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An ADDIE-based mobile inquiry-based learning model for enhancing entrepreneurial competence in higher education

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Abstract

Higher education institutions face a clear mandate to equip students with adaptive, forward-thinking entrepreneurial skills that align with technological progress. Yet, university-level entrepreneurship coursework is often bogged down in traditional theory, offering little exposure to digital tools, inquiry-driven methods, or hands-on practice. To bridge this pedagogical gap, this study developed and evaluated a Mobile Inquiry-Based Learning (M-IBL) model alongside its instructional tools, namely, mobile-based modules, lesson plans, and assessment rubrics. The study employed a Research and Development (R&D) methodology guided by the five-phase ADDIE framework: Analysis, Design, Development, Implementation, and Evaluation. To evaluate performance in a real classroom setting, a single-group pretest–posttest design was conducted with undergraduate students. Data collection drew on expert validation forms, lecturer and student feedback questionnaires, and formal entrepreneurial competency tests, with analysis carried out using descriptive statistics, paired-samples t-tests, and normalized gain (N-gain) scores. Expert evaluations validated the M-IBL framework and instructional materials at 86.66%. In terms of classroom practicality, the model received strong ratings: 92.00% from lecturers and 93.33% from students. Competency assessments revealed statistically significant improvements after the intervention ($p < 0.001$), with a moderate N-gain score of 0.659. These empirical findings indicate that anchoring mobile inquiry-based learning in structured materials creates an authentic educational setting that sharpens students' critical thinking, creative output, and problem-solving capabilities.

Keywords: ADDIE, Entrepreneurial competency, Entrepreneurship education, Higher education, Mobile inquiry-based learning model.

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Contribution of this paper to the literature

This study contributes to educational theory by demonstrating that the ADDIE-based Mobile Inquiry-Based Learning (M-IBL) model effectively enhances university students' critical thinking, creativity, and problem-solving skills. Specifically, its implementation in entrepreneurship courses at Universitas PGRI Jombang highlights the potential of Mobile Inquiry-Based Learning model to support innovative and experiential education.

1. Introduction

The rapid advancement of technology and the transition to the digital economy have radically changed the needs of the workforce and the way entrepreneurship is conducted. These structural transformations demand graduates who are able to adjust swiftly to new business models and workplace automation. Recent literature demonstrates the significance of entrepreneurship education as a contributing factor to graduate employability. In addition to producing a skilled workforce, specialized entrepreneurship training develops the ability to create one's own venture. The capacity to start new businesses is an essential driver of innovation-based economic growth and enhances the resilience of productive sectors to market interference (Nabi, Liñán, Fayolle, Krueger, & Walmsley, 2017; Tiberius & Weyland, 2023). The rapidly changing digital economy requires not only a keen awareness of new technologies but also bold decision-making in situations of market uncertainty. This strategic thinking is key for practitioners and entrepreneurs who wish to reduce the risk of disruption and pursue well-calculated, outcomes-oriented innovation (Audretsch & Belitski, 2021). Real entrepreneurial skill depends on the ability to develop hands-on, practical skills rather than merely acquiring theoretical knowledge. Students should repeatedly be exposed to identifying market opportunities, addressing unstructured problems creatively, calculating risks, and developing feasible business models. One significant obstacle concerns instructional approaches based on conventional, one-way lectures. In such a passive format, students have little opportunity to challenge their business intuition or develop practical skills in realistic or simulated environments. The solution to this pedagogical divide would be to redesign the model of higher education, shifting toward models that integrate theory and practice through an experience-based approach focused on digital technology.

Inquiry-Based Learning (IBL) is a philosophy that is consistent with entrepreneurship education, in which students are viewed as active participants in the process of building their own knowledge. It shifts from the passive, one-way delivery of content to a more exploratory style of learning, in which students formulate key questions, research field-level issues, evaluate empirical data, and contemplate what they have learned to make informed business choices (Hmelo-Silver, Duncan, & Chinn, 2007; Pedaste et al., 2015). There is a strong body of research identifying Inquiry-Based Learning (IBL) as an effective approach to developing higher-order thinking skills, such as analytical reasoning, critical thinking, creativity, and the ability to solve complex problems (Furtak, Seidel, Iverson, & Briggs, 2012; Lazonder & Harmsen, 2016; Zhang & Ma, 2023). These intellectual capabilities align closely with the fundamental needs of entrepreneurship. Practical entrepreneurship in the real world demands that students not only be able to identify market opportunities but also assess empirical evidence systematically, calculate risks, and formulate viable solutions to unstructured problems. Although IBL has strong pedagogical potential, practical challenges exist in implementing it at the university level. Its success will largely depend on effective instructional design and the use of relevant digital technologies (Bond, Buntins, Bedenlier, Zawacki-Richter, & Kerres, 2020). It is difficult to sustain continuous, context-rich inquiry without proper technological integration beyond the limits of the traditional classroom.

Inquiry-based learning can be significantly supported by mobile technology, which offers unique pedagogical affordances. Its flexibility enables students to learn using instructional materials at different times and locations, communicate constantly with instructors and classmates, work in real time, and engage in formative assessment. The available literature supports the idea that mobile integration can make students more engaged and motivated to learn, and can help them achieve greater academic success when supplemented by effective pedagogical practices (Alsswey & Al-Samarraie, 2019; Martínez-Gregorio, Badenes-Ribera, & Oliver, 2021). In addition to promoting communication, handheld devices also allow learners to retrieve field information about real-world settings (Crompton & Burke, 2018; Sung, Chang, & Liu, 2016). The combination of inquiry-based learning (IBL) and mobile technology therefore has great potential to generate flexible, interactive learning environments in which learners can independently investigate challenging business problems.

