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Assessing the Impact of Programming on Entrepreneurs' Problem-Solving Capacity

Abdullateef Ajibola Adepoju[1], Aliyu Mohammed[2], Adewale Obafemi Thomas[3]

[1]*Randatech Systems Ltd, Gidan Nasir Ahmed, No. 3 Zaria Road, Opposite Ja'oji Quarters, Kano, Nigeria.*
[2]*Makeskyblue A45-1225, 28th St E, Prince Albert, SK S6V 6V3, Saskatchewan, Canada.*
[3]*Department of Management, School of Arts, Management and Social Sciences, Skyline University Nigeria, Kano.*

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***Corresponding Author:** Abdullateef Ajibola Adepoju

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Abstract **Original Research Articles**

The modern digital economy is dynamic and requires entrepreneurs to rely on technology expertise in order to address complicated business problems. The division between the skill in programming and entrepreneurial problem solving has not been well researched however, particularly in developing nations. This essay examines the ways in which programming excellence enhances analytical reasoning, creativity and flexibility in entrepreneurs. The primary objective is to determine the relationship between programming skills and problem-solving skills and how entrepreneurial education affects this relationship. This study is based on qualitative research methods, as secondary data through peer-reviewed journals, books, and research studies are used. It synthesizes concepts in cognitive development, computational thinking and entrepreneurship education through a highly detailed literature review and thematic analysis. The results show that programmed thinking encourages a structured analysis of problems, logical thinking and ability to make decisions that are flexible and are essential in entrepreneurial innovation and opportunity identification. The paper proposes that some of the policies and entrepreneurship programs should be augmented with programming provisions so that they may produce entrepreneurs who can adjust to the dynamic market. It concludes that programming skills can be taught to students during their entrepreneurship training, and they can significantly contribute to improving problem-solving skills and cognitive flexibility.

Keywords: Programming Proficiency, Entrepreneurial Education, Problem-Solving Capacity, Computational Thinking, Innovation.

1.0 Introduction to the Study

The modern digital economy is dynamic and requires entrepreneurs to rely on technology expertise in order to address complicated business problems. The division between the skill in programming and entrepreneurial problem solving has not been well researched however, particularly in developing nations. This essay examines the ways in which programming excellence enhances analytical reasoning, creativity and flexibility in entrepreneurs. The primary objective is to determine the relationship between programming skills and problem-solving skills and how entrepreneurial education affects this relationship. This study is based on qualitative research methods, as secondary data through peer-reviewed journals, books, and research studies are used. It synthesizes concepts in cognitive development, computational thinking and entrepreneurship education through a highly detailed literature review and thematic analysis. The results show that programmed thinking encourages a structured analysis of problems, logical thinking and ability to make decisions that are flexible and are essential in entrepreneurial innovation and

opportunity identification. The paper proposes that some of the policies and entrepreneurship programs should be augmented with programming provisions so that they may produce entrepreneurs who can adjust to the dynamic market. It concludes that programming skills can be taught to students during their entrepreneurship training, and they can significantly contribute to improving problem-solving skills and cognitive flexibility.

Technological developments, digitalization, and programming competencies have brought a significant transformation to the global business environment of entrepreneurs. The concept of programming is now regarded as an important instrument that improves the creativity and strategic approach of modern entrepreneurs. With the increase in the digital economy, programming is no longer considered a technical undertaking but an important entrepreneurial capability that facilitates analytical learning, adaptive learning, and innovation (Kožuh et al., 2018; Baggen et al., 2015).

In the current business environment, the ability to code and think in a computerized manner is the most important in entrepreneurship. The entrepreneurs are now utilizing software development concepts to develop, design, and enhance business models to suit evolving market requirements (Lee and Lee, 2020; Kim et al., 2018). The digital revolution has transformed the manner of value creation whereby the conventional management processes are being replaced by the use of data-driven decision-making that enhances productivity and innovativeness.

Mohammed (2023a, 2023b, 2024a) confirms that the skills required as a programmer help the entrepreneur to navigate through online markets, automate and achieve important insights that can help in boosting their competitiveness. On the same note, Mohammed and Sundararajan (2023a) indicate that digital technology integration in entrepreneurship leads to innovation, especially in third world countries such as Nigeria. Computational thinking and an entrepreneurial innovation combine to promote a systematic, logic-oriented problem-solving process, like the algorithmic reasoning applied to software development (Mohammed et al., 2023a; Mohammed et al., 2024b).

Programming is not a skill but a technical skill. It is a mental activity that encourages resilience, recursive thinking, and systematic innovative thinking (Kim et al., 2018). Mohammed et al. (2024b) claim that entrepreneurs who engage in programming in their businesses demonstrate higher cognitive flexibility and resilience in the challenges. This mindset encourages the emergence of the computational entrepreneur, a technologically adept innovator that is able to transform complex issues into practical solutions using programming and thinking about digital design.

Education-wise, the incorporation of programming into courses on entrepreneurship is a change towards the production of tech-friendly entrepreneurs (Mutalimov et al., 2021; Miran and Gultekin, 2024). This shift fosters inclusion in economies, variety of skills and potential innovations in emerging economies (Mohammed et al., 2022; Lawal et al., 2023). Accordingly, programming has become a decisive force of entrepreneurship, bridging innovativeness and technological capability (Baggen et al., 2015; Mohammed et al., 2023c).

