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Research paper

Boosting Entrepreneurial Competence Through Mobile Inquiry-Based Learning: Evidence from A Quasy Experiment

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Abstract

This study investigates the effectiveness of a Mobile Apps-based Inquiry-Based Learning (IBL) model in developing entrepreneurial skills. Using a quasi-experimental one-group pre-test-post-test design with 52 students, data were collected through tests, questionnaires, and observations. Statistical analysis revealed a significant increase in skills (Sig. 2-tailed = 0.000), with a high N-gain score of 0.7693 (76.92% improvement). Student acceptance was also positive at 75.2%. The findings conclude that integrating-ing IBL with mobile technology creates a powerful and effective pedagogical framework for active entrepreneurship education.

Keywords: *Effectiveness; Inquiry-Based Learning; Mobile Apps; Quasi-Experimental; Entrepreneurship Skills.*

1. Introduction

Higher education entrepreneurship programs play a crucial role in developing students' character formation and business competencies. In response to the demands of Industry 4.0, educators must equip students with capabilities as researchers, problem-solving experts, and individuals who possess critical and creative thinking abilities [1]. Despite the existence of numerous entrepreneurship initiatives, the practical implementation of skill-based learning approaches remains constrained and underdeveloped. Inquiry-Based Learning (IBL) emerges as a promising pedagogical strategy for enhancing entrepreneurship education by facilitating active student participation through research-oriented learning processes [2].

The rapid advancement of technology has led to increased adoption of mobile learning applications in educational contexts. These mobile e-learning platforms offer students enhanced flexibility and dynamic interaction opportunities for accessing educational materials and engaging with content [3]. Consequently, this research seeks to evaluate the effectiveness of Mobile Apps-based Inquiry-Based Learning in fostering entrepreneurial skill development among university students in East Java [4]. N Beyond pedagogical approaches, instructional media significantly impact students' learning competencies and outcomes. Effective learning media catalyze student engagement and participation in educational activities. Learning media continuously evolves to align with technological advances. Contemporary research extensively explores learning media development, particularly Android-based educational applications. This technological advancement represents a strategic move toward establishing comprehensive mobile learning environments that support flexible and accessible education delivery systems [5]. Mobile learning aims for students to not only learn using textbooks in class, but students can actively participate in learning by searching for information using media used in mobile learning, such as smartphones.

In addition, students can search for information and learn in various places and various conditions, so that they are not limited by time and place. One of the mobile learning that has been widely developed is android-based learning media that has been widely developed, one of which is the result of research. In this study, an Android-based mobile learning media was produced for understanding economic learning. This study uses mobile-based mobile application media to develop students' entrepreneurial skills. Inquiry-based learning is an effective educational approach that stimulates student curiosity and learning motivation through experiential and constructive methods. This student-centered methodology emphasizes problem-solving, investigation, and collaborative activities that promote learner autonomy [6]. The approach positively impacts student engagement while developing essential skills, including critical thinking, collaboration, and communication abilities [7]. Research demonstrates that guided inquiry-based learning significantly enhances entrepreneurial competence, particularly in professional skill development [8]. This pedagogical strategy successfully bridges theoretical knowledge with practical application, creating meaningful learning experiences that prepare students for academic and professional success.

