evidence from higher vocational education also indicates that innovative and interactive instruction can strengthen self-efficacy by offering opportunities for modelling, encouragement, task evaluation, and active participation (Han & Hamzah, 2024).

The positive association between TEFA engagement and self-efficacy also supports the argument that TEFA develops more than technical competence. Through communication, teamwork, decision-making, and problem-solving, students encounter situations resembling those found in actual workplaces (Ahmad et al., 2024; Erol & Erol, 2024). These experiences may function as mastery experiences when students successfully complete production assignments and receive evidence that their competencies can produce meaningful outcomes. This interpretation is also compatible with the broader role of self-efficacy in helping individuals undertake specific professional and educational tasks (Duong & Vu, 2025; Lee et al., 2023; Otto et al., 2024).

The association between TEFA engagement and entrepreneurial mindset was positive but weaker than its association with self-efficacy. This pattern suggests that practical production experience may contribute to entrepreneurial thinking but may not be sufficient by itself. TEFA activities need to make the entrepreneurial dimensions of production explicit, including opportunity identification, customer needs, cost calculation, product innovation, quality control, and market feasibility. Interaction with industry professionals may also expose students to entrepreneurial role models and encourage them to view technical problems as opportunities for creating value (Yeap & Thien, 2021).

Entrepreneurial Knowledge

Entrepreneurial knowledge was positively associated with self-efficacy ($\beta = .115, p = .023$) and entrepreneurial mindset ($\beta = .187, p < .001$). Entrepreneurial knowledge provides students with an understanding of opportunity recognition, business planning, marketing, financial management, product development, and risk assessment. Such knowledge gives students a cognitive framework for evaluating business opportunities and planning entrepreneurial activities.

However, entrepreneurial knowledge showed the weakest direct association with self-efficacy. This finding may indicate that knowledge alone does not automatically produce confidence. Students may understand entrepreneurial

principles without having sufficient opportunities to apply them, observe their consequences, and receive feedback on their performance. In contrast, authentic tasks and supportive relationships offer more immediate evidence of capability. The relatively small coefficient is therefore better interpreted as showing the need to connect entrepreneurship content with practical application rather than as evidence that entrepreneurial knowledge is unimportant.

This interpretation is consistent with studies reporting that entrepreneurial literacy among vocational students remains uneven and that knowledge is most valuable when students can apply it to occupationally relevant problems (Liang et al., 2025; Oroka et al., 2024). Practice-oriented projects can help students transform abstract concepts into business ideas, production decisions, and marketable outputs (Mutiaraningrum et al., 2024; Suparno et al., 2025). Consequently, entrepreneurship instruction in TEFA should be embedded in production activities rather than delivered only as a separate theoretical subject.

The stronger coefficient for entrepreneurial mindset than for self-efficacy suggests that entrepreneurial knowledge may be particularly relevant to how students recognize opportunities, evaluate risks, and interpret the commercial potential of their technical skills. Nevertheless, the cross-sectional results do not demonstrate that increasing knowledge will necessarily cause a corresponding increase in mindset. Longitudinal or intervention-based research is needed to determine how the application of entrepreneurial knowledge changes students' confidence and entrepreneurial orientation over time.

Social Relationships

Social relationships had the strongest direct association with self-efficacy ($\beta = .410, p < .001$) and were also positively associated with entrepreneurial mindset ($\beta = .126, p = .037$). These findings highlight the importance of relationships with teachers, peers, school leaders, workplace trainers, and industry professionals in vocational learning. Supportive relationships can provide encouragement, task guidance, role modelling, professional information, and feedback that help students interpret difficulties as manageable learning experiences.

The strength of this relationship is theoretically plausible because self-efficacy is partly socially constructed. Students do not assess their capabilities solely from written knowledge; they also observe competent individuals, compare their performance with that of peers, and respond to feedback from people they consider credible. Research involving vocational students has similarly emphasized the importance of positive feedback and social support from teachers, co-workers, and workplace trainers in strengthening confidence during authentic work tasks (Pylväs et al., 2022). Studies of vocational college students have also found significant relationships between social support and self-efficacy-related outcomes (Zhang et al., 2024).