However, even though research has been ongoing in the fields of entrepreneurship education, inquiry learning, and mobile technologies, there are still several important gaps: Outcome Scope: Existing entrepreneurship education research has focused on foundational, cognitive outcomes, or generalized entrepreneurial intentions, and process-based, authentic competency development has remained under-researched (Lackéus, 2020; Nabi et al., 2017). Disciplinary Context: IBL use in higher education is mostly limited to general academic disciplines, as opposed to being specific to entrepreneurship, which can be characterized by the necessity to identify opportunities, calculate risks, be creative as a business, and innovate commercially (Lazonder & Harmsen, 2016; Pedaste et al., 2015).Technological Role: Mobile learning investigations have concentrated to a significant extent on the usability, accessibility, and motivational advantages, instead of framing mobile devices as a component mechanism incorporated in a structured inquiry syntax (Alsswey & Al-Samarraie, 2019; Crompton & Burke, 2018). Developmental Methodology: The available literature is comprised of explanatory designs, descriptive surveys, and simplistic experimental designs, which have led to lack of validated models of instruction that are developed under rigorous Research and Development (R&D) frameworks (McKenney & Reeves, 2025; Spatioti, Kazanidis, & Pange, 2022).

These gaps demonstrate the necessity of an instructional model that incorporates active pedagogy, mobile technology, real-life business situations and competency-based assessment in a systematic way. In response to this requirement, this paper designs a Mobile Inquiry-Based Learning (M-IBL) model, which involves integrating the stages of the inquiry into an ADDIE-based instructional design model. The model puts students at the heart of the learning experience, consisting of business problem exploration, investigative questioning, collection and analysis of market data, venture solution design, and reflection on evaluation. These phases all include mobile tools to aid

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information retrieval, peer collaboration, and the collection of empirical field data (Bond et al., 2020; Crompton & Burke, 2018). Based on constructivist theory of learning (McKenney & Reeves, 2025; Spatioti et al., 2022) mobile devices do not serve as content-delivery tools, but as instruments of inquiry.

The originality of the M-IBL model lies in its incorporation of inquiry syntax, mobile affordances, real entrepreneurial situations, and competency-based assessment as part of the larger unit of instruction. M-IBL directly integrates mobile functionality into the market research and problem-solving process, unlike traditional mobile learning systems that only disseminate content. Moreover, the inquiry stages are clearly aligned with key entrepreneurial capabilities, such as the ability to identify opportunities, make risk-informed decisions, solve business problems, and create business models. The model is built using an ADDIE-based R&D approach that includes needs analysis, prototyping, expert testing, field testing, and evaluation (McKenney & Reeves, 2025).

The new integration can also rely on recent evidence, which demonstrated that active pedagogical strategies with the help of digital technology could enhance student engagement, motivation, and the quality of learning (Alsswey & Al-Samarraie, 2019; Martínez-Gregorio et al., 2021). The interplay of the inquiry process and mobile technology affordances is likely to make the M-IBL model a more realistic learning setting where students learn to actively seek answers to the problems of entrepreneurship, explore pertinent information, cooperate with others, come up with evidence-based solutions, and reflect on learning. In this regard, the paper has theoretical contributions by linking the constructivist principles of learning with mobile-based inquiry to entrepreneurship education and practical contributions by offering an instructional model and facilitating learning tools that can be used in higher education in the digital transformation era.

Based on this, the following research questions guided this study: 1) How can the ADDIE model be used to design and develop a Mobile Inquiry-Based Learning (M-IBL) model that incorporates inquiry syntax and mobile technology for higher education? 2) How can the conceptual and empirical validity of the M-IBL model be tested through expert judgment and pilot applications in higher education institutions? 3) To what extent can the ADDIE-based M-IBL model improve students' entrepreneurial competence within the framework of the digital economy?

The proposed study should help fill this research gap by creating and testing the Mobile Inquiry-Based Learning (M-IBL) model to enhance university students' entrepreneurial competence through an ADDIE-based research and development strategy. In particular, the research aims to (1) create an M-IBL learning model based on a combination of inquiry syntax and mobile technology, (2) examine the model's conceptual and empirical soundness, and (3) assess the model's effectiveness in facilitating the development of students' entrepreneurial competence within the framework of the digital economy.

2. Literature Review

2.1. Entrepreneurship Education in the Digital Era

Education in entrepreneurship is a strategic tool in equipping students to meet the challenge of creating a digital economy that is technologically disruptive, with a quickening consumer behavior and business models. Colleges and universities must not only deliver academically qualified graduates but also those ones, who have innovative, adaptive, and value-generating skills (Nabi et al., 2017; Tiberius & Weyland, 2023). Entrepreneurial competency, in this case, is a significant dimension of increasing job preparedness and competitiveness of graduates in the knowledge-based economy (Audretsch & Belitski, 2021).

Entrepreneur competencies can be described along various dimensions such as the opportunity recognition ability, creative thinking, risky decision-making, problem-solving, and the ability to build sustainable business models (Bacigalupo, Kampylis, Punie, & van den Brande, 2016; Morris, Webb, Fu, & Singhal, 2013). These competencies cannot be effectively developed by the process of acquiring theoretical knowledge only, since entrepreneurship demands that students transfer knowledge to uncertain, dynamic, and real-life situations. Nonetheless, the existing studies suggest that higher education entrepreneurship education will continue to be biased toward a theoretical focus, thus offering students fewer real-world experiences to cultivate entrepreneurial skills in the most effective way possible (Hägg & Gabrielsson, 2020; Lackéus, 2020).

This situation creates the need for an instructional strategy that bridges the gap between entrepreneurial ideas and authentic investigation, experimentation, reflection, and problem-solving. In entrepreneurship education, students should be encouraged to recognize real-world problems, explore market needs, identify business opportunities, process relevant information, and develop innovative solutions. These learning objectives align with the principles of Inquiry-Based Learning (IBL), and the incorporation of mobile technology can provide flexible and contextualized learning environments that facilitate these inquiry processes.

