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Development and Initial Evaluation of a Sharia Based Mathematics Entrepreneurship Learning Model to Strengthen Santri's Applied Mathematics Competence in Pesantren

Siti Najma[1], Nur Azmi[2*], Rauzatul Jannah[3], Rizky Amelia Putri Br Gajah[4]

[1,2]UIN Sultanah Nahrasiyah Lhokseumawe, Aceh, Indonesia
[*]Corresponding Author: nurazmi@uinsuna.ac.id

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Abstract

Pesantren require contextual entrepreneurship learning that enables santri to use mathematics in business decisions while remaining guided by Sharia ethics. This study developed and initially evaluated the SME-Sharia Learning Model for strengthening applied mathematics competence in a pesantren context. Using the ADDIE research-and-development framework and a one-group pretest-posttest design, the study involved 20 Grade IX female santri at Pondok Pesantren Al Muslimun Lhoksukon, Aceh Utara; five caregivers contributed to the needs analysis. Data were obtained from student and caregiver needs surveys, expert appraisal, readability testing, an applied mathematics test, observation, interviews with five santri, and a post-intervention Sharia-values questionnaire. Quantitative data were analyzed descriptively and with a paired-sample t-test, Cohen's dz, and a supplementary Wilcoxon test, while qualitative data were analyzed thematically. Preliminary appraisal means were 3.60 for the mathematics education expert and 3.80 for the Sharia economics expert, and readability averaged 3.52 on a four-point scale. Applied mathematics scores increased from 59.5 to 78.5 on a 0-100 reporting scale (mean difference = 19.0, 95% CI [12.1, 25.9]), $t(19) = 5.729$, $p < .001$, $dz = 1.28$; 17 students improved, two declined, and one was unchanged. Supporting descriptive evidence indicated ethical awareness and active participation during business simulations. Because the study lacked a control group, item-level reliability data, and a validated pretest-posttest readiness measure, the findings are preliminary. The model offers an integrative approach linking applied mathematics, entrepreneurship practice, and Sharia ethical reasoning in Islamic boarding schools.

Abstrak

Pesantren memerlukan pembelajaran kewirausahaan kontekstual yang memungkinkan santri menggunakan matematika dalam pengambilan keputusan bisnis dengan tetap berpedoman pada etika Syariah. Penelitian ini mengembangkan dan mengevaluasi secara awal SME-Sharia Learning Model untuk memperkuat kompetensi matematika terapan dalam konteks pesantren. Dengan menggunakan kerangka penelitian dan pengembangan ADDIE serta desain satu kelompok pretes-postes, penelitian melibatkan 20 santriwati kelas IX di Pondok Pesantren Al Muslimun Lhoksukon, Aceh Utara; lima orang pengasuh berkontribusi dalam analisis kebutuhan. Data diperoleh melalui survei kebutuhan santri dan pengasuh, penilaian ahli, uji keterbacaan, tes matematika terapan, observasi, wawancara terhadap lima santri, dan angket nilai-nilai Syariah setelah intervensi. Data kuantitatif dianalisis secara deskriptif serta menggunakan uji-t sampel berpasangan, Cohen's dz, dan uji Wilcoxon sebagai analisis tambahan, sedangkan data kualitatif dianalisis secara tematik. Rata-rata penilaian awal adalah 3,60 dari ahli pendidikan matematika dan 3,80 dari ahli ekonomi Syariah, sedangkan keterbacaan mencapai 3,52 pada skala empat poin. Skor matematika terapan meningkat dari 59,5 menjadi 78,5 pada skala pelaporan 0-100 (selisih rata-rata = 19,0; 95% CI [12,1, 25,9]), $t(19) = 5,729$, $p < 0,001$, $dz = 1,28$; sebanyak 17 santri mengalami peningkatan, dua mengalami penurunan, dan satu tidak berubah. Temuan pendukung secara deskriptif menunjukkan kesadaran etis dan partisipasi aktif selama simulasi bisnis. Karena penelitian tidak menggunakan kelompok kontrol, tidak memiliki data reliabilitas tingkat butir, dan tidak menerapkan ukuran kesiapan kewirausahaan pretes-postes yang tervalidasi, temuan ini bersifat awal. Model ini menawarkan pendekatan integratif yang menghubungkan matematika terapan, praktik kewirausahaan, dan penalaran etis Syariah di pondok pesantren.

Introduction

Entrepreneurship education has increasingly become an essential part of educational development because it contributes to students' creativity, employability, self-reliance, and readiness to face social and economic change (Haj Youssef et al., 2026). In many educational contexts, entrepreneurship is no longer understood merely as the ability to start a business, but as a learning process that develops initiative, problem-solving ability, opportunity recognition, adaptability, ethical judgment, and responsible decision-making. Recent work on embedded entrepreneurship pedagogy also emphasizes that entrepreneurship education at the school level should cultivate creativity, persistence, opportunity recognition, adaptability, and entrepreneurial mindset across curricular learning experiences, rather than limiting entrepreneurship to business start-up training alone (Hadley, 2026). This orientation is particularly relevant in Indonesia,

where educational institutions are expected to prepare students not only with academic knowledge but also with practical competencies that enable them to participate productively in society (Gonzalez-Perez et al., 2025). In the Indonesian educational context, the development of entrepreneurship ecosystems is increasingly linked to practical competence, stakeholder support, and digital readiness, although gaps in facilities and implementation remain visible across schools (Sultono et al., 2025).

