

Challenge-Based versus Real Job Learning: Effects of Entrepreneurial Interest on Vocational Students' Entrepreneurial Knowledge and Skills

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Abstract

Entrepreneurship education in vocational schools requires instructional approaches that develop both conceptual knowledge and practical entrepreneurial skills through authentic learning experiences. However, evidence directly comparing different Project-Based Learning (PjBL) models while considering students' entrepreneurial interest remains limited. This study examined the effects of Challenge-Based Learning (CBL), Real Job Learning (RJL), entrepreneurial interest, and their interaction on entrepreneurial knowledge and skills. A quasi-experimental 2×2 factorial design was implemented with 70 Grade XII Multimedia students at one Indonesian vocational high school. Two intact classes were assigned to CBL ($n = 35$) and RJL ($n = 35$), while students were categorized according to high or low entrepreneurial interest. Data were collected using an entrepreneurial interest questionnaire, a 17-item entrepreneurial knowledge test, and a 12-item performance-based entrepreneurial skills rubric. MANOVA revealed significant multivariate effects of the PjBL model (Pillai's Trace = .853, $F = 188.20$, $p < .001$), entrepreneurial interest (Pillai's Trace = .806, $F = 135.20$, $p < .001$), and their interaction (Pillai's Trace = .125, $F = 4.64$, $p = .013$). Follow-up analyses showed significant effects of the PjBL model on entrepreneurial knowledge ($F = 14.136$, $p < .001$, $\eta^2 = .18$) and skills ($F = 381.376$, $p < .001$, $\eta^2 = .85$), and of entrepreneurial interest on knowledge ($F = 6.340$, $p = .014$, $\eta^2 = .09$) and skills ($F = 274.585$, $p < .001$, $\eta^2 = .81$). Significant interactions were also found for knowledge ($F = 4.650$, $p = .035$) and skills ($F = 6.121$, $p = .016$). Overall, CBL produced stronger entrepreneurial outcomes than RJL, while the interaction patterns indicate that instructional effectiveness varied according to students' entrepreneurial interest. These findings support the integration of authentic, challenge-oriented projects while recognizing differences in students' initial entrepreneurial orientation in vocational entrepreneurship education.

Keywords: Challenge-Based Learning, Entrepreneurial Interest, Entrepreneurial Knowledge, Entrepreneurial Skills, Real Job Learning, Vocational Education

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INTRODUCTION

Vocational education plays a strategic role in preparing graduates who can respond to changing labor-market demands, technological development, and emerging opportunities for self-employment. In increasingly dynamic economic and technological environments, technical competence alone is insufficient; vocational graduates also require entrepreneurial knowledge, skills, and dispositions that enable them to identify opportunities, organize resources, solve market-related problems,

and translate vocational expertise into productive economic activities (Daud & Nordin, 2023; Muchira et al., 2022; Som et al., 2023). Competency-based vocational curricula therefore need to develop entrepreneurial competencies alongside occupational skills rather than treating entrepreneurship as an additional or peripheral component of technical training (Aziz et al., 2021; Mack et al., 2019). This need has become more pronounced as digital transformation and Industry 4.0/5.0 reshape work processes and encourage vocational education systems to integrate entrepreneurship, digital competence, industry collaboration, and market-oriented learning experiences into their curricula (Khasawneh et al., 2023; Teng et al., 2021; Zeng et al., 2024).

Entrepreneurship education in vocational schools consequently requires pedagogical approaches that connect conceptual knowledge with authentic entrepreneurial practice. Project-Based Learning (PjBL) is particularly relevant because it engages students in meaningful projects through which they investigate problems, collaborate, make decisions, produce tangible outcomes, and apply knowledge in contexts resembling professional or market environments (Helle et al., 2020; Pérez-López et al., 2017). Recent evidence indicates that the contribution of PjBL to entrepreneurial competence is associated with several interconnected mechanisms, including task authenticity, learner autonomy, collaboration, iterative problem solving, and interaction with external or market-oriented contexts (Kujala et al., 2021; Meurer et al., 2023; Oliveira & Cardoso, 2021; Rachmawati et al., 2024). Such characteristics allow students to move beyond passive acquisition of entrepreneurship concepts toward learning by designing, producing, evaluating, and improving solutions. Studies across entrepreneurship and applied educational settings have consequently reported stronger creativity, problem-solving ability, engagement, and entrepreneurial competence under project-based and other active learning approaches than under predominantly classroom-based instruction, although the magnitude of these effects remains dependent on implementation quality, mentorship, and contextual support (Carrer et al., 2022; Chen et al., 2022; Cruz et al., 2023; Shi & Li, 2024).

Within this broader project-based orientation, Challenge-Based Learning (CBL) and Real Job Learning (RJL) represent two instructional environments with different emphases. CBL organizes learning around authentic and often open-ended challenges that require students to investigate a problem, generate and evaluate alternative solutions, collaborate, implement their ideas, and respond to feedback from realistic contexts (Mustafa et al., 2021; Oliveira & Cardoso, 2021; Wang et al., 2022). Its emphasis on learner autonomy, inquiry, iteration, and externally meaningful problems can stimulate creativity, self-regulated learning, problem solving, and the transfer of knowledge into applied competence (Briegas et al., 2021; Kujala et al., 2021; Rachmawati et al., 2024). These characteristics are especially relevant to entrepreneurship education because entrepreneurial activity requires learners not merely to reproduce established procedures but also to interpret market conditions, formulate ideas, test solutions, and adapt their actions in response to uncertain outcomes.

RJL, as operationalized in this study, emphasizes projects structured around tasks and competencies that resemble actual vocational work. Although the term “Real Job Learning” is less common in the international literature, its pedagogical orientation is closely related to work-based learning, work-integrated learning,

teaching-factory approaches, workplace simulation, and other forms of authentic workplace learning that connect classroom activities with real or simulated production and occupational processes (Dwijayanthi & Rijanto, 2022; Jamaludin et al., 2023; Mitchell & Buntic, 2022; Pretorius, 2022). These approaches can strengthen occupational competence, work readiness, employability, and entrepreneurial capabilities by exposing students to industry-aligned tasks and production environments (Hendrayati et al., 2022; Ngubane et al., 2024). Thus, both CBL and RJL provide authentic learning opportunities, but their pedagogical orientations differ: CBL places greater emphasis on addressing open-ended challenges through inquiry, autonomy, iteration, and solution development, whereas RJL emphasizes the performance of authentic job-related tasks aligned with vocational competencies. This distinction provides a substantive basis for examining whether the two approaches produce different entrepreneurial learning outcomes.

The effectiveness of these learning environments may also depend on students' entrepreneurial interest. Entrepreneurial interest refers to a positive orientation toward exploring and engaging in entrepreneurial activities and should be distinguished from entrepreneurial intention, which concerns a more explicit future commitment to entrepreneurial action; entrepreneurial motivation, which concerns the forces that drive such action; and entrepreneurial self-efficacy, which concerns perceived capability to perform entrepreneurial tasks (Latif et al., 2022; Porfirio et al., 2022; Yang, 2024). Entrepreneurial interest can develop through the interaction of individual and contextual factors, including personality-related dispositions, family environment, previous entrepreneurial knowledge, perceived opportunities, and educational experiences (Arshad et al., 2018; Amalia et al., 2024; Yang, 2024). In educational contexts, students with stronger entrepreneurial interest are generally more inclined to engage with entrepreneurship-related activities, while authentic and project-based learning experiences may themselves reinforce such interest by making entrepreneurial activity more meaningful and concrete (Amalia et al., 2024; Jaenudin et al., 2023; Latif et al., 2022).