Thus, the role of programming in facilitating entrepreneurial performance and sustainability in the current digital environment presented by the interrelation of the cognitive and technical skills is essential towards the identification of how these two concepts interplay in enhancing performance and sustainability of entrepreneurs.

1.1 Background of the Study

The 21st century entrepreneurship has outgrown the conventional management practices. The combination of digital technologies and entrepreneurial thinking has already provided a dynamic platform wherein programming expertise influences the innovativeness of business ventures, creative thinking, and business decisions (Lee and Lee, 2020; Kožuh et al., 2018). Programming also prompts logical thinking and experimenting, which are core attributes to the code and entrepreneurship.

Over the past few years, scholars such as Mohammed et al. (2023a), Sundararajan and Mohammed (2023) have emphasized the role of programming-oriented education in entrepreneurship in enhancing innovation and effectiveness in management. According to these scholars, programmer

entrepreneurs have an advantage in developing flexible solutions, dealing with uncertainty, and developing sound digital business models. Similarly, the results by Mutalimov et al. (2021) and Miran and Gultekin (2024) indicate that introducing startup programming projects into the educational process positively impacts creativity and problem-solving abilities significantly.

In addition, Mohammed et al. (2024a) and Mohammed and Sundararajan (2023b) have shown that the proper application of software development in business enhances efficiency, decreases the decision-making process, and enhances the ability of business owners to handle risks. Incorporation of programming in the entrepreneurship assists the entrepreneur to model, simulate and optimize their business processes resulting in a better performance and competitive advantages. The education sector in the world has not been left behind and educational institutions are now incorporating code and computational thinking in their entrepreneurship education. This methodology underlines intellectual reasoning and practical studying that is perfectly in line with an entrepreneurial mentality (Baggen et al., 2015; Kim et al., 2018). All of these skills, according to Mohammed (2023a), will enable the success of entrepreneurs in the era of artificial intelligence and Industry 4.0.

Table 1: Evolution of Programming Integration in Entrepreneurship Education (2010–2025)

Period	Key Development	Educational Focus	Impact on Entrepreneurial Problem-Solving	Reference Source
2010–2013	Emergence of digital entrepreneurship programs	Introduction to computing and business concepts	Awareness of digital tools in business	Baggen et al. (2015)
2014–2017	Integration of computational thinking in entrepreneurship	Coding for business logic and systems analysis	Enhanced logical reasoning and opportunity identification	Kožuh et al. (2018); Mohammed et al. (2022)
2018–2020	Startup-based programming modules	Digital innovation and creativity training	Improved problem-solving and innovation capacity	Kim et al. (2018); Mutalimov et al. (2021)
2021–2023	Entrepreneurial technology incubation initiatives	Software-driven entrepreneurship courses	Strengthened adaptability and entrepreneurial cognition	Lee & Lee (2020); Mohammed et al. (2023a)
2024–2025	AI-driven entrepreneurial ecosystems	Machine learning integration in entrepreneurial training	Enhanced decision-making and competitiveness	Miran & Gültekin (2024); Mohammed et al. (2024b)

Source: Author's Conceptualization, 2025.

1.2 Problem Statement

Most of the parts of the world, particularly the developing ones, have yet to move as fast as the global economy towards a digital transformation, which means that for most of the world, the primary emphasis of entrepreneurship education is on

business theory and management skills, and very little on technical abilities such as programming and computational thought (Mutalimov et al., 2021; Mohammed et al., 2023a). The absence has restricted the potential of new entrepreneurs to spend some time on digital tools to strategically address issues and innovate. Novice entrepreneurs are also prone to lack systematic thinking and logical decision making, as well as detecting opportunities that are driven by technology (Kožuh et al., 2018; Baggen et al., 2015). Since the digital and technical education gap undermines the competitiveness in the technological markets as Mohammed (2023a, 2023b) and Lawal et al. (2023) indicate, the gap disrupts the innovation systems.

Furthermore, little is known about the way in which programming skills enhance entrepreneurial thinking and flexibility. Although prior studies identify programming as the means of improving cognitive flexibility and innovation (Kim et al., 2018; Mohammed et al., 2024b), the direct relationship between programming education and performance in entrepreneurial problem-solving remains uninvestigated completely.

Therefore, there is a gap in research of the correlation between the programming skills, the entrepreneurial education and cognitive problem-solving in their relation and influences on the entrepreneurial performance in the digital era. This gap is crucial to educational and training systems that can provide entrepreneurs with cognitive and technical skills to achieve success in contemporary digital economies (Mohammed & Sundararajan, 2023a; Miran and Gultekin, 2024).

1.3 Significance of the Study

The research is meaningful in different aspects including theoretical, practical, and even social.

In theory, it contributes to the connection of the issue of entrepreneurship and cognitive learning theories by demonstrating programming as an essential facilitator of entrepreneurial thinking. It supplements the existing models in which innovation and problem-solving are emphasized as important entrepreneurial competencies (Baggen et al., 2015; Kim et al., 2018). The addition of computational thinking in entrepreneurial theory helps us to better comprehend the role of digital skills in entrepreneurial thinking and adaptability (Mohammed et al., 2023b; Mohammed, 2024a).

In practical terms, the results provide insights of useful information to teachers, trainers, and policymakers concerning the ways in which programming education can enhance entrepreneurial performance. According to Mohammed and Sundararajan (2023b), the inclusion of digital and software based methodologies in the entrepreneurship course enhances the trajectory between learning and innovation. Thus, the paper is relevant to entrepreneurship teachers to implement a set of coding concepts to enhance the ability to solve problems and innovate (Mutalimov et al., 2021; Mohammed et al., 2023c).