Teacher support is particularly important because teachers determine how responsibilities are distributed, how feedback is communicated, and how much autonomy students receive. Evidence from vocational colleges indicates that teacher support and learner autonomy are closely connected with student self-efficacy (Wang et al., 2024). Research in technical and vocational education also shows that constructive teaching, professional skill development, and social support are

important for strengthening professional capabilities and self-efficacy (Shodipe & Ogbuanya, 2024).

The positive relationship between social relationships and entrepreneurial mindset can be interpreted through access to information and networks. Teachers, peers, and industry professionals may introduce students to customer needs, business opportunities, technical innovations, and possible career pathways. Strong relationships can also provide emotional support when students encounter uncertainty or failure. These networks may consequently encourage students to consider entrepreneurship as an attainable career option (Susantiningrum et al., 2023).

Nevertheless, the direct coefficient linking social relationships with entrepreneurial mindset was smaller than the coefficient linking social relationships with self-efficacy. This pattern is consistent with the possibility that social support first strengthens students' confidence, which may subsequently support entrepreneurial thinking. However, because the significance of the indirect effect was not formally tested, this explanation should be treated as a theoretically plausible interpretation rather than evidence of statistical mediation.

Self-Efficacy and Entrepreneurial Mindset

Self-efficacy was the strongest direct predictor of entrepreneurial mindset ($\beta = .499$, $p < .001$). This result indicates that students who are more confident in their ability to complete difficult tasks, solve problems, and overcome obstacles also tend to demonstrate a stronger entrepreneurial orientation. Confidence may encourage students to take initiative, persist when initial attempts fail, evaluate uncertain situations, and act on identified opportunities.

An entrepreneurial mindset requires more than knowledge of business principles. Students must believe that they can apply their knowledge under conditions involving uncertainty, limited resources, technical challenges, and possible failure. Self-efficacy may therefore help transform educational experiences into proactive behavior by influencing how students interpret difficulties and whether they persist in addressing them. This interpretation is consistent with research identifying entrepreneurial self-efficacy as an important psychological foundation for entrepreneurial attitudes, intentions, and behavior (Adeniyi et al., 2022; Duong & Vu, 2025; Taneja et al., 2024).

In the present context, self-efficacy may be strengthened when students successfully complete TEFA assignments, observe competent role models, receive constructive feedback, and obtain support from their social environment. These experiences can encourage students to perceive entrepreneurial tasks as manageable rather than beyond their capabilities. However, the findings do not demonstrate that self-efficacy causes entrepreneurial mindset because both constructs were measured at the same point in time.

Integrated Interpretation of the Findings

Figure 5 provides a visual summary of the first model. It presents the squared standardized coefficients originally reported for TEFA engagement, entrepreneurial knowledge, and social relationships, together with the total variance in self-efficacy explained by the model. The displayed values of 12.96%, 1.32%, and 16.81% correspond respectively to .360 squared, .115 squared, and .410 squared. The value of 54.4% represents the model-level coefficient of determination, R^2 .