This relationship is important because students do not necessarily respond uniformly to the same instructional environment. Research on project-based and experiential learning suggests that motivation, interest, self-efficacy, achievement goals, and other learner dispositions are associated with differences in engagement, self-regulation, and learning outcomes (Liu, 2022; Makransky & Petersen, 2021; Pulkka & Budlong, 2022; Su, 2022). Entrepreneurship education studies similarly indicate that motivational characteristics can mediate or condition relationships between educational experiences and entrepreneurial outcomes (Larsen et al., 2023; López-Núñez et al., 2022; Porkodi & Saranya, 2023). These findings support the proposition that the effectiveness of an entrepreneurial learning environment may partly depend on the characteristics that students bring to that environment. A challenge-oriented model that provides autonomy, market-relevant problems, and opportunities to test ideas, for example, may engage students differently depending on their initial entrepreneurial interest.

Despite these developments, the available literature leaves an important gap. Previous research has demonstrated the benefits of PjBL for creativity, professional competence, entrepreneurial competence, and student engagement (Chen et al., 2022; Helle et al., 2020; Pérez-López et al., 2017), while vocational and work-based studies have shown the value of authentic occupational and production-oriented learning

(Mitchell & Buntic, 2022; Ngubane et al., 2024). Other studies have established relationships between entrepreneurial education, motivational characteristics, entrepreneurial interest, self-efficacy, and related outcomes (Amalia et al., 2024; Latif et al., 2022; López-Núñez et al., 2022). However, these strands of research have largely developed separately. Direct evidence comparing distinct project-based models while simultaneously testing whether their effects vary according to students' entrepreneurial interest remains limited. In particular, explicit tests of the interaction between a project-based instructional model and entrepreneurial interest in predicting both entrepreneurial knowledge and performance-based entrepreneurial skills are not clearly established in the literature reviewed for this study. This limitation is especially relevant in secondary vocational education, where entrepreneurship learning must integrate cognitive understanding with the capacity to perform entrepreneurial activities in authentic contexts.

The present study addresses this gap by comparing Challenge-Based Learning and Real Job Learning within the same factorial research design and examining entrepreneurial interest as a student-level factor associated with differences in entrepreneurial learning outcomes. The study focuses on two complementary outcomes: entrepreneurial knowledge, representing the cognitive mastery of entrepreneurship concepts, and entrepreneurial skills, representing students' ability to apply entrepreneurial competencies through performance-based activities. By examining these outcomes simultaneously, the study extends previous work that has tended to investigate PjBL effectiveness, authentic vocational learning, or entrepreneurial motivation separately. It also provides evidence from the Indonesian vocational-school context, where entrepreneurship education is expected to contribute not only to work readiness but also to students' capacity for self-employment and entrepreneurial activity (Said et al., 2017).

Accordingly, this study aims to determine whether the Project-Based Learning model (CBL versus RJJ), students' entrepreneurial interest (high versus low), and the interaction between these two factors influence vocational students' entrepreneurial knowledge and entrepreneurial skills. Three hypotheses are tested: (1) the PjBL model has a significant effect on entrepreneurial knowledge and entrepreneurial skills; (2) entrepreneurial interest has a significant effect on entrepreneurial knowledge and entrepreneurial skills; and (3) the PjBL model and entrepreneurial interest interact significantly in influencing entrepreneurial knowledge and entrepreneurial skills. By testing these effects within a 2×2 factorial framework, the study seeks to clarify not only which project-based learning environment is associated with stronger entrepreneurial outcomes, but also whether its effectiveness varies across students with different levels of entrepreneurial interest.

METHOD

Research Design

This study employed a quantitative approach using a quasi-experimental design. A quasi-experimental design was considered appropriate because the study examined the effects of instructional interventions under naturally occurring classroom conditions, in which random assignment of individual students was impractical (Creswell, 2018; Tanner, 2013). This approach is particularly relevant to vocational education because it enables instructional interventions to be evaluated in authentic classroom settings while recognizing that control over extraneous variables

is more limited than in a true experimental design (Tanner, 2013). The design was also consistent with the implementation-oriented nature of the Creative Products and Entrepreneurship (PKK) subject in vocational high schools, where instructional models are applied within existing classroom structures (Peters et al., 2013).

Specifically, the study used a 2×2 factorial design to examine the main and interaction effects of two independent variables simultaneously (Field, 2018). The first factor was the Project-Based Learning (PjBL) model, consisting of two instructional conditions: Challenge-Based Learning (CBL) and Real Job Learning (RJL). The second factor was entrepreneurial interest, categorized into high and low levels. The two dependent variables were entrepreneurial knowledge and entrepreneurial skills. This design enabled the study to examine (1) the main effect of the PjBL model, (2) the main effect of entrepreneurial interest, and (3) whether the effect of the PjBL model differed according to students' level of entrepreneurial interest. The four factorial conditions are presented in Table 1.

Table 1. 2×2 Factorial Design

Project-Based Learning Model (X1)	Low Entrepreneurial Interest (X2)	High Entrepreneurial Interest (X2)
Real Job Learning (RJL)	RJL-R	RJL-T
Challenge-Based Learning (CBL)	CBL-R	CBL-T

As shown in Table 1, the factorial structure generated four analytical conditions: RJL with low entrepreneurial interest (RJL-R), RJL with high entrepreneurial interest (RJL-T), CBL with low entrepreneurial interest (CBL-R), and CBL with high entrepreneurial interest (CBL-T). These four conditions formed the basis for examining the interaction between the instructional model and entrepreneurial interest.

Participants and Group Assignment

The study population consisted of 108 Grade XII students enrolled in the Multimedia Vocational Program at SMK Negeri 1 Mojokerto during the 2020/2021 academic year. Cluster random sampling was used because the experimental units were naturally established classes rather than individual students. Two intact classes were selected from the Grade XII Multimedia classes, after which a lottery procedure was used to determine which class would receive the CBL intervention and which would receive the RJL intervention.

The final sample consisted of 70 students, with 35 students in the CBL group and 35 students in the RJL group. Before the intervention, students' report-card grades were examined to assess the comparability of the two classes in terms of their initial academic ability. This preliminary examination indicated that the two treatment groups had comparable initial abilities.

The Grade XII Multimedia cohort was selected because students were at the final stage of vocational secondary education, where preparation for employment, further study, and entrepreneurship becomes particularly relevant. The Multimedia Vocational Program also included core learning experiences related to Creative Products and Entrepreneurship (PKK) and Digital Simulation, providing an appropriate curricular context for examining entrepreneurial learning outcomes.

Before implementation of the instructional treatments, students completed the Entrepreneurial Interest questionnaire and were subsequently classified into high-

and low-interest categories. Combining these interest categories with the two instructional conditions produced the four factorial groups shown previously in Table 1. Entrepreneurial interest therefore functioned as the second factor in the factorial analysis rather than as an instructional treatment.

Research Instruments

Three researcher-developed instruments were used to collect the study data: an Entrepreneurial Interest questionnaire, an Entrepreneurial Knowledge Achievement test, and an Entrepreneurial Skills Achievement rubric. All instruments underwent expert validation and empirical testing before their use in the study.