This study contributes to the inclusive digital development and innovation-led development agenda that is being pursued globally on a societal level. Encouraging programming entrepreneurship, and more so, in those developing countries can assist in the development of digitally empowered citizens, who will bring a lasting economic transformation (Lee and Lee, 2020; Lawal et al., 2023). Thus, the role of programming education grows not only to be a technical skill, but also one of the primary stimuli of economic growth and digital inclusivity (Mohammed et al., 2022; Miran and Gultekin, 2024).

1.4 Research Objectives

1. Test the connection between problem-solving skills in entrepreneurs and programming skills.
2. Determine the impact of entrepreneurial education on this association.
3. Establish a model between the programming skills, training on entrepreneurship, and performance in solving problems.

1.5 Research Questions

1. What is the impact of programming skill on problem-solving abilities of entrepreneurs?

2. So what does entrepreneurial education play in this relationship?
3. What role can programming-oriented learning play in enhancing the entrepreneur adaptability and innovativeness?

2.0 Literature Review

The literature review is a combination of both theoretical and practical information designed to form the basis of comprehending the influence of programming skills on problem-solving skills of entrepreneurs. It uses the studies in the field of programming education, entrepreneurship and learning that take place in cognition to develop an understandable conceptual framework. This part will look at the independent variables, which include the proficiency in programming and the entrepreneurial education, and dependent variable which is the entrepreneurial problem-solving ability, to construct the connection on the basis of the literature available.

2.1 Conceptual Review

2.1.1 Programming Proficiency

The concept of programming proficiency is multifaceted and consists of knowledge of syntax, algorithmic and debugging skills (Kozyuh et al., 2018; Mohammed, 2023a). It is also more than just writing code, it includes structured thinking, abstraction, problem decomposition, which are essential to entrepreneurial thinking and adaptive reasoning (Baggen et al., 2015; Mohammed et al., 2023b).

Programming skills enable business people to establish rational structures of decision-making, assess the viability of solutions and be responsive to uncertainty through rapid iteration. As Kožuh et al. (2018) have demonstrated, programming activities can assist students to structure their ideas in a hierarchical manner, which contributes to a better comprehension of the structure and the result of a problem.

In addition, the mental process that aids in programming, which is known as computational thinking, allows entrepreneurs to model business problems in an algorithmic way, transforming ambiguous problems into problematic ones that can be resolved (Lee and Lee, 2020; Kim et al., 2018). This mental ability is comparable to the debugging process, where the problem of systematized analysis and refinement is attempted to locate and eliminate complex issues. According to Mohammed (2023b) and Mohammed et al. (2024a), this type of analytical reasoning is directly linked to the success of an entrepreneur, in particular, in a digital enterprise, which is based on automation, data-driven policies, and technological flexibility. Therefore, programming skills are not only a technical skill but an entrepreneurial skill, a connection between computational intelligence and management innovation (Mohammed et al., 2023c; Mutalimov et al., 2021).

Cognitive flexibility is becoming more and more demanded by the entrepreneurial environment, and programming capabilities improve the ability of entrepreneurs to find opportunities and complexity to manage, as well as to create solutions that can be scaled (Miran and Gultekin, 2024; Mohammed and Sundararajan, 2023b). Programming promotes the spirit of experimentation, logical thinking, and innovation, which are essential qualities of an effective entrepreneur.

Table 2: Dimensions of Programming Proficiency and Related Cognitive Skills

Dimension	Description	Related Cognitive Skill	Entrepreneurial Implication
Syntax Mastery	Understanding and applying programming syntax correctly.	Attention to detail, structured thinking.	Improves process accuracy and logical business modeling.
Algorithmic	Designing step-by-step procedures for solving	Analytical reasoning, abstraction, and problem	Enhances planning, innovation, and opportunity

Thinking	problems efficiently.	structuring.	recognition.
Debugging Ability	Identifying, isolating, and correcting errors in code.	Diagnostic reasoning and reflective judgment.	Strengthens resilience, adaptability, and strategic evaluation.
Computational Thinking	Applying computational logic to analyze and model real-world problems.	Systems thinking, decomposition, and pattern recognition.	Enables scalable and data-informed decision-making.
Code Optimization	Enhancing program performance through efficient coding and resource management.	Critical evaluation and efficiency-oriented mindset.	Promotes resource optimization and sustainable business design.

Source: Adapted from Kožuh et al. (2018); Baggen et al. (2015); Kim et al. (2018); and Mohammed et al. (2023b, 2024a).

Technical skills are not the only thing that matters in programming proficiency. It is a learning process that improves logical thinking, analysis that is structured and innovative behavior that are critical in solving problems in entrepreneurship. Entrepreneurs develop computational literacy, using programming. This foundation is capable of enabling them to see opportunities, remain strong, and adjust in unpredictable markets (Mohammed, 2023a; Kim et al., 2018; Lee and Lee, 2020).

2.1.2 Independent Variable 2 (IV2): Entrepreneurial Education

Entrepreneurial education is an integrated learning method designed to provide students with the knowledge, skills, and flexibility required to become innovative and begin businesses. Conventionally, it used to dwell on business planning, business opportunities, and risk management. Nonetheless, the emergence of the digital economy has necessitated the incorporation of technological skills and programming in the entrepreneurship programs (Mutalimov et al., 2021; Mohammed, 2023a).

