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Technology-Based Startup Ideas and MVP Development: A Digital Literacy Perspective among High School Students

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Abstract: The rapid growth of digital technologies has created new opportunities for entrepreneurship among younger generations, including high school students. This study explores the emerging trends of technology-based startup ideas and evaluates the potential for *Minimum Viable Product (MVP)* development from the perspective of digital literacy. Using a descriptive–qualitative approach, data were collected from student business proposals, pitch decks, and prototype outputs generated during a startup competition for high school students. The analysis categorized startup ideas into various technological domains such as fintech, edtech, agritech, and health tech, while also assessing the quality and feasibility of MVPs based on lean startup principles. Findings reveal that students demonstrate strong creativity in problem identification and solution design yet often face challenges in translating ideas into functional MVPs due to limited technical capacity. Moreover, higher levels of digital literacy—particularly in digital creativity, technological adaptability, and collaborative skills—were positively correlated with the quality of MVP outcomes. This study highlights the importance of integrating digital literacy into early entrepreneurship education, suggesting that fostering these competencies can enhance the capacity of young innovators to develop feasible and impactful technology-driven startups.

Keywords: technology-based startups, MVP development, digital literacy, high school students, innovation

INTRODUCTION

Entrepreneurship has emerged, arguably, as one of the most vital competencies of the digital epoch, over which continual technological evolution has restructured established sectors and engendered an expanding palette of commercial prospects(Liang et al., 2025). The accelerated permeation of digital instruments increasingly allows the youngest cohorts—especially Generation Z—to initiate entrepreneurial undertakings at

ages previously associ¬ated with university or later stages (Jalil et al., 2025). Augmented by ubiquitous information access, immersive social media, and affordable digital solutions, secondary-school individuals are evincing robust proclivity towards tech-oriented innovations and the establishment of start-up enterprises. (Norberg et al., 2025)

In light of this observable trend, a constellation of secondary educational bodies and pervasive non-governmental organisations has inaugurated an array of entrepreneurship contests and structured training curricula, thereby constituting formal scaffolding for the cultivation of creative and innovative outlooks (M. Simanjuntak et al., 2023). Such programmes effect an early exposure of learners to fundamental entrepreneurial theorems whilst motivating learners to transpose intellectual constructs into practical, observable outcomes via structured, experiential pedagogy(Duan, 2024). Within this framework, formalised start-up competitions afford secondary learners the structured opportunity to articulate novel commercial propositions, devise initial prototypes bearing requisite evidential underpinnings, and cultivate an entrepreneurial ethos concordant with the transformative exigencies of the digital knowledge economy.(Rodríguez-Sánchez, 2023)

This research rigorously examines the trajectory of technology-oriented venture concepts articulated by high school students, while simultaneously assessing their proficiency in evolving these concepts into workable prototypes, conceived here as Minimum Viable Products (MVPs). A corollary objective of the inquiry is the systematic quantification of digital literacy as a mediating variable, with particular attention to its correlational strength in adjudicating the cogency of the initial entrepreneurial concept, as well as the fidelity of the resultant MVP. Through the triangulation of these variables, the investigation aims to augment the extant literature on digital entrepreneurship pedagogy directed at adolescent cohorts.

Despite a notable proliferation of scholarship devoted to the pedagogy of entrepreneurship, empirical attention to the high school demographic remains sparse (Nasution & Zahrah, 2014). The prevailing corpus of literature disproportionately affirms the obsolescence of entrepreneurial instruction at the tertiary level, neglecting the emergent entrepreneurial proclivity observable among pre-university students (Nasution & Zahrah, 2015). The progressive dematerialization of infrastructural exigencies—engineered by digital mediators—has concurrently democratized the entrepreneurial process, imbuing secondary learners with the agency to conceptualize, validate, and iteratively refine technology-interfaced solutions. (Silaban, 2024)

The limited empirical attention devoted to high school student entrepreneurship inhibits a comprehensive appraisal of their capacity to conceptualize technology-driven ventures matching prevailing market exigencies. Complementarily, despite widespread endorsement of digital literacy as a non-negotiable proficiency, the specific competence necessary to translate literacy into minimal viable product (MVP) execution has received scant sustained investigation. These intersecting lacunae thus generate a compelling warrant for enquiry that interrogates the overlapping domains of digital literacy, innovative ideation, and the purposeful fabrication of MVPs within a student-led startup framework.