First, entrepreneurial interest was measured using a non-test questionnaire covering three components: knowledge of entrepreneurship, entrepreneurial personality, and family environment. These components were used collectively to characterize students' entrepreneurial interest before the instructional intervention. The knowledge component within this questionnaire should be distinguished from the entrepreneurial knowledge dependent variable. In the interest questionnaire, knowledge of entrepreneurship represented one component associated with students' pre-existing orientation toward entrepreneurship, whereas Entrepreneurial Knowledge Achievement represented a cognitive learning outcome measured separately after the instructional treatment. Thus, although the two measurements are conceptually related to entrepreneurship, they served different operational purposes in the research design.

Second, Entrepreneurial Knowledge Achievement was assessed using an objective cognitive test. The initial instrument contained 20 items, of which three were excluded following validity testing, resulting in 17 items used in the final assessment. This instrument measured students' cognitive mastery of the entrepreneurship content addressed during the instructional intervention.

Third, Entrepreneurial Skills Achievement was measured using a performance-assessment rubric consisting of 12 activity-assessment items. The rubric was used to evaluate students' application of entrepreneurial competencies through project performance. The entrepreneurial projects were assessed with reference to six key areas: production, branding, packaging, promotion, marketing, and sales.

Instrument development included content or rational validity through expert judgment involving supervisors and practitioners, followed by empirical/construct validity testing using Pearson Product Moment correlation. Reliability was evaluated using Cronbach's alpha. The Entrepreneurial Knowledge instrument yielded a Cronbach's alpha coefficient of .971, while the Entrepreneurial Skills instrument yielded a coefficient of .964. These coefficients indicated very high internal consistency for the two outcome instruments.

Research Procedure and Instructional Intervention

The research procedure consisted of four stages: preparation, initial measurement, implementation of the instructional intervention, and final measurement. The complete research sequence is summarized in Figure 1.

During the preparation stage, the researchers developed the PjBL instructional materials, including Flipped Classroom Content Visualization resources, instructional videos, lesson plans, and the research instruments. Instrument validation was also completed during this stage.

During the initial-measurement stage, students' initial academic information was reviewed and the Entrepreneurial Interest questionnaire was administered. The questionnaire results were used to classify students into high- and low-entrepreneurial-interest categories for the factorial analysis.

The experimental stage consisted of four instructional sessions. One class received the Challenge-Based Learning intervention, whereas the other class received the Real Job Learning intervention. Both instructional models required students to work collaboratively to complete their projects, consistent with the cooperative characteristics of project-based learning (Apugliese & Lewis, 2017; Warfa, 2015). To maintain a comparable instructional framework across the two groups, both treatments were implemented using the same flipped-classroom framework (Ozdamli & Asiksoy, 2016). The flipped-classroom approach was incorporated to support project-based and entrepreneurship learning activities by providing instructional content that students could engage with in conjunction with project implementation (Nam, 2017).

The principal difference between the two experimental conditions concerned the orientation of the project activities. The CBL condition organized learning around entrepreneurial challenges that required students to develop and implement project solutions, whereas the RJL condition organized learning around activities aligned with authentic vocational work and job-related competencies. Apart from these differences in project orientation, both groups operated within the same general flipped-classroom and project-based instructional framework.

During the final-measurement stage, students completed the Entrepreneurial Knowledge Achievement test, and their entrepreneurial project performance was evaluated using the Entrepreneurial Skills Achievement rubric. The performance assessment covered production, branding, packaging, promotion, marketing, and sales. Figure 1 illustrates the sequence from project determination and instructional preparation through the implementation of CBL and RJL, completion of the four instructional sessions, assessment of entrepreneurial knowledge and skills, and subsequent statistical analysis.

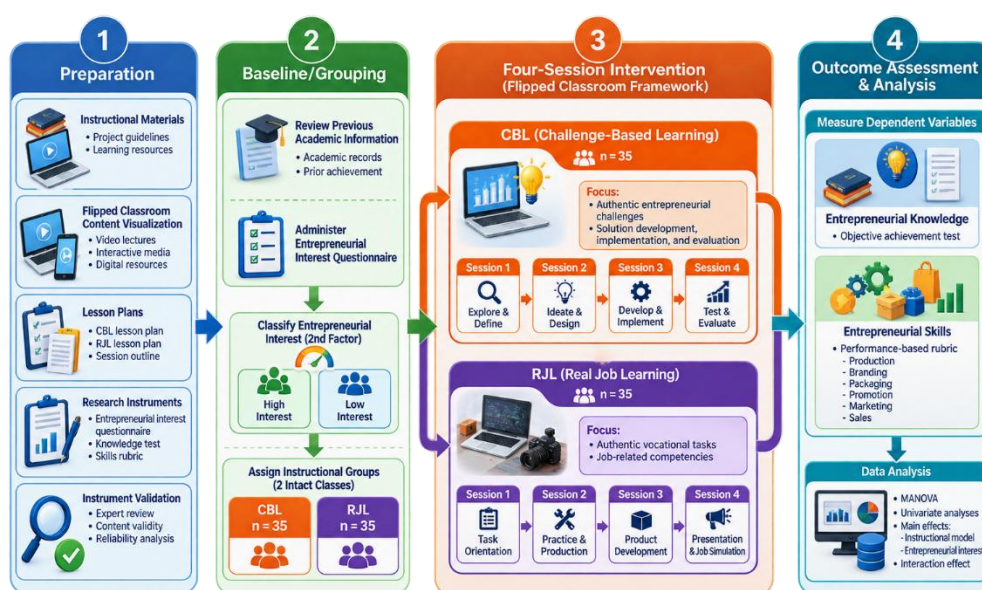


Figure 1. Research Procedure for Examining the Effects of PjBL Model and Entrepreneurial Interest on Entrepreneurial Knowledge and Skills

Data Analysis

Data analysis was conducted in three stages: descriptive analysis, statistical-assumption testing, and hypothesis testing. Descriptive statistics, including the mean and standard deviation, were used to summarize entrepreneurial knowledge and entrepreneurial skills across the CBL and RJL groups and across the high- and low-entrepreneurial-interest categories.

Before hypothesis testing, normality and homogeneity assumptions were evaluated in accordance with the requirements of parametric statistical analysis (Field, 2018). Normality was assessed using the Kolmogorov-Smirnov or Shapiro-Wilk procedure specified in the original analytical procedure, with $p > .05$ interpreted as indicating no statistically significant departure from normality. Homogeneity of variance was evaluated using Levene's test, with $p > .05$ indicating homogeneous variances. The preliminary analyses indicated that the entrepreneurial knowledge and entrepreneurial skills data satisfied the reported normality and homogeneity requirements.

The hypotheses were tested using Multivariate Analysis of Variance (MANOVA). MANOVA was selected because the study examined two related dependent variables—entrepreneurial knowledge and entrepreneurial skills—simultaneously in relation to two factors: the PjBL model and entrepreneurial interest. Compared with conducting multiple independent analyses separately, MANOVA enables the combined dependent-variable structure to be examined while controlling the inflation of Type I error and accounting for relationships among the outcome variables (Hair et al., 2018).

Following the multivariate analysis, univariate tests of between-subjects effects were used to determine the effects of each factor on entrepreneurial knowledge and entrepreneurial skills separately. The analyses therefore examined three effects: (1) the main effect of the PjBL model (CBL versus RJL), (2) the main effect of entrepreneurial interest (high versus low), and (3) the interaction between the PjBL model and entrepreneurial interest. Statistical significance was evaluated at $\alpha = .05$; an effect was considered statistically significant when $p < .05$. This analytical procedure directly corresponded to the factorial structure presented in Table 1 and the research sequence illustrated in Figure 1.