Digital technologies accelerate change, transforming organizations socially, culturally, and technically. Post-COVID-19 pandemic digital transformation in universities provides a broad systematic review that shows the cause and effect of academic entrepreneurship processes [9]. The use of mobile applications in inquiry-based learning improves students' attitudes and understanding of the field of science [10].
In the field of entrepreneurship, the mobile learning platform facilitates students in submitting assignments and creating ideas and presentations. Students can also share images and videos, and lecturers can provide feedback, guide how to make products, and develop entrepreneurial skills [11]. The use of mobile-based learning platforms improves entrepreneurial competency [12].
Some educational institutions take a pedagogical approach to entrepreneurship, but this does not match the needs of practical entrepreneurship, resulting in graduates lacking many types of entrepreneurial skills [13]. In his research, he carried out an inquiry-based learning model, namely an approach based on experience through a mobile application, which is expected to be able to improve the development of student skills in higher education.
Entrepreneurial skills are one of the important skills in facing the challenges and demands of the 21st century. The inquiry-based learning model for creative entrepreneurial learning improves science-based entrepreneurial skills [14]. The mobile learning-based inquiry learning model has a big influence on students' creative thinking skills [15].
Mobile technology expands our access to information and facilitates interaction in learning and group work. Mobile devices enhance the dynamics of education by increasing the means of communication available [16];[17]. The use of mobile applications is effectively applied in entrepreneurship learning. The use of collaborative Mobile Inquiry-Based Learning in science supports data sharing and visualizations that allow learners to reflect on findings and discuss them. This study attempts to demonstrate that in the context of entrepreneurship teaching, IBL can engage students in activities such as business idea development, market analysis, and business strategy planning, all of which are important in developing entrepreneurial skills. Over the last decade, there has been a lot of interest in mobile technology in teaching and learning as a new and innovative tool [18]. Although there are many challenges in using mobile technology in learning, it is undeniable that technological support, such as mobile applications, can provide a more interactive and contextual learning experience, and this is very relevant to entrepreneurship learning [19].
Previous research demonstrates that Inquiry-Based Learning (IBL) effectively enhances learning outcomes, motivation, entrepreneurial skills, creative thinking, leadership, and communication abilities. Studies show IBL improves student motivation, problem-solving skills [20], creative thinking, and positive behaviors [21], and academic achievement in science education [22].
This study examines the effectiveness of Mobile Apps-based Inquiry-Based Learning in developing students' entrepreneurial skills, aiming to enhance learning quality for economics education students. The research objectives are: 1) to evaluate the effectiveness of Mobile Apps-based IBL in improving entrepreneurial skill development, and 2) to assess student responses to this learning model implementation. This research addresses the need to strengthen students' entrepreneurial capabilities through innovative, technology-integrated approaches that create meaningful and effective educational experiences. This study contributes to applied sciences by leveraging mobile technology to enhance pedagogical outcomes in entrepreneurship education.

2. Theoretical Review

2.1. Mobile app–based inquiry-based learning (IBL)

Inquiry-Based Learning (IBL) is defined as a pedagogical approach that positions students at the center of the learning process through sequential phases of questioning (orientation), conceptualization, investigation, conclusion, and discussion, thereby promoting critical thinking and problem-solving skills [23 - 25]. IBL emphasizes active student engagement in discovering knowledge and applying it to real-life contexts. In entrepreneurship education, this approach is highly relevant as it requires students to explore business problems, test hypotheses, and reflect on entrepreneurial practices [26], [27]. The integration of IBL into digital platforms—particularly mobile applications—enables these inquiry phases to be carried out more flexibly, sustainably, and contextually beyond the conventional classroom [28].
The use of mobile applications as a medium for IBL offers several practical benefits: anytime access to learning resources, real-time collaboration, multimedia support for simulations, and efficient feedback mechanisms [29]. Systematic reviews of mobile learning indicate that mobile devices enhance engagement, personalization, and contextual connection to real-world learning. However, the effectiveness of mobile IBL is determined not merely by the technology itself, but by how the app features are intentionally designed to support the phases of inquiry. [30], [31].
Nevertheless, meta-analyses and systematic reviews also highlight potential challenges: disparities in device accessibility and connectivity may exacerbate the digital divide, and heterogeneous effects are often reported depending on the quality of pedagogical integration (e.g., task design, scaffolding, and instructor roles [32], [33]. In other words, adopting mobile apps without aligning with core IBL principles—such as authentic tasks, opportunities for reflection, and adequate facilitation—risks producing superficial activities with little impact on substantive competencies. Consequently, empirical research on mobile IBL should carefully articulate instructional design and examine the mechanisms through which it operates [34].
In summary, the literature demonstrates that mobile IBL holds strong potential to transform learning into more contextual and applied experiences, yet its effectiveness hinges on pedagogical design and equitable access. [34].
For entrepreneurship education, the main research gap lies in the scarcity of studies explicitly linking mobile IBL to entrepreneurial skill development (rather than merely entrepreneurial intention or general academic outcomes), and in the limited exploration of psychological mediators that explain its mechanisms of influence. This opens avenues for studies that integrate IBL, mobile applications, and mediation analysis.