2.2. Inquiry-Based Learning as a Pedagogical Foundation

Inquiry-Based Learning (IBL) is a constructivist pedagogical model that focuses on knowledge construction through exploration, inquiry, and experiential learning. In IBL, learners are facilitators of their own learning by asking questions or identifying problems, conducting investigations, gathering and analyzing data, drawing inferences, and reflecting on what they have learned (Hmelo-Silver & Barrows, 2006; Pedaste et al., 2015). These processes are particularly applicable to the field of entrepreneurship education, since entrepreneurial processes also involve identifying problems and opportunities, collecting evidence, analyzing data, and developing innovative solutions.

Previous studies have been able to find that IBL enhances higher-order competencies. In (Furtak et al., 2012) inquiry-based strategies were shown to have a positive impact on learning and conceptual knowledge in students, whereas (Lazonder & Harmsen, 2016) revealed that inquiry learning can be more effective with proper guidance and instructional scaffolding. Such results indicate that inquiry-based learning must not merely offer students the chance to enquire, but the process should be facilitated by a sequence of learning, relevant materials, instructions, and evaluation.

In terms of an entrepreneurship education perspective, the weakness of IBL is that it places students as active knowledge seekers as opposed to passive consumers of entrepreneurial knowledge. Inquiry activities will enable students to explore customer needs, predict the market environment, identify business opportunities, assess risk, and

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create evidence-based solutions. Thus, IBL offers a robust pedagogical model to develop critical thinking, creativity, problem-solving skills, and decision-making skills, which are closely associated with entrepreneurial competency (Bacigalupo et al., 2016; Morris et al., 2013).

However, IBL implementation at the tertiary level might be complicated, as activities involving inquiry necessitate constant access to information, teamwork, data gathering and classroom interactions. These activities may be constrained in terms of their flexibility and continuity by conventional classroom-based implementation. This makes the incorporation of IBL with digital technology relevant to developing more contextual, flexible, and effective inquiry experiences (Bond et al., 2020).

2.3. Mobile Learning in Digital Learning

Mobile learning is a technology-based method that uses mobile equipment to enable flexible and lifelong learning, allowing students to receive learning materials anywhere and anytime and encouraging interaction and collaboration (Crompton & Burke, 2018; Sung et al., 2016). Mobile learning is not just a valuable tool in pedagogy because it involves the use of smartphones or other mobile devices; however, it is a tool that offers flexibility of access to information, enables communication, promotes collaboration, and links learning processes with real-life situations.

It has been established that mobile learning can enhance the level of student engagement, motivation, and learning, especially in the case of m-technology implementation combined with proper pedagogical practices (Alsswey & Al-Samarraie, 2019; Martínez-Gregorio et al., 2021). The affordances are quite applicable to inquiry-based learning since students engaged in inquiry need to have access to various types of information, access to gathering information in the context of a real-life situation, and the means of communicating with peers and instructors.

The interrelationship between mobile learning and IBL can thus be envisioned as a complementary blend of pedagogical activity and technological affordances. IBL defines how students participate in inquiry, including the identification of problems, gathering of evidence, analysis of information, and drawing of conclusions. Meanwhile, mobile learning introduces technological affordances through which such processes can be performed flexibly across different locations and learning settings. Mobile technology can therefore take the inquiry process beyond the physical classroom and support ongoing investigation and collaboration.

Nevertheless, the mere application of mobile technology does not necessarily constitute Mobile Inquiry-Based Learning (M-IBL). Merely delivering electronic learning resources via mobile devices constitutes mobile-supported learning, but does not necessarily create an inquiry-based learning environment. M-IBL cannot be achieved without the meaningful integration of mobile technology, instructional activities, learning resources, and assessment processes with the stages of inquiry. This distinction is especially important in entrepreneurship education, as inquiry must be guided toward real-world entrepreneurship issues and competency building.

2.4. Mobile Inquiry-Based Learning in Previous Studies

Combining Inquiry-Based Learning and mobile learning has become a potential method in technology-enhanced education. Mobile technology has the potential to enhance inquiry activities as students are able to access information, gather and record data and communicate with others, collaborate and reflect on their learning opportunities to happen in various contexts. This integration facilitates more versatile and contextual learning experiences and aligns with the requirements of 21st-century education that values active learning and incorporation of digital technology (Bond et al., 2020; Martínez-Gregorio et al., 2021).

The results of earlier research on mobile learning also suggest that the impact of mobile technology heavily depends on the pedagogical approach into which it is incorporated. Mobile devices may be used to enhance engagement and motivation, and their educational impact is even more significant when they are involved in a structured learning experience and have a learning goal (Alsswey & Al-Samarraie, 2019; Martínez-Gregorio et al., 2021). In this light, M-IBL could be pitched as a method of instruction that incorporates the pedagogical power of inquiry and the versatility and adaptability of mobile technology.

However, the literature shows that utilization of mobile inquiry-based methods is not a properly investigated area in entrepreneurship education. A significant portion of the literature on mobile learning has placed emphasis on engagement, motivation, flexibility, collaboration, and overall learning effectiveness, whereas IBL studies have been largely centered around the inquiry processes, conceptual knowledge, critical thinking, and problem solving (Furtak et al., 2012; Lazonder & Harmsen, 2016). Though these results are applicable to entrepreneurship, they are not quite reflective of the wider entrepreneurial capabilities needed in a real entrepreneurship setting.

Specifically, little effort has been devoted to developing the potential of mobile-supported inquiry to systematically support the development of opportunity recognition, creative thinking, risk-based decision-making, problem-solving, and value creation in entrepreneurship courses. Thus, the integration of IBL and mobile learning should be further contextualized so that the inquiry process is not merely technologically facilitated but is explicitly related to the problems, actions, and competency indicators within the realm of entrepreneurship.