RESULTS AND DISCUSSION

The effects of the Project-Based Learning (PjBL) model and entrepreneurial interest on entrepreneurial knowledge and entrepreneurial skills were examined using a 2×2 factorial MANOVA, followed by univariate tests for each dependent variable. After the statistical assumptions described in the Method section were satisfied, the analysis proceeded in two stages. First, multivariate effects were examined simultaneously for entrepreneurial knowledge and entrepreneurial skills. Second, tests of between-subjects effects were used to determine the effects of the PjBL model, entrepreneurial interest, and their interaction on each outcome separately.

Multivariate Effects of PjBL Model and Entrepreneurial Interest

Table 2 presents the simultaneous multivariate effects of the PjBL model, entrepreneurial interest, and their interaction on the combined dependent variables of entrepreneurial knowledge and entrepreneurial skills. Pillai's Trace was used as the primary statistic for interpreting the multivariate effects.

Table 2. Results of the Simultaneous Multivariate Test

Effect	Multivariate Statistic	Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.999	5.341E4 ^a	2.000	65.000	.000
	Wilks' Lambda	.001	5.341E4 ^a	2.000	65.000	.000
	Hotelling's Trace	1.643E3	5.341E4 ^a	2.000	65.000	.000
	Roy's Largest Root	1.643E3	5.341E4 ^a	2.000	65.000	.000
PjBL	Pillai's Trace	.853	1.882E2 ^a	2.000	65.000	.000
	Wilks' Lambda	.147	1.882E2 ^a	2.000	65.000	.000
	Hotelling's Trace	5.791	1.882E2 ^a	2.000	65.000	.000
	Roy's Largest Root	5.791	1.882E2 ^a	2.000	65.000	.000
Interest	Pillai's Trace	.806	1.352E2 ^a	2.000	65.000	.000
	Wilks' Lambda	.194	1.352E2 ^a	2.000	65.000	.000
	Hotelling's Trace	4.161	1.352E2 ^a	2.000	65.000	.000
	Roy's Largest Root	4.161	1.352E2 ^a	2.000	65.000	.000
PjBL × Interest	Pillai's Trace	.125	4.637 ^a	2.000	65.000	.013
	Wilks' Lambda	.875	4.637 ^a	2.000	65.000	.013
	Hotelling's Trace	.143	4.637 ^a	2.000	65.000	.013
	Roy's Largest Root	.143	4.637 ^a	2.000	65.000	.013

Note. ^a Exact statistic. Design: Intercept + PjBL + Interest + PjBL × Interest.

As shown in Table 2, the PjBL model produced a statistically significant multivariate effect on the combined entrepreneurial outcomes, Pillai's Trace = .853, $F(2, 65) = 188.20$, $p < .001$. Entrepreneurial interest also showed a significant multivariate effect, Pillai's Trace = .806, $F(2, 65) = 135.20$, $p < .001$. Importantly, the interaction between the PjBL model and entrepreneurial interest was also significant, Pillai's Trace = .125, $F(2, 65) = 4.637$, $p = .013$. These results indicate that the two dependent variables considered jointly differed according to the instructional model, students' entrepreneurial interest, and the combination of these two factors. The significant multivariate results therefore justified examination of the corresponding univariate effects presented in Table 3.

Effects on Entrepreneurial Knowledge

The tests of between-subjects effects presented in Table 3 show a significant main effect of the PjBL model on entrepreneurial knowledge, $F(1, 66) = 14.136$, $p < .001$. The mean entrepreneurial knowledge achievement of students taught through CBL was higher than that of students taught through RJL. This result supports the first hypothesis with respect to the cognitive entrepreneurial outcome and indicates that entrepreneurial knowledge differed significantly between the two instructional conditions.

Entrepreneurial interest also had a significant effect on entrepreneurial knowledge, $F(1, 66) = 6.340$, $p = .014$. Students classified as having high entrepreneurial interest achieved higher entrepreneurial knowledge scores than students classified as having low entrepreneurial interest. Thus, the second hypothesis was also supported for entrepreneurial knowledge.

In addition to these main effects, Table 3 shows a statistically significant interaction between the PjBL model and entrepreneurial interest for entrepreneurial knowledge, $F(1, 66) = 4.650$, $p = .035$. This result indicates that differences in

entrepreneurial knowledge associated with the instructional model varied according to students' level of entrepreneurial interest.

Table 3. Results of Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Entrepreneurial Knowledge	244.115 ^a	3	81.372	7.046	.000
	Entrepreneurial Skills	3066.541 ^b	3	1022.180	201.144	.000
Intercept	Entrepreneurial Knowledge	320445.392	1	320445.392	2.775E4	.000
	Entrepreneurial Skills	473829.465	1	473829.465	9.324E4	.000
PjBL	Entrepreneurial Knowledge	163.248	1	163.248	14.136	.000
	Entrepreneurial Skills	1938.095	1	1938.095	381.376	.000
Interest	Entrepreneurial Knowledge	73.213	1	73.213	6.340	.014
	Entrepreneurial Skills	1395.401	1	1395.401	274.585	.000
PjBL × Interest	Entrepreneurial Knowledge	53.699	1	53.699	4.650	.035
	Entrepreneurial Skills	31.107	1	31.107	6.121	.016
Error	Entrepreneurial Knowledge	762.171	66	11.548		
	Entrepreneurial Skills	335.402	66	5.082		
Total	Entrepreneurial Knowledge	331522.000	70			
	Entrepreneurial Skills	485964.000	70			
Corrected Total	Entrepreneurial Knowledge	1006.286	69			
	Entrepreneurial Skills	3401.943	69			

Note. ^a $R^2 = .243$ (Adjusted $R^2 = .208$). ^b $R^2 = .901$ (Adjusted $R^2 = .897$).

As also reported in Table 3, the overall factorial model accounted for 24.3% of the variance in entrepreneurial knowledge ($R^2 = .243$; adjusted $R^2 = .208$). The interaction patterns for entrepreneurial skills and entrepreneurial knowledge are presented in Figures 2 and 3, respectively.

Figure 3 shows that entrepreneurial knowledge varied across combinations of learning model and entrepreneurial-interest level. The highest average entrepreneurial knowledge was observed in the combination of CBL and high entrepreneurial interest. The significant interaction reported in Table 3 confirms that the difference between CBL and RJL was not identical across the two entrepreneurial-interest categories. This interaction pattern is interpreted further in the Discussion section.