2.2. Entrepreneurial skills among students

Entrepreneurial skills encompass a set of practical competencies, including creativity, opportunity recognition, business model design, decision-making, business management, and execution capability. Systematic reviews of entrepreneurship education have found that educational programs can influence entrepreneurial capacity and intentions, but their impact on practical skills is more varied and often dependent on experiential pedagogies.[35]. In other words, cultivating genuine entrepreneurial competence requires more than theoretical lectures; hands-on experiences, project-based learning, and exposure to real business ecosystems have proven to be more effective.
Kolb's theory of experiential learning affirms that learning through concrete experience, reflection, conceptualization, and active experimentation is a primary pathway for building practical competence. In entrepreneurship education, Kolb's cycle provides a foundation for giving students opportunities to engage in entrepreneurial activities (e.g., simulations, small business projects), followed by reflective

analysis to generate meaningful learning. Thus, IBL that integrates practice-based and reflective activities has strong theoretical potential to foster entrepreneurial skills.[36].

Despite this, empirical reviews and meta-analyses show heterogeneous outcomes: while some studies report increased entrepreneurial intention, not all demonstrate significant improvements in practical skills.[37], [38]. Variations are often attributed to program duration, integration with industry, and the intensity of experiential learning. Therefore, measuring entrepreneurial skills requires multidimensional, performance-based criteria rather than relying solely on self-reported intentions. Studies combining survey instruments with performance assessments (e.g., portfolios, projects) are likely to provide more robust evidence [39]. From an intervention design perspective, combining IBL with mobile applications presents a pragmatic pathway. Mobile apps can facilitate project-based assignments, cross-campus collaboration, and process documentation (e.g., digital portfolios), thereby capturing, reflecting, and assessing entrepreneurial practice. Nevertheless, ultimate effectiveness depends on whether these experiences transfer into real-world entrepreneurial competence—a dimension that requires further empirical validation.[40]. Mobile Apps allow for documentation of process (photos, videos, diaries, task logs) as well as regular reflection, which is important in developing metacognitive skills and self-regulation, something that is less addressed in methods like traditional PBL or lectures.

3. Methodology

3.1. Research design

This study employs a Quasi-Experimental methodology utilizing a single-group pretest-post-test design framework. The research begins with administering a pretest to assess students' initial entrepreneurship skill development competencies before the introduction of the Mobile Apps-based Inquiry-based Learning model. Following the collection of baseline data, participants undergo treatment through the implementation of the Mobile Apps-based Inquiry-based Learning approach. This intervention is conducted over multiple sessions, with the treatment being administered four separate times to ensure varied outcomes and comprehensive exposure to the learning model. Upon completion of the intervention phase, a post-test is administered to measure students' entrepreneurship skill development capabilities and determine the effectiveness of the Mobile Apps-based Inquiry-based Learning model. This research design allows for the comparison of pre-test and post-test measurements to evaluate the impact of the treatment on students' entrepreneurship skill development.

Pre-Test	Treatment	Post-Test
O1	X	O2

Fig. 1: Quasi-Experimental Design Illustrating Pretest, Treatment, and Posttest Phases (Haegele & Hodge, 2015).

3.2. Population and sample

The study population comprises students enrolled in the Economic Education Study Program who have completed the Entrepreneurship course, with a total of 52 participants. The research framework is structured around two primary variables that form the foundation of the investigation. The study identifies the Mobile Apps-based Inquiry-based Learning model as the independent variable, which represents the educational intervention being tested for its effectiveness. Conversely, the dependent variable focuses on the enhancement of students' entrepreneurial skills, which serves as the outcome measure to assess the impact of the implemented learning approach. This variable structure allows for a clear examination of the relationship between the innovative teaching methodology and its influence on students' entrepreneurial competency development within the context of economic education.