This study advances the knowledge and application of student entrepreneurship in several key ways. First, it makes a theoretical contribution by broadening the academic corpus concerning high school entrepreneurship, a realm hitherto neglected, by systematically linking nascent ventures to the specific sphere of digital literacy development. Second, it supplies a practical contribution by translating empirical results

into actionable recommendations for educators and policymakers, thereby facilitating the design of entrepreneurship curricula that intentionally marry digital competency with immersive startup practice. Finally, the research yields a strategic contribution by illustrating to universities and innovation hubs how youth-centred competitions may simultaneously serve recruitment, mentorship, and branding functions, thereby consolidating institutional prominence in the cultivation of creative and commercial talent. (Silaban, 2024)

This investigation confines itself to high school students (SMA) in the city of Medan who entered a local startup competition. Evidence is situated within the creative artefacts these entrepreneurs produced—specifically, final business proposals, recorded pitch presentations, and minimum viable product components, including visual mockups, physical prototypes, and operational landing pages. By design, the analysis refrains from longitudinal tracking of operational implementations, sales metrics, or post-competition survival rates, which would exceed the logistical and financial constraints of the study. Consequently, although the conclusions hold diagnostic and prescriptive value for the innovation ecosystem, they remain contingent upon the unique socio-economic, institutional, and infrastructural fabric of the Medan milieu and therefore may not generalise to national or transnational settings without further corroboration.

Entrepreneurship and Early-Stage Innovation

Contemporary scholarship positions entrepreneurship as a principal engine of economic dynamism and inventive progress within the trajectory of the twenty-first century (Setiawan et al., 2025). The democratization of digital technology has concomitantly reduced the traditional impediments to venture initiation, affording individuals, in particular adolescent learners, the capacity to undertake entrepreneurial experiments long before the completion of formal education (Kania et al., 2020). Empirical investigations, notably Imanuella et al., 2025, document that the infusion of entrepreneurship curricula prior to university attendance engenders a statistically significant increase in entrepreneurial intention, while manifestly equipping learners with conceptually rich heuristics for managing risk and ambiguity. This preparatory experience cultivates transferable competencies—creative ideation, analytical problem-solving, and collaborative leadership—whose reach outstrips the confines of disciplinary study (Mirzanti et al., 2015).

The focus of early-stage innovation is consequently oriented toward the systematic generation and refinement of nascent ideas, eschewing the more resource-intensive demands of full-scale deployment (Végh et al., 2025). Young venture creators are thus instructed to diagnose unmet needs, hypothesize inventive remedies, and to scaffold plausible business architectures prior to the prosaic demands of market entry (Dhuri & Patkar, 2024). In response, curricular and extra-curricular structures theorizably militate toward this developmental endpoint, as regional, national, and transnational innovation competitions, together with accelerator-like co-curricular modules, engender a scaffolded arena for ideational testing and the proof of concept within student populations (Silaban, 2024).

Technology-Based Startups

Technology-based startups constitute entrepreneurial endeavours that harness digital instruments—tools, platforms, or systems—to engineer novel responses to pressing societal challenges (Pratiwi et al., 2025). Among the ascendant domains are financial technology (fintech), educational technology (edtech), health technology (healthtech), and agricultural technology (agritech), which are lauded for their capacity to scale and their intrinsic social pertinence (Trapsilawati et al., 2025). These sectors have witnessed pronounced activity, making them illustrative of digital entrepreneurship that simultaneously pursues economic returns and societal good. (Alamanda et al., 2026)

For secondary-school learners, the formulation of technology-driven startup concepts frequently arises from quotidian encounters and the identification of unmet needs within their localities (Sellami et al., 2024). Although many concepts remain formative, their prevalence signals the deep-rooted orientation of Generation Z towards digital ecosystems (Chamoli et al., 2025). Earlier investigations affirm that this cohort, categorised as "digital natives," tends to exhibit pronounced inventiveness in conceiving remedies but encounters obstacles in translating ideas into durable enterprises, partly attributable to modest technical and managerial competencies (Correia et al., 2023).