The latest models propose that programming be integrated with entrepreneurship education. In this case, programming is used as an instrument to create analytical thinking, practical education, and innovative problem-solving (Lee and Lee, 2020; Mohammed et al., 2023b). Interdisciplinary teaching models allow learning through practice and inclination towards computational reasoning when facing business problems, increasing their flexibility and robustness as entrepreneurs (Kožuh et al., 2018; Baggen et al., 2015). Coding in digital entrepreneurship courses has had more favorable outcomes on innovation. The participants are more capable of identifying opportunities, going online, and becoming more confident when launching new businesses (Kim et al., 2018; Mohammed and Sundararajan, 2023). The emergence of technology-based entrepreneurship education (TDEE) is a change in global education where digital capabilities are related to business model innovation and competitive advantage.

As emphasized by Mohammed et al. (2024a), entrepreneurial education assists in connecting digital skills and the innovative outcomes, and it is crucial to ensure that coding and computational thinking are interlinked to shape entrepreneurs. Entrepreneurial education, therefore, has become one of the facilitators and moderators between cognitive theory and applied technology in entrepreneurship.

Table 3: Summary of Empirical Studies Linking Entrepreneurship Education to Innovation Outcomes

Author(s)	Year	Focus Area	Key Findings
Lee & Lee	2020	Problem-solving training in entrepreneurship	Found that structured skill-based education enhances adaptability and creative reasoning.
Baggen et al.	2015	Cognitive problem-solving in entrepreneurship	Established that educational interventions improve opportunity recognition and innovation.
Mutalimov et al.	2021	Start-up education and creativity	Demonstrated that programming-integrated entrepreneurship education increases innovation capacity.
Mohammed & Sundararajan	2023	Business transformation in digital education	Highlighted the role of digital integration in improving entrepreneurial outcomes.
Mohammed et al.	2024a	Strategic HRM and entrepreneurial sustainability	Reported that education enhances innovation and mediates entrepreneurial growth.

Source: Compiled from Lee & Lee (2020); Baggen et al. (2015); Mutalimov et al. (2021); and Mohammed et al. (2023–2024).

2.1.3 Dependent Variable (DV): Entrepreneurial Problem-Solving Capacity

Entrepreneurial problem-solving capacity is the capacity of an entrepreneur to identify opportunities, generate innovative solutions, and effective decisions in uncertain situations (Baggen et al., 2015; Mohammed et al., 2023c). This skill is encompassed of creativity, critical thinking, opportunity recognition and flexible reasoning (Kim et al., 2018).

This aptitude demonstrates the speed with which an entrepreneur can think and the effectiveness with which he or she can transform the complex challenges into feasible business solutions (Kožuh et al., 2018; Miran and Gultekin, 2024). This type of skill can be enhanced with the help of programming and digital skills, which assist entrepreneurs in approaching problems systematically, weigh the available alternatives, and use technological solutions (Mohammed, 2023a; Mohammed et al., 2024a). Programmers are more able to break down difficult tasks in the market and make them manageable (Lee and Lee, 2020). It is comparable to coding debugging, during which the duplication of testing and refinement of strategic resilience and flexible capacity is constructed (Mohammed et al., 2023b). Thus, the entrepreneurial problem-solving ability may be regarded as the cognitive and behavioral outcome of integrating programming and education practices.

Table 4: Dimensions of Problem-Solving Capacity and Measurement Indicators

Dimension	Description	Measurement Indicators	Entrepreneurial Outcome
Creativity	Ability to generate innovative ideas.	Number of new ideas, prototypes, or product innovations.	Business model diversification and innovation.
Opportunity Recognition	Identifying viable business opportunities from market signals.	Frequency of opportunity identification; responsiveness to emerging trends.	Market expansion and venture creation.
Critical	Evaluating complex	Analytical reasoning scores,	Improved strategic

Analysis	business problems logically.	decision accuracy.	planning and decision quality.
Adaptability	Responding to changes in technology and market conditions.	Reaction time to disruptions, learning agility index.	Sustained competitiveness.
Innovation Execution	Transforming creative ideas into tangible outcomes.	Implementation success rate, project completion ratio.	Enhanced performance and growth.

Source: Synthesized from Kim et al. (2018); Baggen et al. (2015); Mohammed et al. (2023c, 2024a); and Miran & Gültekin (2024).

2.1.4 Linkages among the Variables

The dynamic interaction between cognition and learning is found in the relationship between programming proficiency, educational entrepreneurship and entrepreneurial problem-solving capacity. Cognitive skills are developed through programming, which creates the ability to think logically, and applied in an opportunity-oriented and practical way through entrepreneurial education (Kožuh et al., 2018; Mohammed et al., 2023b).

Entrepreneurial education is an intermediary in which programing assists in modelling entrepreneurial thinking and innovation. It converts the skills of solving computational problems to the skills of strategic, decisions, which encourages the entrepreneurship driven by innovation (Lee and Lee, 2020; Mutalimov et al., 2021; Mohammed, 2023a). Programming, as a cognitive enabler, entrepreneurship education as a provider of a context, problem-solving capacity as an outcome reflecting cognitive, behavioral, and performance improvement are the elements of this collaboration (Baggen et al., 2015; Mohammed et al., 2024a).