3.3. Data and collection techniques

This research employs a comprehensive multi-method approach to data collection, incorporating four distinct techniques: observation, interviews, documentation, and questionnaires. The observation method utilizes structured guidelines to evaluate the appropriateness and effectiveness of the project-based learning framework and assess the successful integration of mobile applications within the educational context. Assessment tests serve as a measurement tool to gauge the extent of students' entrepreneurial skill development capabilities throughout the intervention period. Additionally, questionnaires are administered to capture students' perceptions, attitudes, and responses regarding the implementation of the Inquiry-based Learning model. The documentation technique supports the research by providing supplementary evidence and maintaining comprehensive records of the intervention process. This multi-faceted data collection strategy ensures triangulation of findings and enhances the reliability and validity of the research outcomes by capturing both quantitative measures of skill development and qualitative insights into student experiences with the mobile app-based learning approach. The lack of a control group limits causal inferences, and future studies should incorporate randomized controlled trials to validate findings.

4. Results and Discussion

Based on Table 1, by using the IBL method based on the Mobile Application, the pre-test results with the number of cases (N) = 52 respondents have an average of 70.08 standard deviation = 3.229, and an average standard error of 0.448. Post-test with several cases (N) = 52 respondents; has an average = 92.85, standard deviation = 3.426, and an average standard error of 0.475.

Table 1: Descriptive Paired t Test

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	70.08	52	3.229	0.448
	Test Post	92.85	52	3.426	0.475

Source: Processed data, 2024.

The paired samples test results presented in Table 2 demonstrate a statistically significant difference between pre-test and post-test measurements, as evidenced by the Sig (2-tailed) value of 0.000, which falls below the conventional significance threshold of 0.05.

Table 2: Development of Student Entrepreneurship Skills

		Paired Differences				
		95% Confidence Interval of the Difference				
		Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pre Test - Post Test	-23.165	-22,373	-115,407	51	.000

Source: Processed data, 2024.

This finding indicates a meaningful distinction between students' entrepreneurial skill levels before receiving instruction through the Mobile Apps-based Inquiry-Based Learning (IBL) model and their performance following the educational intervention. The statistical significance of these results provides empirical support for the effectiveness of the Mobile Apps-based IBL approach in enhancing students' entrepreneurial skill development. Furthermore, the research includes an examination of descriptive statistical outcomes related to the N-gain values, which quantify the improvement achieved through the implementation of the Mobile Apps-based IBL learning model. These descriptive statistics offer additional insights into the magnitude and distribution of learning gains observed in students' entrepreneurial skill development capabilities following the educational intervention.

Table 3: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Gain _score	52	.62	.93	.7693	.09237
Gain _percent	52	62.16	92.86	76.9268	9.23680
Valid N (listwise)	52				

Source: Processed data, 2024.

Table 3. Showed that from the total data, N = 52, the minimum N-gain score value is 0.62 and N-gain percent is 62.16%, while the maximum N-gain score value is 0.93 and N-gain percent is 92.86%. The average N-gain score value is 0.7693, and the N-gain percent is 76.93%. The standard deviation of the N-gain score value is 0.092368, and the N-gain percent is 9.23%. N-gain score is a measure used to determine the effectiveness of learning or intervention by comparing the increase in student learning outcomes before and after treatment (pretest and posttest), then normalizing it against the maximum possible score that can be achieved.

Table 4: Interpretation of Gain Values

Scale	Interpretation
$-1 \leq g \leq 0.0$	Decrease
$g = 0.0$	Stable
$0.0 \leq g \leq 0.30$	Low
$0.30 \leq g \leq 0.70$	Everage
$0.70 \leq g \leq 1.00$	High

Source: Processed Data, 2024.

The enhancement of students' entrepreneurial competencies following the implementation of the Mobile Apps-based Inquiry-Based Learning (IBL) model is evidenced by the mean N-gain score of 0.7693, which translates to a substantial improvement rate of 76.93 percent. When evaluated against established gain value interpretation standards, this average N-gain score of 0.7693 exceeds the threshold of 0.70, categorizing the learning improvement as high-level effectiveness. These results demonstrate that the Mobile Apps-based IBL pedagogical approach yields significant positive outcomes when applied within the economic education study program context. The substantial gain score provides compelling evidence that this innovative learning methodology is highly effective for fostering entrepreneurial skill development among students. The magnitude of improvement observed suggests that the integration of mobile applications with inquiry-based learning strategies creates a powerful educational environment that successfully enhances students' entrepreneurial capabilities and competencies.