2.5. Research Gap and Distinction of the Proposed M-IBL Model

The literature synthesis reveals three gaps that are interrelated. To begin with, entrepreneurship education must take place in authentic and experience-based learning environments since entrepreneurial competencies involve applying knowledge to practical and uncertain scenarios; yet, entrepreneurship education in higher education continues to be often dominated by theoretical methods (Hägg & Gabrielsson, 2020; Lackéus, 2020). Second, IBL offers a suitable pedagogical basis to build higher-order competencies by investigating, analyzing, reflecting, and solving problems, but its execution may be limited by access to information, collaboration, and out-of-class learning (Bond et al., 2020; Hmelo-Silver & Barrows, 2006; Pedaste et al., 2015). Third, mobile learning is flexible, readily accessible, interactive, and collaborative, yet its use in entrepreneurship education has been placed at the periphery, not as an integral part of a structured inquiry process (Alsswey & Al-Samarraie, 2019; Crompton & Burke, 2018).

These loopholes suggest that integrating IBL and mobile learning should not merely be a combination of two teaching methods. The integration must establish a coherent connection among the entrepreneurial learning goals,

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inquiry actions, mobile technological opportunities, and competency evaluation. To meet this requirement, this study proposes the Mobile Inquiry-Based Learning (M-IBL) model, which positions mobile technology as an inseparable part of the inquiry process in entrepreneurship education.

The M-IBL model differs from a traditional mobile learning design because mobile technology is not used merely to provide learning resources or facilitate communication. Instead, it supports the entire inquiry process, including identifying the problem, searching for information, collecting data, analyzing findings, developing solutions, collaborating, and reflecting. Another difference between the model and a general IBL design is that the inquiry activities are clearly situated within the context of real-world entrepreneurial problems and are oriented toward developing entrepreneurial competencies.

Moreover, the suggested model is facilitated by systematic pedagogical resources, including learning modules for mobile devices, lesson plans, and assessment instruments. These elements are intended to ensure alignment among the learning goals, inquiry processes, mobile learning tasks, and the assessment of entrepreneurial competencies. In this way, the systematic combination of entrepreneurship education, inquiry-based learning, mobile technology, authentic learning experiences, and competency-based assessment constitutes the unique contribution of the proposed M-IBL model.

Based on this, the proposed M-IBL model cannot be considered a technological modification of the current IBL or mobile learning strategies. Instead, it is a contextualized instructional model uniquely structured to transform entrepreneurship education into an active, authentic, collaborative, and technology-assisted learning process. This stance offers a point of departure for examining whether inquiry and mobile technology can be successfully integrated to enhance students' entrepreneurial skills, especially their critical thinking, creativity, and problem-solving skills.

3. Research Method

3.1. Research Approach and ADDIE Framework

The paper uses an R&D approach to design and test a Mobile Inquiry-Based Learning (M-IBL) architecture to help develop entrepreneurial skills within a tertiary institution. The instruction development is based on the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) and uses its structured, iterative, and flexible design to develop effective technology-enhanced learning interventions (McKenney & Reeves, 2025).

3.2. Development Design

This work was carried out following a rigorous R&D procedure to construct and empirically test the M-IBL model in the field. The ADDIE model was adopted because of its detailed architecture, which enables continuous iterative refinement while maintaining close correspondence among learning goals, learning activities, and assessment processes.

3.3. Analysis

The needs analysis revealed a significant pedagogical imbalance that underlies the rationale for the M-IBL model. Although modern curricula focus increasingly on applied skills, including the ability to recognize opportunities, creativity in problem-solving, and venture planning, entrepreneurship instruction remains largely theoretical. This disconnect is exacerbated by the profile of the students in question, who, although digitally literate and naturally innovative, often struggle to engage in real-world assignments, such as validating markets through data and empirically testing the feasibility of particular ideas. These findings indicate a clear need for an instructional model that addresses the requirements of both conceptual learning and authentic inquiry.

3.4. Design

The conceptual and pragmatic models of the M-IBL intervention were well organized as a result of the design phase. The major outputs were: (1) a mobile-integrated inquiry learning syntax; (2) sequences of instructions specific to digital venture discovery; (3) additional artifacts comprising lesson plans and mobile learning units; and (4) a rubric-based performance assessment system. A combination of these components created the blueprint and initial working version (Draft I) of the model.

3.5. Development

The development phase focused on creating the entire teaching package and mobile learning media, followed by systematic expert judgment. The conceptual grounding of the model, learning syntax, modular content, and assessment tools was assessed by subject-matter and instructional-design professionals. The results of the Likert-scale assessments were used to calculate a validity index, and further iterative refinements resulted in the completed second version of the model (Draft II).

3.6. Implementation

During the implementation period, the M-IBL model was implemented in small steps through small-scale piloting and a large-scale field test. The experimental design used to assess the pedagogical intervention was a one-group pretest–posttest design. Before instructional delivery, participants were given a 15-item diagnostic test to determine their baseline competencies, performed tasks involving mobile-supported entrepreneurial inquiry, and completed a posttest and an instructional perception survey. Quantitative gains in entrepreneurial competency were then analyzed using inferential statistical tests.

3.7. Evaluation

The assessment phase was used to determine whether the M-IBL model could achieve its predetermined instructional thresholds. By using quantitative performance measures from pre- and post-performance evaluations, together with student perception measures, the evaluation provided a scientific basis for targeted optimization, which continually improved the model's instructional quality, efficiency, and relevance.

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3.8. Research Subjects

To fully assess the M-IBL model across three important dimensions—validity, practicality, and effectiveness—we based data collection on three distinct instruments: construct validation through expert judgment, user-practicality assessment through structured questionnaires administered to lecturers and students, and cognitive-performance testing involving 52 Economics Education undergraduates at Universitas PGRI Jombang.