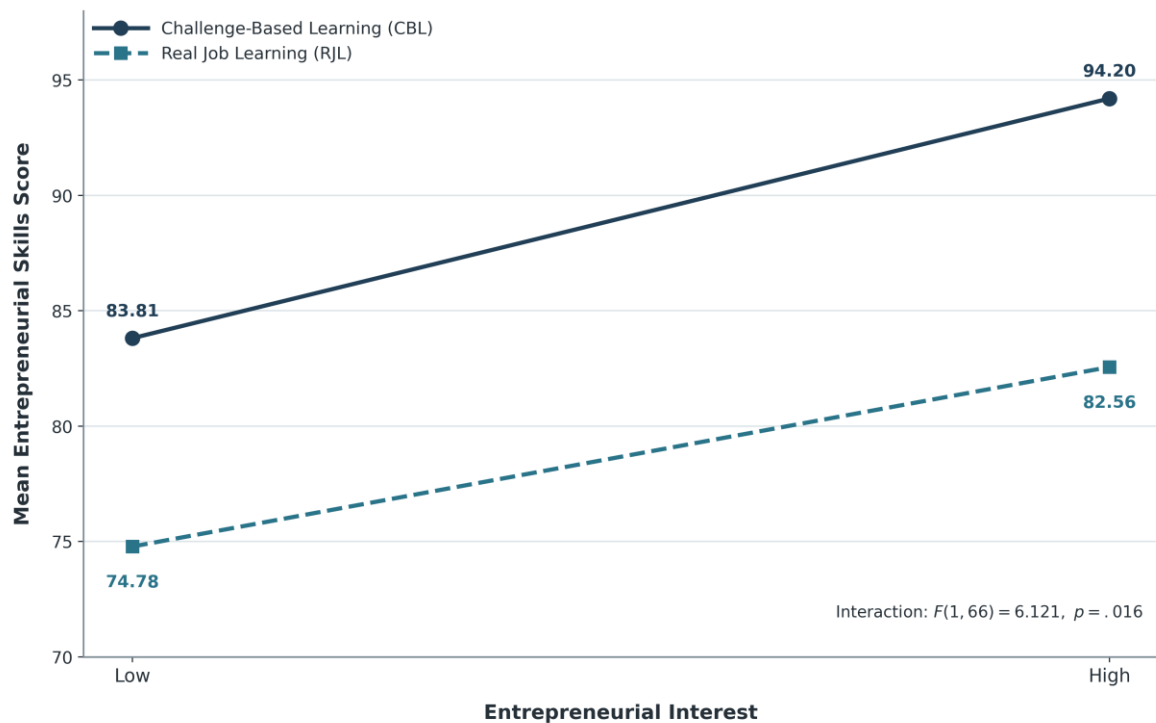


Figure 2. Interaction Between Project-Based Learning Model and Entrepreneurial Interest in Entrepreneurial Skills

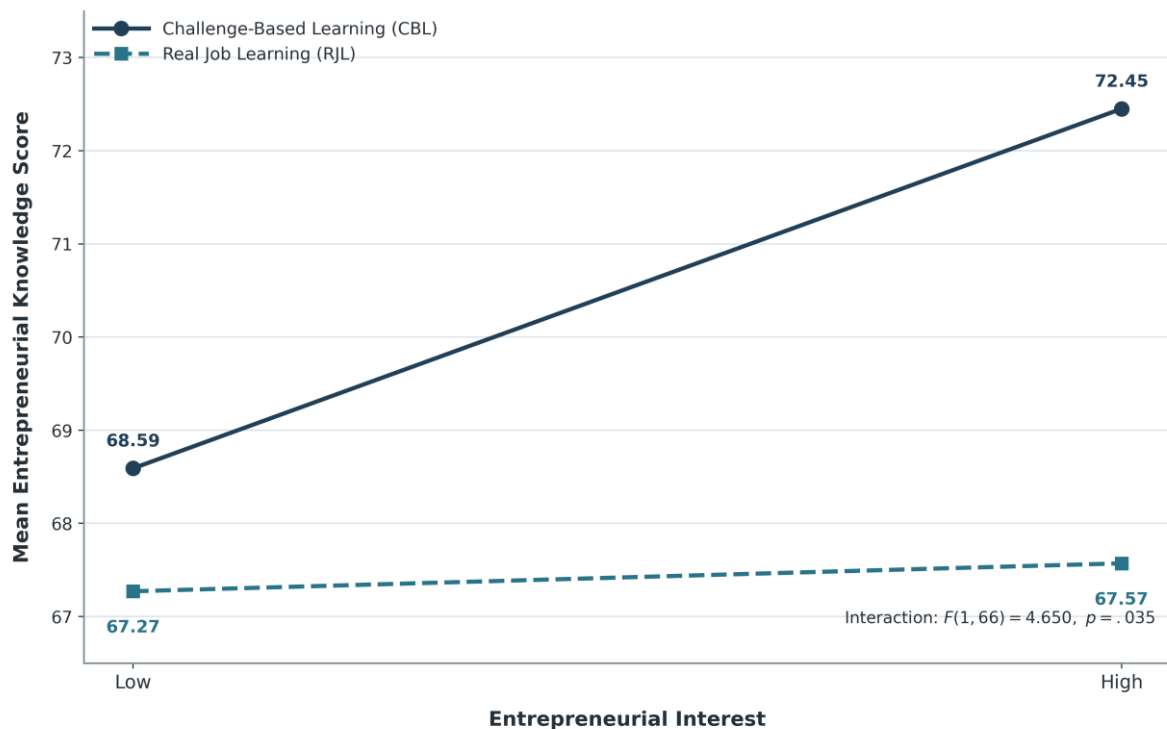


Figure 3. Interaction Between Project-Based Learning Model and Entrepreneurial Interest in Entrepreneurial Knowledge

Effects on Entrepreneurial Skills

Table 3 also demonstrates a strong main effect of the PjBL model on entrepreneurial skills, $F(1, 66) = 381.376, p < .001$. Students participating in CBL achieved higher entrepreneurial skills than those participating in RJL. The magnitude of this difference was substantially more pronounced for entrepreneurial skills than

for entrepreneurial knowledge, consistent with the performance-oriented character of the outcome.

Entrepreneurial interest likewise produced a statistically significant effect on entrepreneurial skills, $F(1, 66) = 274.585$, $p < .001$. Students with high entrepreneurial interest generally demonstrated higher entrepreneurial skills than students with low entrepreneurial interest. Therefore, the main effects of both instructional model and entrepreneurial interest were significant for the performance-based entrepreneurial outcome.

The factorial model for entrepreneurial skills explained 90.1% of the observed variance ($R^2 = .901$; adjusted $R^2 = .897$), as reported in Table 3. This result indicates that the combination of the two factors included in the model accounted for a substantial proportion of variation in students' entrepreneurial skills within the present sample.

Interaction Between PjBL Model and Entrepreneurial Interest on Entrepreneurial Skills

Beyond the two main effects, Table 3 shows a significant PjBL model $\times$ entrepreneurial interest interaction for entrepreneurial skills, $F(1, 66) = 6.121$, $p = .016$. Thus, the effect of the instructional model on entrepreneurial skills differed according to students' entrepreneurial-interest level. The corresponding interaction pattern is presented in Figure 2.

As illustrated in Figure 2, the CBL condition produced higher entrepreneurial skills overall than the RJL condition. A particularly notable pattern was observed among students with low entrepreneurial interest: their entrepreneurial skills remained comparatively high under CBL, whereas low-interest students in the RJL condition showed lower entrepreneurial skills. Students with high entrepreneurial interest also demonstrated strong outcomes, but the significant interaction indicates that the difference between instructional models varied across entrepreneurial-interest levels.

Taken together, the multivariate findings in Table 2, the univariate findings in Table 3, and the interaction patterns presented in Figures 2 and 3 support all three hypotheses. The PjBL model significantly affected entrepreneurial knowledge and entrepreneurial skills; entrepreneurial interest significantly affected both outcomes; and the PjBL model interacted significantly with entrepreneurial interest for both entrepreneurial knowledge and entrepreneurial skills. The substantive meaning of these main and interaction effects is examined in the Discussion section.