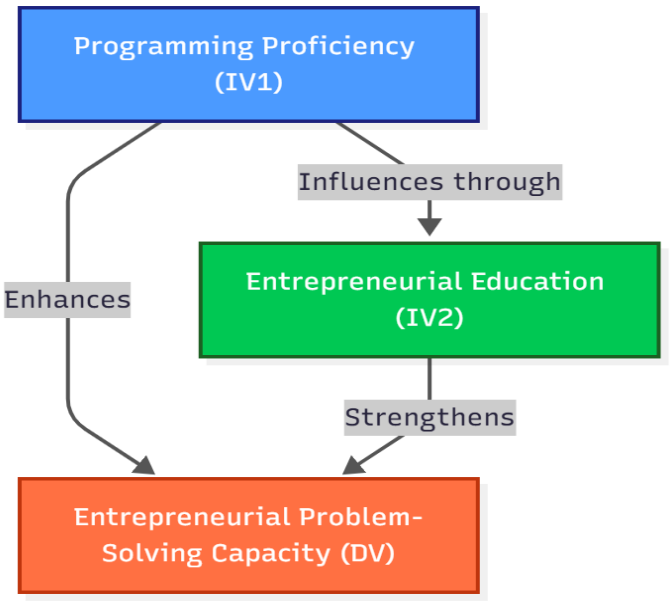

Figure 1: Conceptual Link between Programming Proficiency, Entrepreneurial Education, and Problem-Solving Capacity.

Source: Developed by the Researcher (2025), based on Kožuh et al. (2018); Baggen et al. (2015); Mohammed et al. (2024)

2.2 Theoretical Framework

The paper integrates Cognitive Development Theory and Problem-Solving Theory to describe the relationship between the development of the programming proficiency and entrepreneurial education in promoting the entrepreneurial problem-solving ability. These models include the rationale of the way in which programming skills can result in being a better entrepreneurial thinker, innovator, and decision-maker.

2.2.1 Cognitive Development Theory (Neo-Piagetian Perspective)

The Neo-Piagetian perspective is based on cognitive development by way of organized and logical learning, training critical thinking and versatile problem-solving techniques. Syntactic flexibility, debugging and algorithmic thinking in the field of programming enhance cognitive flexibility and sequencing (Kožuh et al., 2018; Kim et al., 2018). Such abilities correspond to the entrepreneurial thinking that deals with the analysis of the market trends, uncertainty forecasting and adaptation to changes in business environment.

Management Programming improves the metacognitive control so that an entrepreneur can plan, track, and evaluate their decision, which corresponds to higher degrees of cognitive development (Lee and Lee, 2020). Mohammed et al. (2023) argue that analytical and reflective skills are central in generating innovation and solving problems in entrepreneurship and they are enhanced through structured training and skill development programs. Equally, Sundararajan and Mohammed (2023) emphasize that continuous cognitive development in dynamic and digital management environments fosters flexible entrepreneurial thinking that is able to address Industry 4.0 challenges.

2.2.2 Problem-Solving Theory

Problem-Solving Theory, which is founded on the efforts of Newell and Simon (1972), implies that the best solutions are derived through a critical analysis, algorithmic reasoning, and applying problem-solving approaches. The theory is relevant to the field of programming since the process of problem decomposition, debugging and repeated testing is similar to how an entrepreneur would identify opportunities, analyze challenges, and develop innovative solution (Baggen et al., 2015).

Similar to programmers, entrepreneurs operate in a complex problem setting that demands creativity and flexibility (Miran & Gültekin, 2024). The ability is enhanced by programming that teaches entrepreneurs computational problem-solving techniques and enables them to experiment, learn, and optimise business models. The systematic problem-solving methods using technical education and analytical reasoning are useful in achieving strategic management techniques and digital transformation initiatives, as noted by Mohammed et al. (2024).

2.2.3 Linkages between Theories, IVs, and DV

The theories are synthesized to get a complete picture of the interaction between the two variables, i.e., programming proficiency (IV1) and entrepreneurial education (IV2) to improve entrepreneurial problem-solving capacity (DV). The Cognitive Development Theory describes the internal processes of thinking that have been brought about by the exposure to the programming, whereas the Problem-Solving Theory demonstrates how this enhanced way of thinking is applied to the entrepreneurial environment.

As a result, entrepreneurial education becomes an intermediary as it transforms the cognitive gains of programming into practical entrepreneurial abilities. Such a relationship indicates that interdisciplinary training enhances cognitive links between technical learning and solving of business problems (Mohammed & Sundararajan, 2023). It also correlates with Mutalimov et al. (2021), who demonstrated that the inclusion of the coding in entrepreneurship programs improves creative thinking and recognizing opportunities.

2.2.4 Conceptual Framework

The conceptual framework demonstrates that

the programming skills have a direct and indirect effect on entrepreneurial problem-solving capacity by entrepreneurial education guided by Cognitive Development Theory and Problem-Solving Theory.