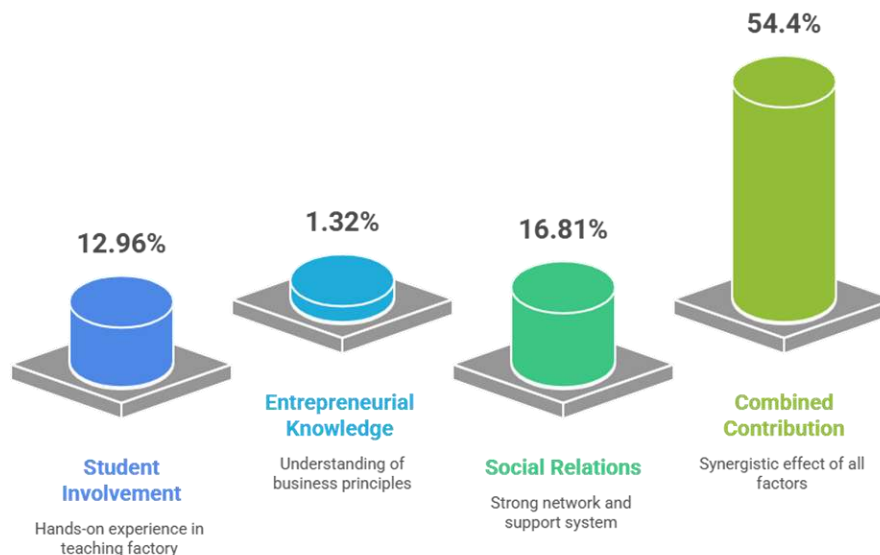


Figure 5. Descriptive visualization of the squared standardized coefficients and explained variance in self-efficacy. The values of 12.96%, 1.32%, and 16.81% are squared standardized regression coefficients. Because the predictors may share explanatory variance, these values should not be interpreted as unique or additive percentages of variance. The value of 54.4% represents the total variance in self-efficacy explained by Model 1.

Figure 5 illustrates two important findings. First, social relationships had the largest standardized association with self-efficacy, followed by TEFA engagement and entrepreneurial knowledge. Second, the three predictors jointly explained substantially more variance than the individual squared coefficients suggest because the model includes shared relationships among the predictors. The figure should consequently be interpreted as a descriptive visualization rather than a decomposition of independent contributions.

Figure 6 presents a conceptual synthesis of the study's findings. It illustrates how TEFA participation provides authentic experience, entrepreneurial instruction supports knowledge acquisition, and social relationships provide modelling and support. These elements are interpreted as contributing to stronger confidence, which is associated with entrepreneurial mindset formation.

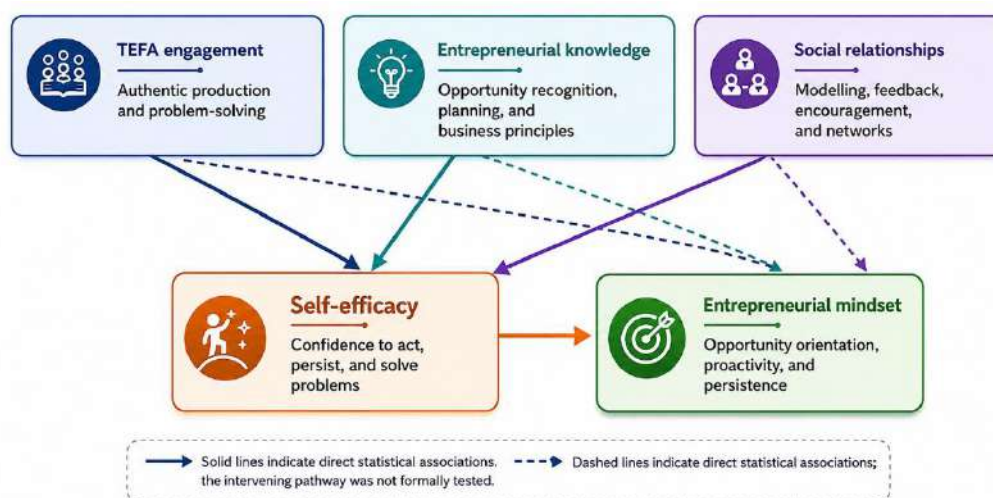


Figure 6. Conceptual integration of TEFA participation, entrepreneurial knowledge, social support, self-efficacy, and entrepreneurial mindset

The sequence shown in Figure 6 should not be interpreted as a longitudinal or experimentally confirmed process. Instead, it summarizes the educational logic suggested by the observed relationships. TEFA participation exposes students to authentic production tasks; knowledge acquisition provides concepts for understanding business opportunities; networking and support provide modelling, encouragement, and feedback; and stronger confidence is associated with a mindset characterized by initiative, opportunity orientation, and persistence. Project-based vocational pedagogies similarly emphasize creativity, collaboration, critical thinking, and active student participation, although their effectiveness depends on how deliberately these elements are integrated into the learning process (Li & Wang, 2025).