3.9. Data Collection Technique

Information was systematically mapped onto the ADDIE model to address three fundamental developmental measures: validity, practicality, and effectiveness. Initial needs were identified through observational field notes and stakeholder interviews. During the development stage, construct validity was established through expert review forms. Practical utility was assessed through post-implementation surveys of lecturers and students, while learning efficacy was evaluated using a pretest–posttest measure supported by students' business plan deliverables and detailed learning documentation.

3.10. Data Analysis

Both quantitative and qualitative data were analyzed systematically to establish the validity, practicality, and pedagogical effectiveness of the model. Expert review rubrics were used to establish content and construct validity, with an empirical benchmark threshold of at least 70% indicating instructional viability. The practicality of implementation was assessed by quantifying the responses of the teaching staff and students as percentages and comparing them with the qualification criteria on a standard form. Lastly, instructional efficacy was evaluated by administering pre- and post-tests and conducting paired-samples t-tests and normalized-gain (N-gain) tests, which provided empirical support for significant increases in students' entrepreneurial competencies.

4. Results

The practicality test was conducted using a questionnaire administered to lecturers and students after the model was implemented in the Economics Education Study Program, which included 52 students at PGRI Jombang University.

4.1. Lecturers' Responses

The lecturer response questionnaire scored 46 that is close to the maximum score of 50. The percentage of practicality was determined through the following:

Percentage = (46 / 50) × 100%

Percentage = 92%

This score belongs to a very practical category, which means that the model is not difficult to follow or adopt and also provides a systematic, applicable learning flow for lectures on the topic of economic entrepreneurship. According to the lecturers, the M-IBL model successfully combines business-oriented problem-solving with group learning.

4.2. Students' Responses

The student response questionnaire outcomes gave a total of 3,640 out of 3,900 as the maximum score. The practicality percentage was determined in the following way:

Percentage = (3,640 / 3,900) × 100%

Percentage = 93.33%

This outcome is described as highly practical. Participants mentioned that they found the M-IBL model more active in learning, more engaging in discussions, and helpful in learning entrepreneurial concepts because they could practice them. In general, therefore, the model met the criterion of practicality in terms of user responses (lecturers and students).

4.3. Model Validity Test Results

The validity of the M-IBL model was assessed through expert judgment involving three experts with expertise in economics education and learning models. The validation instrument assessed the suitability of the learning syntax, the comprehensibility of the phases, contextualization, innovativeness and creativity, media integration, practicality of implementation, theoretical justification, and measurability of outcomes. The three expert validators awarded a total score of 104 out of a possible 120. The percentage of validity was determined using the following formula.

Percentage = (Score obtained / Maximum score) × 100%

Percentage = (104 / 120) × 100%

Percentage = 86.66%

The results indicate that the model is highly valid (85–100%). Therefore, the developed M-IBL model satisfies the criteria of conceptual and practical feasibility and can be used without major adjustments in the learning process. The learning instructions were only slightly edited by the validators.

4.4. Model Effectiveness Test Results

The model was tested using a paired-samples t-test to compare the pre-test and post-test scores (at a significance level of 0.05) alongside the calculation of normalized gain (N-gain).

4.4.1. Analysis of Pretest and Posttest Differences

Prior to the paired sample t -test, a normality test was carried out.

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Table 1. Tests of normality.

Variables	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0.090	52	0.200*	0.969	52	0.197
Posttest	0.092	52	0.200*	0.958	52	0.065

Note: a. Lilliefors Significance Correction
*. This is a lower bound of the true significance.

As indicated in Table 1 of the normality test above, the Kolmogorov-Smirnov test had a significance value of 0.200 for the pre-test, which is greater than 0.05, while the Shapiro-Wilk test had a significance value of 0.197, also greater than 0.05. These results indicate that the pre-test data followed a normal distribution. For the post-test, the Kolmogorov-Smirnov test yielded a significance value of 0.200, which is greater than 0.05, and the Shapiro-Wilk test yielded a significance value of 0.065, also greater than 0.05. This implies that the post-test data were normally distributed. Moreover, the descriptive results of the paired-samples t-test are as follows:

Table 2. Paired samples statistics.

Pair	Variables	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	74.789	52	3.455	0.479
	Posttest	90.981	52	5.117	0.709

According to Table 2, the average pre-test score was 74.7885, and the average post-test score rose to 90.9808, with a maximum score of 100.The standard deviation is 3.455 and the mean standard error is 0.479 for the pre-test. Meanwhile, the post-test results show a standard deviation of 5.117 and a mean standard error of 0.709. The outcome of the paired-samples test is presented below:

Table 3. Paired-samples test.

Paired differences 95% confidence interval of the difference						
Pair	**Paired variables**	**Lower**	**Upper**	**t**	**df**	**Sig.**
Pair 1	Pretest - posttest	-17.012	-15.373	-39.659	51	0.000

Table 3 presents the results of the paired-samples t-test. The findings indicate that the inquiry-based learning model using mobile applications in the entrepreneurship course enhances the students' entrepreneurial skills (Sig. = 0.000 < 0.05).

4.4.2. Analysis N-Gain

The N-Gain Score and N-Gain percentage outcomes are as follows; they indicate the change in the competence of the students in entrepreneurship.

Table 4. N-Gain.

Variable	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain	52	0.31	1.00	0.659	0.165

The results show that Sig. is 0.000 < 0.05, indicating that the inquiry-based learning model using mobile apps in entrepreneurship courses is effective at improving students' entrepreneurial competencies. The N-Gain value is categorized as high if (N-Gain ≥ 0.70), medium if (N-Gain is between 0.30–0.69), and low if (N-Gain < 0.30). The mean N-Gain of 0.659 is average, which is categorized as medium based on Table 4.