4.1. The effectiveness of mobile app-based IBL in improving entrepreneurial skill development

The study findings reveal that the Mobile Apps-based Inquiry-Based Learning (IBL) model demonstrates significant effectiveness when implemented for enhancing students' entrepreneurial competencies, achieving an impressive average improvement rate of 76.93 percent. These results confirm that the integration of Inquiry-Based Learning methodology with mobile application technology creates a powerful educational framework for fostering entrepreneurial skill development among students. The success of this approach stems from its ability to promote active student engagement through questioning, independent information seeking, and autonomous exploration of business-related solutions, thereby creating a more meaningful and practically applicable learning experience. Students are empowered to take ownership of their learning journey, developing critical thinking and problem-solving abilities that are essential for entrepreneurial success. This pedagogical approach transforms the traditional learning environment into a dynamic, student-centered experience where learners actively construct knowledge through investigation and discovery. The effectiveness of this model is further validated by its alignment with existing research literature, particularly the work of [41], which demonstrates that inquiry-based learning methodologies consistently contribute to enhanced student skill development across various educational contexts. [41].

The use of Mobile Apps as a learning medium provides easy access to learning resources and increases students' flexibility in learning anytime and anywhere. Mobile applications that support collaboration and business simulations allow students to practice managing business ideas, conducting market research, and presenting their findings digitally. This increases students' motivation to learn and independence in developing entrepreneurial skills. In addition, the implementation of IBL based on Mobile Apps also strengthens students' soft skills, such as communication skills, teamwork, critical thinking, and decision making, which are very important in the world of entrepreneurship. Through the inquiry process, students are trained to identify real problems, collect data, analyze information, and design creative and innovative business solutions.

The application of the Inquiry-Based Learning (IBL) model supported by mobile applications has proven effective in improving students' entrepreneurial skills. IBL encourages students to actively ask questions, investigate, and find solutions independently, which is in line with the characteristics of entrepreneurship that require creativity and initiative.

Research demonstrates significant improvements in students' critical thinking abilities following the implementation of Inquiry-Based Learning (IBL) models. These enhancements are evident across multiple indicators, including simple explanations, foundational skills development, conclusion drawing, advanced explanations, and strategic thinking capabilities [33].

In line with the research, the application of the Inquiry-Based Learning model using Android-based learning media is more effective than the application of the teacher-centered learning model in improving learning competencies in the basic competencies of passive elements in direct current circuits of class X TITL SMK N 2 Klaten. The inquiry-based learning model based on mobile learning has a significant influence on students' creative thinking skills. Comparative studies reveal that IBL approaches using Android-based learning media substantially outperform traditional teacher-centered methods in developing learning competencies, particularly in technical subjects such as passive elements in direct current circuits for vocational students.

Mobile learning-integrated IBL models demonstrate considerable influence on students' creative thinking development [42]. These findings indicate that mobile-based inquiry learning effectively enhances students' skills, values, and attitudes across educational contexts. The research emphasizes the critical importance of inquiry-based approaches in developing comprehensive student competencies spanning various disciplines, including entrepreneurship education. Additional studies confirm that IBL models utilizing Android-based learning platforms significantly improve both cognitive and affective competencies among students [43]. Comparative research consistently shows IBL methodologies achieving superior effectiveness compared to conventional teacher-centered approaches in enhancing overall learning competencies [44]. These collective findings establish IBL as a robust pedagogical framework that successfully transforms learning experiences and outcomes across diverse educational settings.

4.2. Student responses to this learning model implementation

The integration of mobile applications in the IBL model allows students to access information flexibly, collaborate online, and apply entrepreneurial concepts in real-world contexts. This increases students' motivation and independence in learning, as well as strengthening digital skills that are essential in today's entrepreneurial world.