Implications for Vocational Education

The findings indicate that TEFA should be designed as an integrated educational environment rather than merely as a school-based production facility. Authentic production tasks should be accompanied by structured entrepreneurial learning, opportunities for reflection, constructive feedback, and sustained interaction with industry professionals. Students need opportunities to experience success while gradually undertaking more complex responsibilities.

For Welding Engineering students, TEFA assignments could integrate technical production with entrepreneurial decision-making. Students could interpret customer specifications, estimate material and labor costs, develop product prototypes, evaluate quality, communicate with prospective customers, and assess potential markets. Such activities would connect technical expertise with opportunity recognition and business planning without changing the occupational focus of the program.

Teachers and industry mentors should also provide clear demonstrations, performance criteria, formative feedback, and opportunities for students to revise unsuccessful work. Vocational students report that hands-on experience, modelling by experienced workers, and social support are particularly valuable for confidence and learning in authentic settings (Pylväs et al., 2022). Innovative pedagogical arrangements that increase interaction and learner participation have also been associated with stronger self-efficacy in higher vocational education (Han & Hamzah, 2024).

Finally, schools should strengthen networks among students, teachers, alumni, entrepreneurs, and industry partners. These networks can provide role models, mentoring, technical advice, market information, and access to professional communities. The strong association between social relationships and self-efficacy indicates that developing entrepreneurial readiness is not solely an individual cognitive process; it also depends on the quality of the learning and professional environment surrounding students.

Interpretive Boundaries

The findings should be interpreted within several boundaries. First, the cross-sectional ex post facto design does not permit definitive causal conclusions. Second, although self-efficacy was positioned as an intervening variable, indirect effects were not formally tested using bootstrapping, confidence intervals, or another mediation procedure. Third, the squared standardized coefficients displayed in Figure 5 do not represent unique variance contributions. Finally, the conceptual sequence in Figure 6 is an interpretation of the model rather than a tested developmental progression. Future longitudinal or intervention studies should examine how TEFA participation,

entrepreneurial learning, social support, self-efficacy, and entrepreneurial mindset develop over time.

CONCLUSIONS

This study found that student engagement in the Teaching Factory (TEFA), entrepreneurial knowledge, and social relationships were positively associated with self-efficacy among Grade 12 students in Welding Engineering programs at vocational high schools in East Java. Together, these variables explained 54.4% of the variance in self-efficacy. Social relationships showed the strongest direct association with self-efficacy, followed by TEFA engagement and entrepreneurial knowledge.

Student engagement in TEFA, entrepreneurial knowledge, social relationships, and self-efficacy were also positively associated with entrepreneurial mindset and jointly explained 63.6% of its variance. Self-efficacy emerged as the strongest direct predictor of entrepreneurial mindset. These findings indicate that entrepreneurial development in vocational education depends not only on technical and entrepreneurial knowledge but also on students' confidence and access to supportive relationships with teachers, peers, and industry professionals.

Because the study used a cross-sectional ex post facto design, the results should be interpreted as statistical associations rather than definitive causal effects. Moreover, although self-efficacy was positioned as an intervening variable, indirect effects were not formally tested; therefore, the findings do not establish statistical mediation.

RECOMMENDATIONS

Vocational high schools should strengthen TEFA as an integrated learning environment that combines authentic production activities, entrepreneurship instruction, and structured social support. In Welding Engineering programs, students should be given opportunities to apply technical competencies while identifying customer needs, estimating production costs, developing products, evaluating quality, and exploring business opportunities related to their field. Teachers and industry mentors should provide clear demonstrations, constructive feedback, progressive task responsibility, and opportunities for students to reflect on their performance. Schools should also strengthen collaboration among students, teachers, alumni, entrepreneurs, and industry partners so that learners can access role models, professional guidance, market information, and business networks.