4.5. The Result of ADDIE Phase

4.5.1. Analysis

According to the needs-analysis results, entrepreneurship education remains largely theoretical, with limited incorporation of digital tools. Although existing curricular frameworks officially support experiential learning, including opportunity discovery, creative problem-solving, and strategic venture planning, these ideas are frequently applied in the classroom without sufficient connection to real-world contexts. Moreover, there is an evident digital paradox: although they are digital natives, students find it difficult to transfer their daily digital routines into practical skills, particularly when conducting data-driven market analyses and objectively validating business ideas.

4.5.2. Design Phase

In the design phase, the pedagogical and structural architecture of the M-IBL model was codified. The model is organized into five successive pedagogical phases: problem orientation in digital business, inquiry question formulation, exploration of market data using mobile assistance, development of an entrepreneurial solution, and critical reflection and validation of an idea. In parallel, instructional artifacts such as semester syllabi (RPS, which stands for a Semester Learning Plan), modular content, digital activity sheets, and customized evaluation rubrics were created. In order to achieve holistic competency gains, a multidimensional performance evaluation system was developed to assess the cognitive, behavioral, and affective dimensions of entrepreneurship.

4.5.3. Development Phase

The production stage involved the creation of an M-IBL prototype that was empirically tested and validated (Draft II). The model was appraised by a panel of experts in instructional design, entrepreneurship education, and educational technology, yielding strong indices of content and construct validity (Aiken's V > 0.80) across the theoretical framework, instructional syntax, learning media, and assessment tools. Based on the experts' feedback, the instructional guides, assessment rubrics, and mobile interface features were revised several times to enhance the model's pedagogical rigor, structural integrity, and practical viability.

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4.5.4. Implementation Phase

The high practical feasibility of the M-IBL model in the classroom setting was confirmed by the preliminary results of the small-scale trial. Feedback reports were highly positive, and there was general praise for the platform's accessibility, the interactive nature of the inquiry tasks, and the realistic correlation between curricular content and real-world business dynamics. In the full-scale field implementation that followed, comparative analyses indicated statistically significant improvements in students' entrepreneurial competencies, as reflected in post-test performance that was far above baseline pre-test levels.

4.5.5. Evaluation Phase

The overall evaluation results support the validity, feasibility, and pedagogical effectiveness of the M-IBL framework. User satisfaction was also found to be high, especially in terms of ease of access, instructional flexibility, and the relevance of authentic learning. Importantly, the model enhanced higher-order thinking skills, enabling students to navigate entrepreneurial problems with analytical rigor and innovative thinking. In addition to establishing instructional feasibility, the evaluation shows that the model has a twofold effect: enhancing the learning process and improving student competencies. The conceptual framework for the M-IBL model is represented in Figure 1.

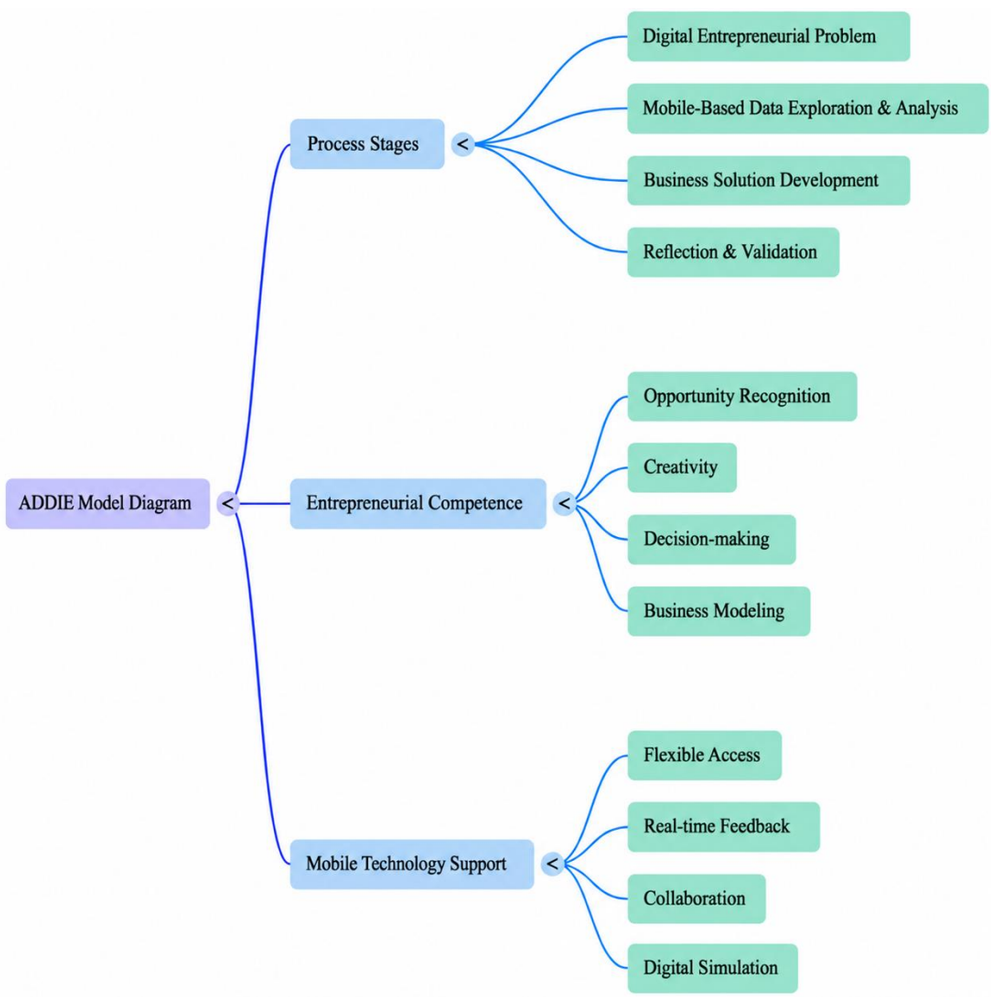


Figure 1. Conceptual framework of M-IBL model.