The inquiry strategy emphasizes maximum student activity to search and find, meaning that the inquiry approach places students as learning subjects. All activities carried out by students are directed to search and find for themselves from something that is questioned, so that it is expected to foster an attitude of self-confidence, which means that in the inquiry approach, the teacher is placed not as a source of learning, but as a facilitator and motivator of student learning. The purpose of using the inquiry learning strategy is to develop intellectual abilities as part of the mental process [45]. Thus, the implementation of the mobile application-based IBL model is not only effective in improving students' entrepreneurial skills but is also relevant to technological developments and the increasingly dynamic needs of the business world. Overall, this study makes significant contributions to the advancement of entrepreneurship education within higher education contexts. The finding that the Mobile Apps-based IBL model effectively enhances students' entrepreneurship skills provides a valuable reference for educational institutions seeking to implement innovative pedagogical approaches that are congruent with contemporary technological advancements. These research outcomes further reinforce the digital transformation initiative in education, which emphasizes the strategic integration of technology to improve learning quality and effectiveness. Consequently, this research not only furnishes empirical evidence substantiating the efficacy of the learning model but also establishes a foundation for future developments in technology-enhanced entrepreneurship education.

Mobile applications identify functional features in inquiry learning and explain the relationship between functional features in mobile applications and pedagogical aspects in inquiry-based learning, with mobile applications as their supporters, based on the perceptions of application users. The results of the study indicate that informative material features play an important role in supporting the exploration and conclusion aspects of inquiry-based pedagogy [46].

Enhancing entrepreneurship education represents a critical priority due to its fundamental role in cultivating an entrepreneurial mindset and spirit among students. Effective entrepreneurship learning develops comprehensive competencies across cognitive, affective, and psychomotor domains. The selection of appropriate teaching methods and instructional media is essential for creating engaging, comprehensible, and motivating learning experiences that inspire students to pursue entrepreneurial knowledge and skills. Well-designed entrepreneurship education transforms potentially mundane content into dynamic learning opportunities that capture student interest and facilitate meaningful skill development. In the context of entrepreneurship, IBL is essential because students are given the opportunity to investigate real cases, plan businesses, and identify solutions to challenges faced by entrepreneurs. IBL encourages students to be active in the learning process, allowing them to find answers and solutions to the questions they ask themselves.

Teaching and learning approaches are important factors in achieving learning outcomes. New learning approaches are effective in improving students' entrepreneurial skills. Learning carried out with electronic media has been widely carried out in universities, making it easier to transfer knowledge, which ultimately improves entrepreneurial skills among students [47].

Entrepreneurship education is important to be implemented in Higher Education. Universities must ensure that students acquire competencies as catalysts for change. The implementation of effective mobile applications contributed significantly to the development of students' social entrepreneurial skills [48]. Teaching methods should be used in entrepreneurship education to contribute to the entrepreneurship pedagogical program. Working in teams improves problem-solving, collaboration, and communication skills. The questionnaire results showed that most students responded positively to the use of mobile apps-based IBL. Particularly regarding the ease of collaboration and digital documentation. However, there was variation in participation levels and consistency of app use. This suggests that the success of the intervention is influenced not only by instructional design but also by students' intrinsic and extrinsic motivational factors.

However, the analysis of the relationship between student responses and motivational factors in this study is still descriptive in nature and has not been statistically tested in depth. This limitation is important to note because learning motivation is a key variable that can moderate the effectiveness of mobile IBL. Therefore, future research should examine the causal relationship between motivation and student engagement in mobile IBL using quantitative analysis methods (e.g., SEM or path analysis)

5. Conclusion

This study concludes that the implementation of the Mobile Apps-based Inquiry-Based Learning model has proven effective in comprehensively developing students' entrepreneurial skills. This learning model demands student independence to actively develop their abilities through independent investigation and exploration processes, thereby triggering high and meaningful learning engagement. The student-centered characteristics of this learning approach enable students to actively construct knowledge and develop problem-solving abilities that are essential in the entrepreneurial world. Future research could explore the scalability of mobile IBL across different disciplines or its impact on actual entrepreneurial ventures post-graduation

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