Discussion

Overall Effects of the PjBL Model and Entrepreneurial Interest

The findings demonstrate that entrepreneurial learning outcomes were shaped not only by the instructional model but also by students' entrepreneurial interest and, importantly, by the interaction between these two factors. As reported in Table 2, the multivariate analysis showed significant effects of the PjBL model and entrepreneurial interest on the combined outcomes of entrepreneurial knowledge and entrepreneurial skills, together with a significant PjBL $\times$ entrepreneurial interest interaction. The subsequent univariate analyses in Table 3 further showed that these effects were evident for both outcomes. Taken together, these results indicate that entrepreneurial knowledge and skills cannot be explained solely by exposure to a particular learning

model; students' initial orientation toward entrepreneurship also contributes to how they respond to the learning environment.

The results also reveal an important difference between the cognitive and performance-based outcomes. Although the PjBL model significantly affected both entrepreneurial knowledge and entrepreneurial skills, its effect was substantially stronger for entrepreneurial skills ($\eta^2 = .85$) than for entrepreneurial knowledge ($\eta^2 = .18$). A similar pattern was found for entrepreneurial interest, with a larger effect on entrepreneurial skills ($\eta^2 = .81$) than on entrepreneurial knowledge ($\eta^2 = .09$). This distinction is educationally meaningful because the interventions were organized around project activities that required students to move beyond conceptual understanding and perform entrepreneurial tasks in authentic or work-related contexts. The results therefore suggest that the most pronounced contribution of these learning environments was observed in students' ability to translate entrepreneurial learning into performance.

CBL and RJL in the Development of Entrepreneurial Knowledge

Students participating in CBL achieved higher entrepreneurial knowledge than those participating in RJL, indicating that a challenge-oriented project environment can support cognitive learning in addition to practical competence. This finding is important because challenge-based and authentic project learning are sometimes discussed primarily in relation to applied skills. The present results indicate that their contribution can extend to conceptual understanding when students must use knowledge to interpret problems, formulate solutions, make decisions, and evaluate the consequences of their actions.

The cognitive advantage associated with CBL can be understood from the nature of the learning activities implemented in this study. CBL involved explicit entrepreneurial challenges, including performance targets linked to real business activities, and required students to progress from idea exploration to implementation and evaluation. Such tasks created repeated opportunities to retrieve, reorganize, and apply entrepreneurship concepts rather than merely reproduce information. Evidence from entrepreneurship education similarly suggests that authentic challenges can produce deeper conceptual learning and changes in how learners understand entrepreneurial processes (Venesaar et al., 2021). Entrepreneurial projects have also been associated with development of metacognitive competencies and growth-oriented thinking, including students' capacity to monitor their decisions and adapt strategies during the entrepreneurial process (Brausch-Böger & Förster, 2024; Mets et al., 2022).

This interpretation is consistent with Kolb's Experiential Learning Theory, in which learning develops through engagement with experience, reflection on that experience, conceptualization, and subsequent experimentation (Kolb, 1984). In CBL, entrepreneurial concepts are repeatedly connected with concrete decisions and their consequences. Students therefore encounter knowledge not simply as subject matter to be remembered but as a resource required to solve a challenge. Authentic project environments can strengthen this process because reflection and metacognition facilitate the transfer of knowledge across activities and situations (Poszytek et al., 2023). Related project-based studies have likewise shown that collaboration and open-ended problems promote higher-order cognitive processes, including problem solving and critical thinking (Baveja & Greeley, 2023; Fang et al., 2021).

RJL also provides authentic learning through activities aligned with vocational work, and its contribution should therefore not be interpreted as inherently weak. Rather, the difference observed in this study appears to reflect the particular instructional orientations implemented in the two conditions. RJL emphasized performance of job-related tasks and vocational competencies, whereas CBL added open-ended entrepreneurial challenges that required students to generate and test solutions against explicit outcomes. Within the present implementation, this additional challenge-and-evaluation cycle may have generated more opportunities for students to reorganize entrepreneurial knowledge during project completion. Thus, the findings support CBL as a particularly productive cognitive environment in this study without implying that work-based or job-oriented learning is generally ineffective.

Entrepreneurial Interest and Entrepreneurial Knowledge

The significant effect of entrepreneurial interest on entrepreneurial knowledge indicates that students' initial orientation toward entrepreneurship was associated with differences in their cognitive learning outcomes. Students with high entrepreneurial interest achieved higher entrepreneurial knowledge than students with low interest. This result is consistent with educational research showing that individual and situational interest can increase attention, persistence, perceived relevance, and cognitive engagement, thereby supporting deeper processing of learning material (Ilahi et al., 2024; Maoto, 2023; Walters-Williams, 2022).

In entrepreneurship education, this mechanism is particularly plausible because students who already perceive entrepreneurship as personally relevant have a stronger reason to engage with concepts related to products, markets, promotion, sales, and business decision making. Entrepreneurial projects can further reinforce this relevance because students encounter entrepreneurship as an activity rather than solely as a curricular topic. School- and university-based entrepreneurship interventions have shown that authentic project experiences are associated with stronger engagement, metacognition, career readiness, and entrepreneurial process competencies (Brausch-Böger & Förster, 2024; Mets et al., 2022; Naseer et al., 2025).

However, the present findings should not be interpreted as demonstrating a simple causal pathway in which entrepreneurial interest automatically produces greater knowledge. Existing evidence indicates that the relationship is likely reciprocal and context dependent: interest can support engagement, while meaningful educational experiences can simultaneously strengthen interest. Program design, maturity, and contextual characteristics may also influence this relationship (Ilahi et al., 2024; Mets et al., 2022). In the present study, entrepreneurial interest is therefore more appropriately understood as an initial learner characteristic associated with differences in responsiveness to entrepreneurship learning rather than as a single causal determinant of achievement.

Interaction Between PjBL Model and Entrepreneurial Interest in Entrepreneurial Knowledge

The significant interaction for entrepreneurial knowledge, illustrated in Figure 3, adds an important dimension to the two main effects. The highest entrepreneurial knowledge was observed among students combining CBL with high entrepreneurial interest, indicating that the cognitive advantage associated with CBL was not identical across the two entrepreneurial-interest categories. This supports the study's central

proposition that learner characteristics and instructional environments operate jointly rather than independently.

One explanation is that CBL provides characteristics that are particularly compatible with students who already perceive entrepreneurship as meaningful. Open-ended challenges require learners to identify information needs, make choices, regulate their activities, and persist when an initial solution is inadequate. Prior interest can strengthen these processes by increasing perceived task relevance and intrinsic motivation, which in turn promote information seeking and cognitive investment (Tan et al., 2021; Wang et al., 2021). Autonomy-rich project environments can further encourage persistence and self-regulation when students perceive the learning task as personally valuable (Makkonen et al., 2021; Sixia, 2024). Metacognition and self-efficacy may also operate alongside interest to help students regulate learning strategies when solving complex problems (Arztmann et al., 2023; Wang et al., 2021).

These mechanisms help explain why high-interest students may be particularly able to exploit the autonomy and challenge embedded in CBL. However, the finding should not be interpreted to mean that CBL benefits only students who enter the learning process with high entrepreneurial interest. Rather, Figure 3 indicates a differentiated pattern of knowledge achievement across the four combinations of model and interest, while the interaction test confirms that instructional effects varied according to interest level. Evidence from autonomy-supportive and open-ended learning environments likewise suggests that benefits are contingent on task design, learner support, and motivational characteristics rather than being uniform across students (Ghbari et al., 2025; Ito & Umamoto, 2022; Jin & Zhong, 2025; Makkonen et al., 2021).