As shown in Figure 1, the conceptual framework demonstrates operational synergy between the inquiry-based learning approach and mobile technology affordances. The learning process follows a systematic process comprising five fundamental stages: contextual problem orientation, empirical investigation, mobile-assisted data synthesis, venture solution prototyping, and reflective validation. Through mobile integration, learners have uninterrupted access, seamless connectivity, and opportunities for real-time teamwork at every stage of the inquiry. Finally, this cross-disciplinary pedagogical space offers higher education learners an authentic, context-based platform for developing applied entrepreneurial skills.

5. Discussion

The results show that the M-IBL model meets three fundamental requirements of developmental research: validity, practicality, and effectiveness. Collectively, these standards illustrate that the model is conceptually and empirically sound.

The model is supported by the fact that, since its creation, it has received strong user feedback, with a 92% focus rate among lecturers and 93.33% among students. Specifically, its workflow, simple operational rules, and flexibility were highly praised by instructors in entrepreneurship courses. This flexibility is especially useful because overly complicated processes tend to hinder the implementation of new learning models. From the students' perspective, the model's practicality is so great that they are likely to become more engaged, collaborate more, and be more motivated to learn as a result of business investigation-based learning. This model offers a more context-oriented learning experience compared with traditional lecture-based learning. Pedagogically, these results confirm the

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assumption that models constructed on the basis of real-life, experiential learning are more easily accepted by students because they relate to what is needed in the workplace and in entrepreneurship. The assessments indicate that the M-IBL model can be characterized as highly practical by both lecturers and students. This score validates the model's viability and simplicity when applied to actual classroom settings. In the context of development research, practicality is used as a benchmark and functions by ensuring that an instructional design works in practice rather than merely in theory.

As an instructor, the model is attractive because of its smooth procedural flow, ease of use, and adaptability in integrating digital tools. These findings align with recent research indicating that entrepreneurship training produces more beneficial outcomes when teaching plans are open and flexible for teachers. The M-IBL model meets this need through a structured working plan.

On the student side, great practicality directly equals increased engagement and participation. The mobile based learning provides an interactive mode of learning as compared to the traditional mode, as it provides students with more freedom in the way they learn. This finding is consistent with the empirical research by Hardini, Khaizure, and Godwin (2024) that attributes the intention to use technology to greater student motivation and engagement. Furthermore, the mobile framework is appropriate to the natural dispositions of digital natives since it offers dynamic, customized access to course materials. Since, according to Hammoda (2024), integrating technology into entrepreneurship classes enhances learner interaction and prepares them to work in the digital age, it follows that this will help students excel in their studies and become more employable. After all, the exceptionally high level of practicality of the model is an indication of a successful transition between the main pedagogical needs and digital progress.

The M-IBL model has a high conceptual and structural quality score of 86.66%, indicating that all the main critical elements are represented, such as learning syntax, social systems, reaction principles, and support mechanisms. This positive evaluation demonstrates a close relationship between learning objectives, activities, and evaluation procedures. This coherence directly applies constructivist values, through which students develop practical knowledge by addressing real-life business project tasks.

The feedback provided by the validators also shed light on how the phased structure encourages active and reflective inquiry, which is a fundamental criterion of contemporary instructional innovation in higher education. In general, the results indicate that the model meets the criteria for content and construct validity, demonstrating that it reflects the needs of the curriculum at both the theoretical and operational levels. The development of the model using the R&D model of ADDIE provided this balance, resulting in an instructional tool based on sound theory and prepared for systematic classroom use.

The validity of M-IBL model theoretically supports the importance of constructivist and inquiry-based approaches to entrepreneurship education. Students do not take information passively, but they engage in building knowledge through exploring and thinking about real business issues. This emphasis aligns with the general trends in research: experiential, problem-based approaches continue to be the foundations of entrepreneurship programs due to developing both critical and innovative thinking (Sari, Muchlas, & Wisnujati, 2025). Consequently, the syntactic structure of M-IBL bridges helps prevent the gap between theoretical and practical needs of modern-day learning.

These high validity marks also indicate good instructional coherence in learning activities, media and assessment techniques. The model does not consider the mobile technology as a superficial addition, but it entails the digital tools that were incorporated in the learning process. This structural option is consistent with the results provided by Hammoda (2024), who has noted that pedagogically integrated educational technology can contribute to the quality of designs and their relevance to instruction. Finally, the findings prove that M-IBL follows the main principles of sound, technology-enhanced instructional design.

In addition to its technical viability, the proven M-IBL model has a clear theoretical impact on the education of digital entrepreneurs. The combination of inquiry-based principles and mobile learning will broaden current instructional models and provide an approach that is highly appropriate for technology-based curricula.

The paired-samples t-test and N-Gain evaluation indicate the empirical effectiveness of the model. The paired-samples t-test yielded a significance level of $p < 0.05$, demonstrating a statistically significant improvement in student performance. In particular, the mean score increased from 74.7885 to 90.9808, representing a 16.1923-point difference and indicating a statistically significant and practically meaningful improvement in educational outcomes.

To support these findings, the N-Gain score of 0.6589 indicates moderate improvement. A moderate gain indicates a significant learning impact in quality education, where entrepreneurship coursework needs to be analytical and applied at a high level of complexity. Exposure to real-life business issues helped students reinforce their conceptual knowledge and problem-solving abilities. Finally, the effects of the model go beyond test scores, promoting the critical, creative, and innovative thinking required for entrepreneurship at the university level.