Minimum Viable Product (MVP) and the Lean Startup Approach

The Minimum Viable Product (MVP) construct emanates from the lean startup paradigm, which privileges iterative experimentation and the empirical substantiation of business hypotheses while deploying restrained fiscal and temporal resources (Meyer et al., 2024). An MVP is accordingly defined as the crudest manifestation of a product that generates sufficient evidentiary yield; through this simplified variant, developers are empowered to verify foundational propositions, solicit informed critique, and subsequently enhance their value propositions. (Tripathi et al., 2019a).

For student-led startups, the formulation of a minimum viable product (MVP) commonly involves the generation of mock-ups, functional prototypes, or simple landing pages to convey intended operation and market promise (Dalziel & Basir, 2024). This stage serves a dual purpose: it affirms market alignment while simultaneously affording learners experiential immersion in product visualization and iterative evaluation (Mirzanti et al., 2015; Tripathi et al., 2019a). Nevertheless, prevailing scholarship illuminates a pronounced difficulty among high school initiators in advancing to MVP solely because of inadequate technical fluency and restrictive access to sophisticated development instruments (Imanuella et al., 2025). Consequently, a curricular response that pairs targeted technical scaffolding with the domain of entrepreneurial pedagogy appears indispensable. (Bang et al., 2025)

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Digital Literacy as a Foundation for Innovation

Digital literacy, construed as the leveraged proficiency in manipulating, appraising, and fabricating digital artefacts, is positioned as a premeditated prerequisite for economic engagement in a networked century (Y. Zhang, 2025). Established frameworks, among them the UNESCO Digital Competence Framework and the European DigComp model, systematically decompose the construct into a curated cluster of capabilities: information appraisal, mediated communication, artifact generation, proactive safeguarding, and situated problem resolution (*Digital Competencies and Skills | UNESCO*, n.d.). Within the entrepreneurship curriculum, proficiency in digital tools equips learners to move from conceptual abstraction to concrete creation (DeVolld et al., 2022). Competences in digital expression, virtual teamwork, and adaptive technology use are essential for designing and refining minimum viable products (Koçak Uyaroğlu et al., 2025). Empirical evidence shows that learners exhibiting robust digital literacy are more adept at surveying market needs, substantiating prototypes, and employing online ecosystems to advance venture prototypes . (Król, 2023)

Previous Studies on Student Entrepreneurship and Digital Innovation

Recent literature has examined the linkage between entrepreneurial education and innovation among youth.Cookson and Drasar, (2006) established that experiential learning modules considerably raise entrepreneurial intention, whereas (DeVolld et al., 2022)documented that elevated digital competence correlates with superior venture performance. Nevertheless, the predominant emphasis of existing inquiries has rested on post-secondary cohorts, with isshall for elevated senators to adolescent evidence of (Freese & Lukosch, 2026). This oversight hints at the necessity to interrogate digital competence and entrepreneurial efficacy within the high-school milieu, particularly in environments where innovation-based contests afford learners structured opportunities for experiential and collaborative venture design (Guo et al., 2024).

Conceptual Framework

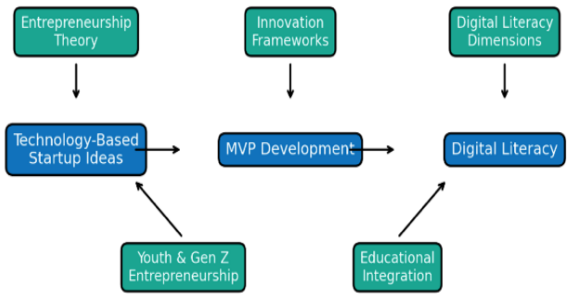

Fig. 1. Knowledge landscape mapping the relationship between technology-based startup ideas, MVP development, and digital literacy, framed by entrepreneurship theory, innovation frameworks, and educational contexts. (Tripathi et al., 2019b)

RESEARCH METHODOLOGY

The inquiry pursues a qualitative exploratory design complemented by descriptive elements, selected to document emergent qualitative patterns of technology-based startup ideas generated by high-school learners and to elucidate the role of digital literacy in the production of minimum viable products (MVPs) (Setiawan et al., 2025). The study is anchored in a case study of the Tech Innovation Challenge for High School Students, conducted in Medan, which provides a structured environment within which contestants articulate, test, and publicly defend their startup projects.