Within this broader educational agenda, Islamic boarding schools, or pesantren, occupy a strategic position. Pesantren are not only religious educational institutions but also social and cultural spaces in which students' discipline, independence, morality, and communal responsibility are shaped through daily learning practices. Their distinctive environment allows entrepreneurship education to be developed without separating economic competence from ethical and spiritual values. Recent research shows that pesantren can integrate religious and economic education to develop santripreneurs who are economically productive, socially responsible, and religiously grounded (Wibowo et al., 2022; Sudarmin et al., 2023). This potential is also reflected in pesantren-based financing, agribusiness, and social entrepreneurship models that support institutional and community economic development (Badrudin et al., 2021; Abroza & Mas'ud, 2024; Rouf et al., 2024). School-based entrepreneurship education can be further strengthened through community networks and cooperative learning structures that build trust, engagement, and students' social capital (Mion et al., 2026).

Despite this potential, entrepreneurship education in many pesantren still faces several pedagogical challenges. One of the main problems is the gap between students' entrepreneurial interest and their practical entrepreneurial competence. Previous studies indicate that santri often show positive attitudes toward entrepreneurship, yet they frequently lack the applied skills needed to transform entrepreneurial ideas into concrete actions, such as calculating production costs, determining selling prices, estimating profits, preparing simple business plans, and making financial decisions (Kasidi et al., 2022; Abdurohim & Kusaeri, 2024). This issue is consistent with previous research showing that pesantren students need life skills, including entrepreneurship, to strengthen their readiness for independent livelihoods (Taufik & Ernawati, 2021). In many cases, entrepreneurship learning remains conceptual and motivational, while students receive limited opportunities to engage in authentic or simulated business practices. Similar concerns have been reported in secondary education contexts where entrepreneurship education often remains theory-driven, weak in experiential learning, and poorly aligned with practical economic realities (Kolajo et al., 2026). As a result, entrepreneurship is frequently introduced as an ideal aspiration rather than experienced as a concrete learning process.

This problem is closely related to students' applied mathematics competence. In this

study, applied mathematics competence is defined as the ability to select, use, interpret, and justify mathematical procedures when solving contextual business problems. Operationally, the construct includes calculating capital and production costs, determining selling prices, analyzing profit and loss, estimating a simple break-even point, and using the results to support a reasoned business decision. Thus, the construct is not limited to arithmetic accuracy; it integrates calculation, interpretation, and decision-making within an entrepreneurial context. In entrepreneurial activities, mathematics functions as a practical tool for reasoning, planning, and decision-making. Previous work on entrepreneurial mathematics has shown that mathematics can be transformed into entrepreneurial activities when students use mathematical concepts to create products, develop designs, and promote them through market-oriented activities (Parhusip et al., 2022). Embedded entrepreneurship pedagogy further suggests that financial literacy, opportunity identification, experimentation, and market analysis need to be treated as explicit classroom learning goals (Hadley, 2026). Therefore, mathematics should not be treated only as an abstract school subject, but also as a functional competence that supports responsible entrepreneurial action. However, in many learning settings, including pesantren, mathematics is still frequently taught through procedural and abstract exercises that are weakly connected to students' everyday economic experiences.

In the pesantren context, entrepreneurship education also carries an ethical dimension that distinguishes it from entrepreneurship learning in general educational settings. Entrepreneurial activities are expected to be guided by Islamic values such as honesty, trustworthiness, fairness, transparency, responsibility, and the avoidance of riba and gharar (Kasidi et al., 2022; Supriyanto et al., 2022). Entrepreneurship education based on Islamic values has been shown to strengthen students' motivation and entrepreneurial orientation while keeping business practices within a moral framework (Wibowo et al., 2022). In the Indonesian context, religiosity has also been discussed as part of human capital that may enrich entrepreneurial orientation and intention by adding moral values, intrinsic motivation, self-efficacy, and resilience (Games et al., 2025). Recent scholarship further argues that entrepreneurship education should not be reduced to profit-oriented training, but should also cultivate ethical responsibility, social justice awareness, human dignity, and value-driven innovation (Enebe & Palmer, 2026). Nevertheless, Sharia principles are often presented as supplementary moral messages rather than being integrated into entrepreneurial decision-making activities. Consequently, students may understand Islamic business ethics conceptually, but they are not always trained to apply these principles when solving real or simulated business problems.