PjBL Model and Entrepreneurial Interest in the Development of Entrepreneurial Skills

The strongest empirical effects in this study emerged for entrepreneurial skills. As reported in Table 3, both the PjBL model and entrepreneurial interest had substantial effects on this performance-based outcome, with CBL producing higher entrepreneurial skills than RJL and students with high entrepreneurial interest generally achieving higher skills than those with low interest. These results indicate that entrepreneurship learning is particularly sensitive to environments in which students must apply knowledge through concrete action.

The performance advantage of CBL is consistent with the principle of learning by doing. Authentic project environments embed learning in activities that resemble entrepreneurial practice and provide opportunities for immediate feedback, iteration, collaboration, and reflection (Rokaya & Pandey, 2023; Saiyed et al., 2023; Suib et al., 2024). In the present study, students' entrepreneurial projects involved production, branding, packaging, promotion, marketing, and sales. These activities require students to coordinate multiple forms of entrepreneurial knowledge and transform them into observable performance. Rather than learning about marketing or sales only conceptually, students must make decisions, implement them, observe outcomes, and adjust their subsequent actions.

Research on entrepreneurial learning supports this knowledge-to-performance mechanism. Hands-on entrepreneurship projects have been associated with improvements in practical entrepreneurial competencies beyond theoretical learning alone (Silitonga et al., 2023). Market-facing activities involving production, branding,

promotion, and sales provide direct opportunities for learners to test value propositions and develop competencies through authentic transactions and feedback (Jiménez-Zarco et al., 2021; Rokaya & Pandey, 2023; Saiyed et al., 2023). Evidence also suggests that entrepreneurial education linked to real market activity can facilitate the transfer of learned concepts into business performance and sales-related behavior (Azahra et al., 2023). These mechanisms are consistent with the comparatively large effect observed for entrepreneurial skills in the present study.

The significant effect of entrepreneurial interest on skills further indicates that practical competence is not determined by instructional opportunities alone. Students with stronger entrepreneurial interest may be more willing to invest effort, persist through project difficulties, communicate with others, and engage seriously with market-oriented tasks. At the same time, because the learning environment itself can influence motivation, the relationship between interest and performance should be viewed dynamically rather than as a fixed student characteristic.

Interaction Between PjBL Model and Entrepreneurial Interest in Entrepreneurial Skills

The interaction presented in Figure 2 is one of the most informative findings of this study. Although students with high entrepreneurial interest generally achieved strong entrepreneurial skills, CBL also maintained comparatively high entrepreneurial skills among students who initially had low entrepreneurial interest. In contrast, low-interest students in the RJL condition showed lower entrepreneurial skills. The significant PjBL $\times$ entrepreneurial interest effect therefore suggests that CBL may have provided learning conditions that were comparatively supportive even when students did not begin with a strong entrepreneurial orientation.

The original interpretation that CBL “forces” low-interest students to develop entrepreneurial competence is too strong for the evidence. A more plausible explanation is that authentic challenges can generate situational interest by making the learning activity meaningful, visible, and consequential. Research indicates that authentic and problem-based environments can increase situational interest and cognitive engagement when learners encounter relevant tasks and experience meaningful autonomy (Neufeld, 2021; Nikou & Economides, 2021; Parsons et al., 2023; Ubando et al., 2024). When students can observe tangible outcomes from their decisions, the learning task may become engaging even for those whose initial individual interest is relatively low.

This interpretation also accords with evidence that participation in realistic entrepreneurial projects and simulations can strengthen motivation, self-efficacy, readiness, and entrepreneurial competence (Hatmanto & Sari, 2023; Silitonga et al., 2023; Suib et al., 2024). Challenge-based environments may support this process by combining autonomy with opportunities to experience competence through concrete accomplishments. From a self-determination perspective, meaningful tasks that support autonomy, competence, and relatedness can help transform temporary situational engagement into more sustained intrinsic motivation (Lysne et al., 2023; Mat & Jamaludin, 2024; Neufeld, 2021; Nikou & Economides, 2021). The present study did not measure change in entrepreneurial interest after the intervention, so it cannot establish that such transformation occurred; nevertheless, this mechanism provides a theoretically plausible explanation for the strong performance of initially low-interest students in the CBL condition.

Visible project outcomes may also be important. Students engaged in authentic challenges receive concrete evidence that their decisions influence production, presentation, promotion, market response, and sales. Such feedback can enhance perceptions of competence and encourage continued engagement, particularly among students who initially perceive entrepreneurship as less personally relevant. Studies involving initially disengaged or less-motivated learners similarly suggest that authentic challenges, autonomy support, competence-building experiences, and tangible outcomes can increase engagement when appropriately structured (Çelik, 2025; Hong et al., 2026; Ubando et al., 2024; Yang & Li, 2025).

The comparison with RJL should nevertheless be interpreted carefully. RJL is not intrinsically incapable of supporting creativity, interest, or entrepreneurial development. Work-based and authentic-job approaches have documented benefits for vocational competence and readiness. The present findings instead indicate that, in the specific implementation examined here, RJL's greater emphasis on carrying out predefined job-related activities was associated with lower entrepreneurial skills among low-interest students than the more open-ended challenge structure of CBL. The result therefore concerns the relative characteristics of these two instructional conditions rather than a universal superiority of one form of workplace learning over another.

Theoretical Integration and Contribution to Vocational Entrepreneurship Education

The findings can be interpreted through the complementary perspectives of experiential and socially constructed learning. Kolb's Experiential Learning Theory emphasizes the transformation of experience through reflection, conceptualization, and active experimentation (Kolb, 1984). Both CBL and RJL provide experiential opportunities, but the CBL condition in this study placed students in a cycle of confronting entrepreneurial challenges, testing solutions, evaluating outcomes, and adapting their actions. This cycle helps explain why the model was associated with both cognitive and performance gains.

Vygotsky's Social Constructivism further emphasizes that learning develops through interaction with others and with culturally meaningful activities (Vygotsky, 1978). The project work in both conditions required teamwork and collaborative problem solving. Within CBL, however, open-ended challenges created additional opportunities for students to negotiate alternative solutions, coordinate decisions, and collectively respond to uncertain outcomes. The value of such interaction is consistent with evidence that collaborative, authentic, and problem-oriented learning environments support higher-order thinking and applied competence (Baveja & Greeley, 2023; Fang et al., 2021).

The present study extends these perspectives by showing that experiential and collaborative opportunities may not have identical effects for all learners. Entrepreneurial interest was independently associated with both entrepreneurial knowledge and skills, while its significant interaction with the instructional model indicates that learner disposition and learning environment jointly contributed to outcomes. The theoretical contribution is therefore not simply that authentic PjBL works, but that different forms of authenticity may interact differently with students' initial entrepreneurial orientation. CBL emphasized entrepreneurial challenge, autonomy, iteration, and market-facing performance, while RJL emphasized authentic

job-related activities. Their different outcome patterns suggest that the design of authenticity itself matters in vocational entrepreneurship education.

Practical Implications

The findings have several implications for vocational entrepreneurship education. First, authentic entrepreneurship education should provide students with opportunities to perform the complete cycle of entrepreneurial activity rather than limiting instruction to conceptual knowledge. Activities involving production, branding, packaging, promotion, marketing, and sales create conditions in which students must integrate knowledge with action and can receive feedback from tangible project outcomes.

Second, challenge-oriented learning appears particularly promising when the objective is to develop performance-based entrepreneurial competence. CBL can be implemented through realistic business problems, explicit performance targets, learner-generated solutions, and iterative evaluation rather than through prescriptive tasks alone. However, sufficient scaffolding remains important because the benefits of open-ended project environments vary according to learner readiness, program maturity, and instructional support (Mets et al., 2022; Marliyah, 2024).