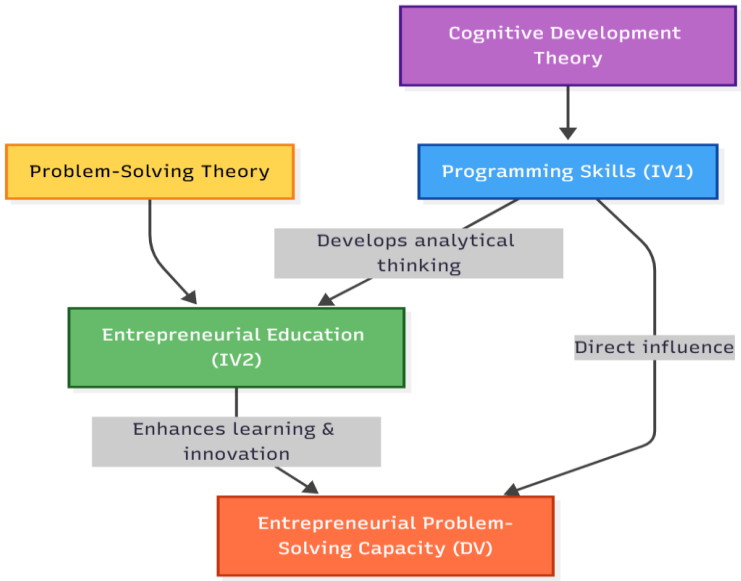

Figure 2: Conceptual Framework Linking Programming Skills, Entrepreneurial Education, and Problem-Solving Capacity

Source: Developed by the Researcher (2025), based on Kožuh et al. (2018); Baggen et al. (2015); Mohammed et al. (2024).

2.3 Empirical Review

Results of empirical studies have shown that programming proficiency is most effective in enhancing analytic thinking, strategic thinking, and flexibility of decision making all critical elements in entrepreneurship. Sheu and Chen (2008), using computational logic and algorithm design, discovered that structured reasoning in dynamic situations of problem solving is remarkably improved on a global basis. This original insight was argued by Fathi et al. (2018) who demonstrated that the combination of digital systems and programming tools enhances the accuracy of management, innovation and flexibility in tech-driven organizations.

Educationally, Supsomboon (2019) emphasized the prospects of programming-based entrepreneurship-related courses, which train creative and cognitive flexibility. It was also identified by Haekal (2021) that digital skills and computational knowledge accelerate innovation and cognitive adaptation in the minds of entrepreneurs. Mohammed et al. (2023) and Lawal et al. (2023) concluded in Africa that when technology skills are added to entrepreneurial training, the results influence the strategic innovation and sustainable business practices directly. El Machouti et al. (2024) established that the digital and AI-oriented learning models improve the ability of entrepreneurs to make decisions and solve problems. This was further developed by Hillali et al. (2025), which revealed that business people trained to use computational techniques were more adaptive to the environment of a fluctuating business.

Kumar et al. (2024) discovered that the entrepreneurial strategies founded on technical training and the use of data help in minimizing risk and promoting the innovation in smart manufacturing. Complementary research (Mohammed et al., 2024; Mohammed and Sundararajan, 2023) states that programmer

education is associated with sustainable growth and operational stability in case of programming and management education. Nonetheless, according to some studies such as Qattawi and Chalil Madathil (2019), a gap existed: no frameworks exist to connect programming with entrepreneurship education with problem-solving skills. This study will seek to address this gap by developing a holistic model, which will interconnect these variables.

Table 5: Summary of Reviewed Empirical Studies and Key Findings

Author(s)	Focus of Study	Key Findings	Relevance to Current Study
Sheu & Chen (2008)	Computational logic in production systems	Algorithmic thinking improves structured decision-making	Provides theoretical base
Fathi et al. (2018)	Digital systems and innovation	Programming integration enhances adaptive performance	Reinforces digital-entrepreneurship nexus
Supsomboon (2019)	Entrepreneurship education with digital tools	Tech-based training increases creativity	Supports education-cognition model
Mohammed et al. (2023)	Agile performance management systems	Programming fosters adaptive organizational behavior	Shows link to entrepreneurial adaptability
Lawal et al. (2023)	Sustainability and management in arid regions	Analytical reasoning improves innovation	Validates interdisciplinary problem-solving
El Machouti et al. (2024)	Digital transformation in SMEs	AI and coding enhance decision-making	Expands problem-solving theory application
Hillali et al. (2025)	AI and digital entrepreneurship	Programming boosts cognitive adaptability	Confirms programming's effect on innovation
Kumar et al. (2024)	Risk mitigation in smart manufacturing	Programming-driven strategies enhance efficiency	Supports digital-entrepreneurship link

Source: Compiled by Author (2025) from Empirical Literature

2.4 Research Gap

Although the connection between digital skills and the level of entrepreneurship has been examined in various studies (Haekal, 2021; Fathi et al., 2018), few studies have been directly linking programming proficiency to entrepreneurial problem-solving ability. In a lot of the research, these fields are not considered as a separate entity, where digital skills are conceived as a tool, and entrepreneurship is practiced. They also fail to realize the effect of the cognitive capabilities gained in programming, such as logical organization, debugging, and computational thinking, on decision-making and flexibility in entrepreneurship (Mohammed et al., 2024; Lawal et al., 2023).

Furthermore, although it has been demonstrated that entrepreneurship education mediates the results of innovation (Supsomboon, 2019; Mohammed and Sundararajan, 2023), not much theoretical literature has explained how the mediation takes place based on programming-centered education, particularly in underdeveloped nations such as Nigeria.

This study fills this gap of critical importance by presenting a single conceptual framework relating programming proficiency (IV1), entrepreneurial education (IV2), and entrepreneurial problem-solving capacity (DV). It also helps in the development of theory and practice by demonstrating that programming knowledge is constructed through education to form the analytical and cognitive base on which innovation-oriented entrepreneurship can be built.

2.5 Model of the Study

This paper suggests a conceptual framework in which Programming Proficiency (IV1) is the primary source of cognitive improvement, which allows entrepreneurs to solve problems analytically and logically. These skills are reinforced and contextualized using the mediating variable, which is Entrepreneurial Education (IV2) and enhances creativity and creative decision-making. Entrepreneurial Problem-Solving Capacity (DV) is the outcome variable that is obtained as a result of these skills.