The investigation operates within a tri-departmental collaborative initiative entailing the Division of Digital Business, the Division of International Trade, and the Division of Information Systems at the host institution. The initiative comprises a technology- and entrepreneurship-oriented contest expressly targeted at Medan-based secondary school pupils aged 15–18. The program thus affords a distinctive lens through which researchers may observe the translation of juvenile imaginative ideation and ubiquitous digital fluency into formally engineered commercial propositions and tier-one product demonstrators known as minimum viable products.

The empirical domain is coextensive with the cohort of contest applicants. The research population is coterminous with the aggregated set of pupils submitting written concept documents, while the targeted empirical subset is constituted by the proffered proposal set, anticipated to number between 30 and 50 documents, and the handful of advance finalists designated to orchestrate formal pitches and MVP reveal segments, anticipated to comprise approximately 10 consortia. A purposeful sampling schema has thus been deployed, accentuating the density of data and insight entailed by exemplary pipeline artifacts and final demonstrative deliverables, thereby guaranteeing intense scrutiny of cases within the anticipated instructional and entrepreneurial field.

Data for the study is assembled from a triangulated set of sources. Initially, written artefacts—business plans and slide decks submitted by contestants—are dissected to surface dominant entrepreneurial themes and recurrent patterns of innovative reasoning. Subsequent to this, systematic non-participant observation is conducted during both the weekend workshops and the final pitching forum to register interactional styles, collaborative dynamics, and modes of verbal and visual argumentation. The evaluative focus then turns to the artefacts of the Minimum Viable Product (MVP), comprising low-fidelity mock-ups, invitations to register via landing pages, and rudimentary interactive prototypes; these are examined to measure the degree to which abstract conceptions have been materialized. The final stage of the collection yields quantitative and qualitative data from a tailored digital literacy questionnaire, which is distilled from validated psychometric scales and administered via an online platform; this instrument solicits self-ratings of competency across a spectrum of digital practices.

Consequent to the assembly of datasets, a suite of evaluative instruments is employed. Particular focus is devoted to multidimensional rubrics for both the written plans and the MVP prototypes; dimensions of interest encompass problem-solution

alignment, originality, rational plausibility, user-centred effectiveness, and aesthetic coherence. Parallel to this, an observation guide—anchored by a discreet checklist—controls the systematic coding of verbal and non-verbal modes of cooperation observed during pitch delivery. The quantitative survey of digital literacy features a carefully curated battery of questions, representing the constructs of information curation, digital authorship, online communication competence, and critical evaluation of digital sources.

The resultant dataset is subjected to an integrated multimethod approach combining both qualitative and quantitative analyses. Initial qualitative content analysis systematically codes the entrepreneurial propositions into thematic clusters, encompassing domains such as artificial intelligence, e-commerce, sustainability, and edtech. To supplement the thematic taxonomy, descriptive statistics characterize the distribution of theme frequencies, minimum viable product (MVP) quality metrics, and cohort digital literacy profiles. Subsequent comparative analyses interrogate the correlation between digital literacy scores and the quality ratings of MVPs. Validation is reinforced by triangulating insights from the pitched proposals, MVP demonstrations, and nested survey items, thus bolstering the overall reliability of the conclusions.

Ethical protocols are meticulously adhered to across the study lifecycle. Prior informed consent is secured from both participants and their respective educational institutions, and all personally identifiable information is systematically de-identified to safeguard respondent confidentiality. Data access is circumscribed to scholarly and pedagogical objectives, averting any adverse consequence for participants. Nonetheless, several methodological caveats warrant attention. The investigation is confined to a single entrepreneurial competition based in Medan, thereby circumscribing the external validity of the observed patterns. The temporally bounded nature of the competition necessarily constrains the iterative refinement of MVPs, and reliance on self-reported digital literacy assessments may introduce response bias in the measured variates.