The significant positive change in scores of students highlights the importance of integrating inquiry-driven learning with real-world field experience in developing entrepreneurial skills. This result is similar to those by Blankesteijn (2024), who conducted a study and found that experiential learning was one of the best approaches in entrepreneurship education because it provides a direct connection between theory and practice. This dynamic is supported by the M-IBL model that grounds classroom activity in real-world business problems.

An average N-Gain is a good measure of progress being made in a multifaceted topic such as entrepreneurship. According to Hammoda (2024), there is an unambiguous increase in competency development introduced through the integration of educational technology, although such gains might happen over time and be conditional. In this case, mobile learning is important as it allows exploring data in real-time, which makes student inquiries much more realistic. This type of digital integration cultivates creativity and innovation in generating business ideas (Shadiev, Yi, Dang, & Sintawati, 2022). Finally, the effectiveness of the model lies in combining active inquiry with mobile tools.

The ADDIE analysis at the diagnostic level identified that there was a long-standing discrepancy between the necessary entrepreneurial skills and the routine classroom practices. This contrast underscores the need to come up with a specific model in the first place. In theory, inquiry builds critical thinking and problem-solving skills, whereas mobile access allows the flexibility of situational learning. The result of this preliminary examination, then, provided

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a good guideline on how to create an M-IBL so that it would meet the needs of students today and adhere to the educational requirements of today.

The existing body of literature shows that inquiry learning is much more effective in strengthening critical thinking, creativity, and cognitive involvement than traditional teaching (Hmelo-Silver & Barrows, 2006); (Lazonder & Harmsen, 2016). At the same time, mobile learning offers high flexibility and accessibility, which promote contextualized, self-directed, and continuous learning (Crompton & Burke, 2018; Sung et al., 2016). A combination of inquiry strategies and mobile tools significantly increases higher-order cognitive skills and academic results, on the whole. As such, deriving the Mobile Inquiry-Based Learning (M-IBL) model is a viable solution to the long-standing disjuncture between the requirements in terms of the skills needed in the twenty-first century and the practice being carried out in the classroom.

The main advantage of the model is that it is a logical combination of the inquiry phases with the digital tools on an operational scheme, keeping the students active during the process. In theory, this system is based on constructivist ideas on active construction of knowledge and the theories of experiential learning which puts emphasis on a direct, hands-on approach.

Actively questioning, investigating and solving real issues, the learners are building up knowledge by engaging in direct action with the environment. Experiential learning reinforces this process by focusing on reflection on specific actions. There is a substantial amount of empirical evidence to support this integration; integrating inquiry with mobile technology can positively impact conceptual learning, enhance cognitive load, and improve analytical problem-solving (Becker, Klein, Gößling, & Kuhn, 2020). Moreover, the results of the meta-analysis prove that the development of mobile environments on the basis of social constructivist principles provides quantifiable benefits in terms of learning achievement and student engagement (Chang, Chang, & Shih, 2016). The combination of inquiry-based learning with mobile technology thus offers a conceptually solid, empirically based framework of active, experiential learning.

The results of the developmental assessment indicate that the research and development (R&D) strategy generates learning models characterized by theoretical depth and practical applicability in the field. R&D offers a systematic way to improve educational products by connecting needs assessment, design, and iterative testing. The use of existing models, such as ADDIE, will also make the resulting tools functionally adaptable and useful in real classrooms, supporting previous research that perceives R&D as a concrete and reliable means of creating valid and practical pedagogical innovations.

The quantifiable improvements in the students' business skills demonstrate the strengths of the M-IBL model, particularly its emphasis on experiential interaction and focused problem-solving. The model, based on experiential learning theory, allows students to transform tangible project experiences into practical knowledge. Such close interaction can be highly useful in entrepreneurship education by helping students recognize market opportunities and make rapid strategic decisions. Additionally, incorporating mobile devices provides learners with access to real-time information and promotes self-directed research. These mobile platforms do not merely deliver information passively; they facilitate collaboration, innovative thinking, and practical decision-making. In conclusion, the assessment establishes that integrating mobile-assisted inquiry into an ADDIE-based design approach is effective in creating a strong, practical framework for entrepreneurship education.

The combination of inquiry-based learning (IBL) and mobile technology within the ADDIE framework is based on sound pedagogical theory. In theory, such a strategy draws on the constructivist models of Piaget and Vygotsky, in which students actively construct knowledge by engaging in practical activities and collaboration, strengthening the role of inquiry-based approaches in developing analytical thinking skills. It also reflects Dewey's experiential approach to learning, as it places greater emphasis on active experience and reflection, two main elements of entrepreneurship education. Empirically, recent Scopus-indexed literature demonstrates that incorporating mobile devices into inquiry-based contexts leads to increased student engagement, greater contextualization of learning, and deeper conceptual understanding.

The ADDIE framework of instruction also supports this design through a systematic and iterative workflow development process. The empirical validity and overall instructional quality of the model are also directly improved by this organized method. Therefore, the combination of IBL, mobile technology, and ADDIE creates a rigorous, evidence-based foundation for building modern entrepreneurship programs.

6. Conclusion

To sum up, the developed Mobile Inquiry-Based Learning (M-IBL) model meets all three criteria of developmental research: validity, practicality, and effectiveness. Conceptually, its validity is enhanced by the fact that it has a coherent syntax based on constructivist principles and the intentional integration of mobile technologies. Practically, the model has been shown to be easy to use, receiving strongly positive feedback from lecturers and students alike. This confirms that the model is easy to implement and well accepted in real classroom situations. The model empirically improves entrepreneurial competencies, as reflected in substantial improvements in student learning outcomes and a medium-level N-gain score. Through the integration of inquiry-based approaches and mobile learning, M-IBL offers a genuine, experiential, and competency-focused model that directly addresses current issues in entrepreneurship education.

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