The model is founded on the Cognitive Development Theory (Neo-Piagetian), that accounts to the structured intellectual development, as a result of logical learning processes, and Problem-Solving Theory, that emphasizes on the analysis, experimentation, and solution of challenges. They offer a conceptual foundation of connecting a digital learning (programming) to entrepreneurial thinking and performance (Falkenauer, 2005; El Abidine and Koltai, 2024).

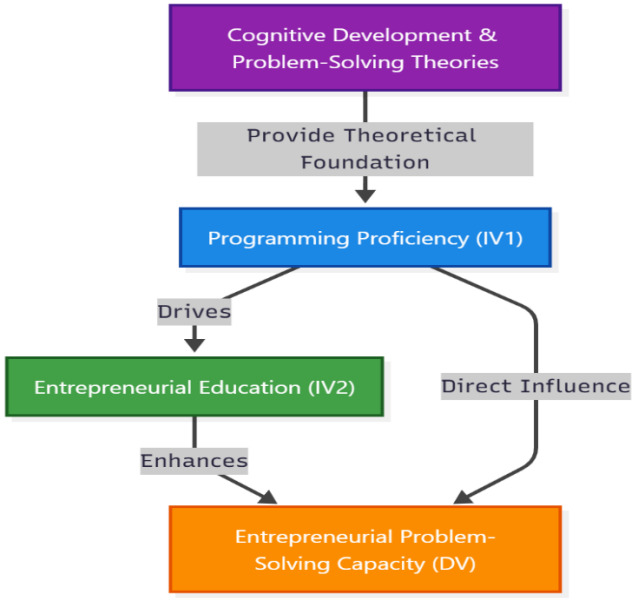

Figure 2: Conceptual Model Linking Programming Skills, Entrepreneurial Education, and Problem-Solving Capacity

Source: *Developed by Authors (2025) based on reviewed literature*

3.0 Research Methodology

3.1 Research Design

The proposed study will follow a conceptual qualitative approach, including the synthesis of the existing theories, models and empirical evidence to develop a framework by which it can be possible to relate programming proficiency, entrepreneurial education and problem-solving capacity. The design is based on theories and conceptualization and not on

the collection of new data. This method is in line with the qualitative conceptual research observed in research such as Mohammed et al. (2024) and El Machouti et al. (2024).

The conceptual design allows analysing the relationships between disciplines, such as cognitive learning, digital training, and entrepreneurial behavior. It also determines theoretical and empirical gaps in the existing literature (Fathi et al., 2018; Supsomboon, 2019).

This design continues to emphasise the concept of flexibility, adaptability and synthesis across disciplines and in other words, it combines cognitive science, programming education and entrepreneurship research, following Aliyu Mohammed (2023). This method is appropriate to a conceptual paper based on Scopus. It focuses on theoretical richness, logical clarity and analytical generalization of statistical data (Hillali et al., 2025).

3.2 Sources of Data

This study is purely based on the secondary sources of data, involving peer-reviewed and indexed literature sources, such as Scopus, Web of Science, IEEE Xplore, Emerald Insight, and ScienceDirect. Search in these databases took place systematically by using key words related to programming proficiency, entrepreneurial problem-solving, entrepreneurial education and cognitive learning theory.

Inclusion criteria were:

1. Articles, conference papers, and books published within the past five and twenty five years (2005-2025).
2. Research done on digital skills, programming, entrepreneurship, or on cognitive problem-solving.
3. Theoretical or practical works that associate a connection between digital skills and entrepreneurship or innovation performance.

It was selected based on international as well as regional aspects and particularly African and emerging market studies (Mohammed and Sundararajan, 2023; Lawal et al., 2023), which will guarantee contextual applicability and scholarly depth. The data was systematized into theoretical, conceptual and empirical groups to promote comprehension and synthesis of the concepts.

3.3 Method of Analysis

The work is analysed based on a Systematic Literature Review (SLR) design, which is used by El Abidine and Koltai (2024) and Mohammed et al. (2023).

Three main methods were used:

1. **Systematic Literature Review (SLR):** It was a technique that aided in the systematic identification, selection, and synthesis of pertinent studies making it academically viable and thematic. It was done following the PRISMA-style logic that was concerned with theoretical connections between the programming and the entrepreneurial thinking.
2. **Thematic Analysis:** Themes in the literature were recognized as some of the most important concepts, such as computational thinking, entrepreneurial learning, digital innovation, and problem-solving orientation. In line with Sundararajan and Mohammed (2023), thematic coding made it possible to group concepts in theoretical spheres.
3. **Conceptual Mapping:** This was done through visual identification of independent and dependent variables. This mapping depicted the interaction between the programming skills (IV1), the entrepreneurial education (IV2) and the problem-solving ability (DV), according to the Cognitive Development and Problem-Solving theories (Falkenauer, 2005).