Future research should employ longitudinal, experimental, or mixed-method designs to examine how TEFA engagement, entrepreneurial knowledge, social relationships, self-efficacy, and entrepreneurial mindset develop over time. Formal tests of indirect effects, preferably using bootstrapping and confidence intervals, are also recommended to determine whether self-efficacy functions as a statistically supported mediating mechanism.

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The authors sincerely thank the participating vocational high schools in East Java, including the school administrators, teachers, and Grade 12 students in the Welding Engineering programs, for their cooperation and participation in this study. The authors also appreciate the support provided during the data collection process.

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Conflict of Interest Statement

The authors declare that they have no financial, professional, or personal conflicts of interest that could have influenced the conduct, interpretation, or reporting of this study.

Ethical Approval

The study was conducted in accordance with applicable ethical standards for educational research involving human participants. Permission to conduct the study was obtained from the participating vocational high schools in East Java. Participation was voluntary, and informed consent/assent and, where required, parental or guardian consent was obtained before data collection. Participants were informed that their responses would be treated confidentially and used solely for research purposes.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The dataset is not publicly available to protect the confidentiality and privacy of the student participants.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Y Setiya Widoretno	✓	✓			✓	✓	✓	✓	✓					✓
Marji	✓	✓		✓						✓		✓		
Tuwoso		✓		✓						✓		✓		
Tri Kuncoro				✓		✓				✓		✓		

C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

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SUPPLEMENTARY MATERIAL

Supplementary Table S1. Frequency Distributions of the Study Variables

Supplementary Table S1 presents the interval-based frequency distributions for student engagement in the Teaching Factory (TEFA), entrepreneurial knowledge, social relationships, self-efficacy, and entrepreneurial mindset. All distributions were based on the complete sample of 210 students. Percentages were calculated from the original frequencies and rounded to one decimal place.

Panel A. Student Engagement in TEFA

Score interval	Frequency	Percentage (%)
60-65	9	4.3
66-71	10	4.8
72-77	26	12.4
78-83	60	28.6
84-89	44	21.0
90-95	32	15.2
96-101	25	11.9
102-107	3	1.4
108-113	1	0.5
Total	210	100.0

Panel B. Entrepreneurial Knowledge

Score interval	Frequency	Percentage (%)
30-35	7	3.3
36-41	22	10.5
42-47	30	14.3
48-53	53	25.2
54-59	37	17.6
60-65	7	3.3
66-71	22	10.5
72-77	25	11.9
78-83	7	3.3
Total	210	100.0

Panel C. Social Relationships

Score interval	Frequency	Percentage (%)
39-42	5	2.4
43-46	12	5.7
47-50	44	21.0
51-54	52	24.8
55-58	44	21.0
59-62	31	14.8
63-66	15	7.1
67-70	4	1.9
71-74	3	1.4
Total	210	100.0

Panel D. Self-Efficacy

Score interval	Frequency	Percentage (%)
48-51	2	1.0

52-55	14	6.7
56-59	43	20.5
60-63	55	26.2
64-67	17	8.1
68-71	42	20.0
72-75	25	11.9
76-79	8	3.8
80-84	4	1.9
Total	210	100.0

Panel E. Entrepreneurial Mindset

Score interval	Frequency	Percentage (%)
53-57	2	1.0
58-62	2	1.0
63-67	20	9.5
68-72	42	20.0
73-77	34	16.2
78-82	47	22.4
83-87	39	18.6
88-92	15	7.1
93-97	9	4.3
Total	210	100.0

General note. Percentages may differ slightly from 100% when independently rounded. TEFA = Teaching Factory. These distributions supplement the descriptive statistics reported in Table 1 of the main manuscript and were not used as separate inputs in the path analysis.