Third, entrepreneurial interest should be considered when designing instruction, but it should not be used to restrict learning opportunities. The comparatively strong skills achieved by low-interest students under CBL indicate that students who initially show limited entrepreneurial interest may still benefit substantially from authentic challenge-based experiences. Vocational teachers can therefore use meaningful challenges and visible real-world outcomes not only to support highly interested students but also to create conditions that may engage students who initially perceive entrepreneurship as less relevant.

Research Limitations and Directions for Future Research

Several limitations should be considered when interpreting these findings. First, the instructional intervention consisted of only four sessions. Although significant differences were observed after the intervention, the study cannot establish whether improvements in entrepreneurial knowledge and skills persist over longer periods or translate into subsequent entrepreneurial behavior. Existing research similarly emphasizes that the effects of entrepreneurial projects can depend on program maturity and that longitudinal evidence is needed to determine the sustainability of learning outcomes (Mets et al., 2022). Future studies should therefore track students beyond the immediate intervention and, where possible, examine whether acquired competencies are retained and applied after graduation.

Second, the study involved 70 students from a single vocational school and one vocational specialization, Multimedia. The findings therefore represent a specific institutional and disciplinary context and should not be generalized automatically to other vocational programs, geographical regions, or resource environments. Replication across different vocational fields and schools would help establish whether the relative effects of CBL and RJL are consistent across settings.

Third, treatment was implemented at the intact-class level, with one class receiving CBL and one class receiving RJL. Although this arrangement reflected the practical realities of classroom-based quasi-experimental research, instructional effects may partly overlap with unmeasured class-level characteristics. Future studies

could strengthen causal inference by including multiple classes within each treatment condition or using multilevel analytical designs.

Fourth, entrepreneurial interest was categorized into high and low levels for the factorial analysis. This approach supported the intended 2×2 design but may not capture the full variability of entrepreneurial interest among students. Future studies could analyze entrepreneurial interest as a continuous construct or examine more differentiated motivational profiles. In addition, the Entrepreneurial Interest questionnaire incorporated knowledge of entrepreneurship, entrepreneurial personality, and family environment. Although the knowledge component served a different operational purpose from the cognitive Entrepreneurial Knowledge Achievement outcome, future research could further examine the relationships among these components and their respective contributions to learning outcomes.

Finally, the study measured entrepreneurial interest before the intervention but did not examine whether CBL or RJL subsequently changed students' interest. This limitation is particularly relevant to the interaction observed for entrepreneurial skills. The comparatively strong performance of low-interest students under CBL is consistent with literature suggesting that authentic challenges can stimulate situational interest, but the present data cannot determine whether students' entrepreneurial interest actually increased. Future research should therefore include repeated measures of interest, motivation, self-efficacy, and engagement to examine the mechanisms through which challenge-based experiences influence entrepreneurial development over time.

CONCLUSIONS

This study examined the effects of two Project-Based Learning models—Challenge-Based Learning (CBL) and Real Job Learning (RJL)—and students' entrepreneurial interest on entrepreneurial knowledge and entrepreneurial skills in vocational education. The findings showed that the PjBL model significantly influenced both outcomes, with CBL producing higher entrepreneurial knowledge and skills than RJL. The effect was particularly pronounced for entrepreneurial skills, indicating that challenge-oriented project environments can provide strong opportunities for students to translate entrepreneurial knowledge into performance-based competence.

Entrepreneurial interest also significantly influenced both entrepreneurial knowledge and entrepreneurial skills. Students with high entrepreneurial interest generally achieved stronger outcomes; however, the significant interaction between the PjBL model and entrepreneurial interest indicates that the effectiveness of the instructional model was not uniform across interest levels. For entrepreneurial knowledge, the combination of CBL and high entrepreneurial interest produced the strongest outcome. For entrepreneurial skills, CBL also supported comparatively strong performance among students with low entrepreneurial interest. These findings suggest that entrepreneurial learning outcomes are shaped jointly by the design of the learning environment and students' initial entrepreneurial orientation.

Overall, the study demonstrates the value of integrating authentic, challenge-oriented entrepreneurial projects into vocational education. Rather than focusing only on job-related task performance, entrepreneurship learning can be strengthened by providing students with opportunities to address realistic challenges, develop and test solutions, and engage directly in production, branding, packaging, promotion,

marketing, and sales activities. Within the context of this study, CBL provided a particularly effective environment for developing both the cognitive and performance dimensions of entrepreneurial learning.

The findings should nevertheless be interpreted within the scope of the study. The intervention consisted of four instructional sessions and involved 70 students from one vocational program at a single school. Therefore, the results provide evidence of short-term learning effects within this specific educational context rather than evidence of long-term entrepreneurial behavior or business creation. Future research should examine the sustainability of these outcomes across longer interventions, multiple vocational programs, different institutional contexts, and broader student populations.

RECOMMENDATIONS

Vocational schools may consider integrating Challenge-Based Learning into entrepreneurship education, particularly when the instructional objective is to develop both entrepreneurial knowledge and performance-based entrepreneurial skills. CBL activities should involve authentic and meaningful entrepreneurial challenges in which students are required to develop, implement, evaluate, and improve solutions rather than simply complete predetermined tasks.

Entrepreneurship projects should provide opportunities for students to engage in the complete entrepreneurial process, including production, branding, packaging, promotion, marketing, and sales. These activities can help students connect conceptual knowledge with practical decision making and observable entrepreneurial performance.

Students' entrepreneurial interest should be considered when designing project-based learning experiences. However, entrepreneurial interest should not be used as a basis for limiting access to challenging learning opportunities. The strong entrepreneurial skills demonstrated by low-interest students in the CBL condition indicate that authentic challenges can also support meaningful learning for students who initially show limited entrepreneurial interest. Teachers therefore need to combine meaningful challenges with appropriate guidance, collaboration, and feedback to accommodate students with different motivational profiles.

Future studies should examine CBL and RJL using longer interventions and longitudinal designs to determine whether improvements in entrepreneurial knowledge and skills are sustained over time and whether they contribute to later entrepreneurial behavior. Research should also involve multiple classes, schools, vocational specializations, and geographic contexts to strengthen the generalizability of the findings.

Future research should further examine entrepreneurial interest as a dynamic learner characteristic by measuring it before and after instructional interventions. Such research could clarify whether authentic challenge-based experiences merely interact with students' initial interest or can also contribute to the development of entrepreneurial interest, engagement, self-efficacy, and sustained entrepreneurial motivation over time.

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Conflict of Interest Statement

The authors declare no conflict of interest.

Informed Consent

Informed consent was obtained from all participants prior to data collection. Where applicable, consent from parents or legal guardians and assent from participating students were obtained in accordance with institutional requirements. Participation was voluntary, and participants were informed about the purpose and procedures of the study.

Ethical Approval

The study was conducted in accordance with the ethical principles applicable to educational research and with permission from the participating school. The research procedures ensured voluntary participation, confidentiality, and the protection of participants' personal information.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available because they contain information related to student participants and are subject to confidentiality and institutional considerations.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Ali Basyah	✓	✓	✓		✓	✓		✓	✓	✓	✓			
Waras Kamdi	✓	✓		✓						✓		✓		
Purnomo		✓		✓	✓					✓		✓		
Tuwoso				✓				✓		✓		✓		

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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