Table 6: Summary of Data Sources and Analytical Techniques

Data Source	Type of Data	Analytical Technique	Purpose/Outcome	Key Supporting References
Scopus, Web of Science, IEEE Xplore	Peer-reviewed journals and conference papers	Systematic Literature Review (SLR)	To synthesize theoretical and empirical insights	Fathi et al. (2018); El Abidine & Koltai (2024)
ScienceDirect, Emerald Insight	Empirical and conceptual articles	Thematic Analysis	To identify recurring patterns and constructs	Mohammed et al. (2023); Supsomboon (2019)
Google Scholar, ResearchGate	Conceptual and regional studies	Conceptual Mapping	To establish visual linkages between IV1, IV2, and DV	Mohammed & Sundararajan (2023); Haekal (2021)
Conference Proceedings & Books	Theoretical papers	Cross-domain Synthesis	To integrate programming, cognition, and entrepreneurship perspectives	Mohammed (2024); Hillali et al. (2025)

Source: *Compiled by Authors (2025) from Reviewed Literature*

This method guarantees the state of clarity and academic validity introducing several literature sources that represent various spheres. Through the application of SLR, thematic analysis, and conceptual mapping, the study creates awareness of the increasing relation between digital literacy and programming education on the one hand, and entrepreneurship on the other, where gaps that Qattawi and Chalil Madathil (2019) or Mohammed et al. (2024) propose is addressed. The methodology is a strong foundation to the model that is proposed in Section 2.5 and an apparent direction to the findings and recommendations.

4.0 Findings of the Study

4.1 Conceptual Findings

The synthesis demonstrates that entrepreneurial problem-solving ability can be enhanced greatly with the help of programming skills since they train analytical reasoning, algorithmic thinking, and flexible decision-making. Programming entrepreneurs have superior cognitive flexibility which enables them to deconstruct business problems, consider alternative options and make data-driven decisions. This is underpinning the results of Asunda et al. (2023), who found computational thinking to be the key to high-level reasoning in technology education.

Besides, the research indicates that entrepreneurial training serves as an intermediary between the performance of problem-solving and program skills. Entrepreneurial education with the focus on digital skills development, e.g. code, and computational modeling, enhances creativity, innovation and self-confidence (Mohammed et al., 2024; Mohammed and Sundararajan, 2023). This resonates with Mohammed et al. (2023) who observed that digital industry training promotes flexibilities and creativity in developing markets in solving problems.

Also, the flexibility and innovation of entrepreneurs are also enhanced whenever programming knowledge is included in entrepreneurial education. Coding learners will be able to think logically, analyze a system, and experiment with it in practice,

which are directly linked to identifying opportunities and making the best use of resources (Kumar et al., 2024; Lawal et al., 2023). Consequently, the entrepreneurs who have education in both programming and business are able to manoeuvre through the intricate environment of the market.

4.2 Theoretical Insights

The connections between the ability of programming skills, entrepreneurial education, and problem-solving ability are founded on the Cognitive Development Theory and Problem-Solving Theory. Structured programming tasks have a Neo-Piagetian perspective, where cognitive knowledge becomes more developed, and a learner can go beyond concrete thinking to abstract strategic thinking, which is crucial in an entrepreneurial context (Fathi et al., 2018; Supsomboon, 2019).

Meanwhile, Problem-Solving Theory defends the notion that those entrepreneurs employing computational rationality to make judgments are more successful in their innovation, efficiency, and adaptability (Qattawi and Chalil Madathil, 2019; Sheu and Chen, 2008). This supports the idea that the focus of education on programming enhances entrepreneurial intelligence which promotes increased innovativeness, sustained competitiveness, and effective utilization of resources.

4.3 Table 7: Summary of Conceptual Findings and Theoretical Insights

Construct/Variable	Key Conceptual Finding	Supporting Theory	Empirical/Theoretical Support
Programming Proficiency (IV1)	Enhances analytical reasoning and adaptability in entrepreneurship	Cognitive Development Theory	Asunda et al. (2023); Mohammed (2023)
Entrepreneurial Education (IV2)	Mediates the influence of programming on problem-solving and innovation	Problem-Solving Theory	Mohammed et al. (2024); Kumar et al. (2024)
Entrepreneurial Problem-Solving Capacity (DV)	Improved creativity, opportunity recognition, and decision-making	Integrated Cognitive Framework	Lawal et al. (2023); Supsomboon (2019)
Combined Effect	Programming-based entrepreneurship curricula foster innovation and digital adaptability	Integrated Cognitive–Behavioral Model	Fathi et al. (2018); Mohammed & Sundararajan (2023)

Source: Author's conceptual synthesis (2025) based on Asunda et al. (2023), Mohammed et al. (2023–2024), and others.

5.0 Recommendations of the Study

5.1 Policy Recommendations

The policymakers should consider coming up with programming skills in the national entrepreneurship development plans. With a policy of digital transformation, entrepreneurship education can empower developing nations to be more innovative and self-sufficient in technology (Mohammed et al., 2024; Lawal et al., 2023). Governments can also facilitate digital upskilling programs among youths and startups, in order to enhance the productivity and competitiveness of the country.

5.2 Educational Recommendations

Colleges ought to introduce hybrid programs

that would incorporate programming fundamentals with courses in computational thinking and business innovation. Multi-disciplinary skills and improvement of entrepreneurial thinking can be achieved through collaborative teaching processes, involving the integration of both computer science and entrepreneurship departments (Asunda et al., 2023; Mohammed and Sundararajan, 2023). The practical courses must emphasize on algorithmic problem-solving and business simulation and project-based learning online.

5.3 Research Recommendations

The model of programming skills, entrepreneur education and problem-solving ability is to be empirically tested in future research which includes quantitative and mixed methods. It proposes cross-country comparisons in the study of differences in digital skills adoption and the entrepreneurial outcomes (Kumar et al., 2024). It should also be considered in future research, how gender, industry, and cultural context can influence computational entrepreneurship dynamics (Sundararajan and Mohammed, 2022).

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