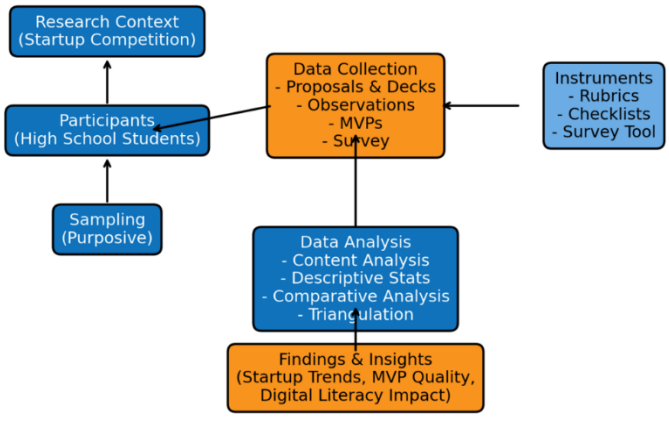

Fig. 2. Research Methodology

Figure 2 illustrates the sequencing of the research methodology, commencing with the delineation of the research context and the successive sampling of participants, progressing through the stages of data collection and the specification of instruments, and culminates in data analysis followed by the presentation of findings pertaining to

entrepreneurial trends, the qualitative assessment of minimum viable product (MVP) standards, and the measured effect of digital literacy.

FINDINGS AND DISCUSSION

Findings

Empirical assessment reveals that the cohort of Medan secondary school students exhibits a satisfactory threshold of digital literacy. Respondents articulated their entrepreneurial propositions with notable clarity and creativity, frequently augmented by digital tools comprising presentation software, visual mock-ups, and working prototypes. Such findings are consonant with existing literature, which documents a marked expansion of digital competencies among adolescents corresponding to the growing embedding of technology within both pedagogical and quotidian contexts (Gnambs & Hawrot, 2025). In addition, the capacity to delineate and propagate novel concepts is identified as a pivotal skill among the digitally literate, enabling youth to deploy technology as a conduit for personal articulation and entrepreneurial inquiry (J. Zhang, 2025).

Nevertheless, participants, despite strengths in creative conception and digital output, presented marked deficiencies in risk management, especially concerning financial exposure and forecasting of prospective market dynamics (Heilbrunn & Almor, 2014). Analogous deficiencies emerged in the analysis of ,which stated that adolescents enrolled in entrepreneurship education frequently exhibited scant financial literacy and limited risk assessment capabilities (Heilbrunn & Almor, 2014; J. Zhang, 2025). Effective management of financial risk encompasses disciplined practices such as budget formation, cost forecasting, and profit capacity analysis—capacities that remain inadequately refinished among emerging entrepreneurs (Ge et al., 2025; Ji et al., 2025).

Concurrently, the learners exhibited a muted forward orientation concerning the assessment of prospective technological or market transformations. This omission aligns with (Khetarpal et al., 2025)who contended that the imaginative and inventive abilities of youth entrepreneurs are substantially outpaced by the experiential capital necessary to identify and respond to enduring trends and uncertainties. Evidence of this interpretative void surfaced in the presented business plans, the greater part of which juxtaposed immediate viability of the offering with scant consideration for sustainable innovation or the establishment of risk containment measures designed to counter forthcoming adversities (Ibidunni et al., 2025).

Discussion

The level of digital literacy displayed by high school students in Medan serves as a proxy for the recent achievements and limitations of national educational initiatives and for the rapidly expanding availability of digital technologies in Indonesian metropolitan environments (E. Simanjuntak et al., 2025). Building on the framework articulated by (Yuan & Li, 2025), digital literacy involves proficiency that extends beyond mere technical operation to the domains of expressive communication, collaborative

production, and innovative problem-solving. The students' ability to articulate and substantiate their propositions thus validates the view of digital literacy as a critical enabler for entrepreneurial practice within the contemporary, technology-mediated economy (Wijaya et al., 2025).

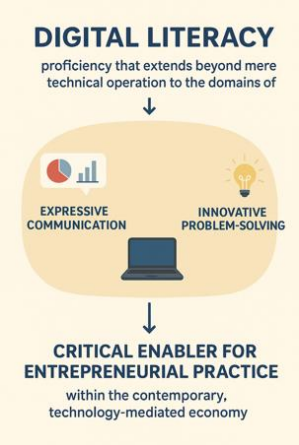

Fig. 3. Critical Enable for Entrepreneurial Practice

However, the observed insufficiency in financial hazard identification and mitigation indicates a significant shortcoming in the currently prescribed entrepreneurship curriculum (Kikuchi et al., 2018). The empirical and theoretical consensus holds that financial astuteness, particularly in relation to the acknowledgement and governance of risk, is decisive for entrepreneurial durability (Zhu, 2018). The noted deficit inevitably predisposes nascent ventures to fragility and, in many cases, premature termination (Tahir, 2025). The findings hence avow that digital competencies, decisive though they may be for information creation and exchange, fall short where evaluative and predictive financial reasoning is concerned. It is therefore incumbent upon curricular design to incorporate systematic financial education; research by Frisancho, 2020 corroborates that integrated initiatives yield significant improvements in students' capacity to align innovative propositions with sustainable, responsible financial practice.

The students' difficulty in forecasting forthcoming market and technological developments indicates a developmental gap. Frisancho, 2020 insists that entrepreneurial education should transcend immediate problem resolution and encompass exercises in strategic foresight and adjustable responses to variability. Absent these competencies, nascent innovators risk constructing interventions that quickly lose viability or relevance in shifting environment (García & Pérez-Oleaga, 2025). Structured mentorship, augmented by retrospective industry-case analyses of transformative periods, may furnish learners with the forward-looking orientation necessary to situate their work within emerging paradigms (Potrich et al., 2025).

Cumulatively, the evidence indicates that Medan's secondary students command a satisfactory level of digital literacy yet require focused instruction in risk governance and future-limited visualization (Sitepu & Rajagukguk, 2022). These competencies prove critical in the transmutation of preliminary concepts into enduring enterprises. further

contend that entrepreneurial curricula must combine impulses to innovate with disciplined inquiry and strategic negotiation of uncertainty (Kurniawan et al., 2022). Accordingly, subsequent cohorts of startup contests should integrate focused modules in financial calibration, scenario-testing, and longitudinal market interpretation, thereby significantly improving participant resilience and foresight (Xiao et al., 2025).

CONCLUSION

This investigation assessed the generation of technology-oriented startup concepts among senior secondary students in Medan alongside their ability to evolve those concepts into viable initial products (MVPs), placing a special focus on the mediating effect of their digital literacy. The data illustrated that the cohort possesses sufficiency in digital literacy to coherently delineate and promote their entrepreneurial propositions. Such a capacity mirrors the accelerated embedding of digital fluency into the pedagogical experiences of contemporary youth and substantiates the hypothesis that digital competences constitute a prerequisite for inventive activity within the prevailing informational economy.

Conversely, the analysis identified pronounced deficiencies in the pedagogical frameworks that cultivate entrepreneurial acumen, manifest in an underdeveloped capacity for financial risk mitigation and strategically anticipatory cognitive styles. Although the investigated sample exhibited both creative ideation and technical adeptness, their constrained facility for evaluating impending financial uncertainties and predicting either market or technological fronts underscores a pedagogical architecture that has yet to furnish resilient entrepreneurial preparedness . Absent a comprehensive approach to risk assessment, even variants of technology-driven concepts that possess intellectual merit remain vulnerable to obsolesence, thereby jeopardising their capacity for durable economic impact.

The theoretical contribution of this inquiry resides in its corroboration that, although proficiency in digital tools fuels both ideation and collaborative discourse, such competence alone fails to furnish adolescents with the strategic acumen requisite for enduring enterprise viability (Zhao et al., 2025). The practical implications assert the essential amalgamation of financial literacy and strategic foresight within the entrepreneurship curricula of secondary schools. From a governance medium, calibration of startup competitions emerges as a strategic conduit through which universities may enlarge their innovation ecosystem while concurrently mapping instructional deficiencies warranting illumination through specialized pedagogic initiatives (Ruhi, 2016).

The overall finding, therefore, affirms that high school students in Medan possess substantial digital dexterity and inherent inventiveness, yet the deficiencies in calibrated risk appraisal and horizon-scanning aptitude necessitate formal, structured pedagogic agent that does, closing the gap between nascent startup propositions and their sustained manifestation, guaranteed that entrepreneurship education not only amplifies inventive propensity but also generates enduring economic as well as societal dividends.

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