Another important aspect of entrepreneurship education is the development of entrepreneurial attitudes and readiness-related dispositions. In this study, entrepreneurial readiness is understood as an emerging state of willingness and perceived

capability to engage in entrepreneurial tasks, reflected in confidence, initiative, opportunity recognition, persistence, and responsible decision-making. Knowledge and skills alone are not sufficient to prepare students for entrepreneurial action; students also need confidence, creativity, motivation, resilience, and the ability to recognize opportunities (Wardana et al., 2020; Zhang et al., 2022). The Theory of Planned Behavior explains that attitude toward a behavior is one of the key determinants of intention, alongside subjective norms and perceived behavioral control (Ajzen, 1991). Contextual learning experiences can strengthen these dispositions by allowing students to practice, reflect, and gain confidence through meaningful activities (Martínez-Gregorio et al., 2021; Wang et al., 2023). However, because the present study did not administer a validated pretest-posttest entrepreneurial-readiness scale, readiness-related evidence was examined only through post-intervention questionnaire responses, observations, and interviews. It is therefore interpreted as descriptive supporting evidence rather than as an outcome whose improvement was statistically established.

From a pedagogical perspective, experiential and constructivist learning approaches provide a suitable foundation for integrating mathematics, entrepreneurship, and Sharia values. Constructivist learning views students as active participants who build knowledge through experience, interaction, and reflection. Similar constructivist approaches in STEM-based social entrepreneurship education have emphasized the importance of practical experience, knowledge application, problem-solving, and social responsibility in preparing students to address real-life problems (Ng et al., 2024). In entrepreneurship education, this principle can be implemented through project-based learning, problem-solving activities, business simulations, and contextual tasks that connect classroom concepts with real-life situations (Martínez-Gregorio et al., 2021; Voss et al., 2025). This orientation aligns with embedded entrepreneurship pedagogy, which combines authentic problem-solving, iterative feedback, experimentation, and reflection to cultivate entrepreneurial self-efficacy and creative confidence (Hadley, 2026). Project-based learning has also been shown to support entrepreneurial character development because it requires students to work creatively, collaboratively, and productively toward concrete learning products (Sudarmin et al., 2023). The ADDIE framework offers a systematic instructional design procedure through the stages of analysis, design, development, implementation, and evaluation, making it suitable for developing a contextual learning model in the pesantren environment (Branch, 2009; Sukarno et al., 2025; Widyastuti et al., 2025). In implementing such innovation, teachers also play a central role because successful educational change depends on teachers' capacity to adapt, create, and guide learning through entrepreneurship, creativity, resilience, and inquisitiveness (Rorije & Vanlommel, 2026).

Although previous studies have examined entrepreneurship education in Islamic educational institutions, applied mathematics in entrepreneurial learning, and Islamic values in business education, these three areas have often been discussed separately. Existing research has not sufficiently developed an instructional model that integrates applied mathematical competence, entrepreneurial attitude formation, and Sharia-based ethical understanding into one coherent learning design for santri at the lower secondary level. Most entrepreneurship education models are also developed in higher education contexts, while empirical evidence from Islamic boarding schools remains limited. Recent youth entrepreneurship literature also notes that secondary and earlier school-level entrepreneurship pedagogies remain less developed than university-level models, especially in cross-curricular and age-appropriate forms (Hadley, 2026; Mion et al., 2026). This indicates a conceptual and practical gap: there is still a need for a contextual learning model that enables santri to learn entrepreneurship through mathematical reasoning, practical business simulation, and Sharia-based ethical decision-making.

Based on this gap, this study aims to develop and conduct an initial evaluation of a Sharia-based mathematics-entrepreneurship learning model for Grade IX santri at Pondok Pesantren Al Muslimun Lhoksukon, Aceh. Specifically, the study examines the preliminary effectiveness of the model in strengthening applied mathematics competence and describes supporting indications of students' entrepreneurial engagement and Sharia-based ethical reasoning during learning activities. The study contributes to entrepreneurship education by offering an integrative instructional model that combines applied mathematics, entrepreneurial practice, and Islamic ethical values within the pesantren context. The model is expected to provide a contextual reference for educators and curriculum developers seeking entrepreneurship learning that is practically relevant, mathematically reasoned, and morally grounded.

Method

This study employed a research and development (R&D) approach using the ADDIE instructional design framework. This approach was selected because the study aimed to develop, appraise, implement, and conduct an initial evaluation of a Sharia-based mathematics-entrepreneurship learning model for santri in the pesantren context. The ADDIE framework provides a systematic procedure for instructional product development through five stages: analysis, design, development, implementation, and evaluation (Branch, 2009). Recent educational development studies have also used ADDIE to design contextual learning models and instructional materials because it enables researchers to connect needs analysis, material development, implementation, and evaluation in a coherent sequence (Sukarno et al., 2025; Widyastuti et al., 2025).

To examine the preliminary effectiveness of the developed model, this study used a one-group pretest-posttest design. The primary inferential outcome was applied

mathematics competence, measured before and after implementation. Supporting data on entrepreneurial engagement and Sharia business-ethics reasoning were collected through a post-intervention questionnaire, observation, and interviews. Because the study did not include a control group, the results are interpreted as preliminary evidence associated with the intervention rather than definitive causal proof. In addition, because entrepreneurial readiness was not measured using a validated pretest-posttest scale, no inferential claim is made regarding an increase in entrepreneurial readiness. The overall research procedure is presented in Figure 1.

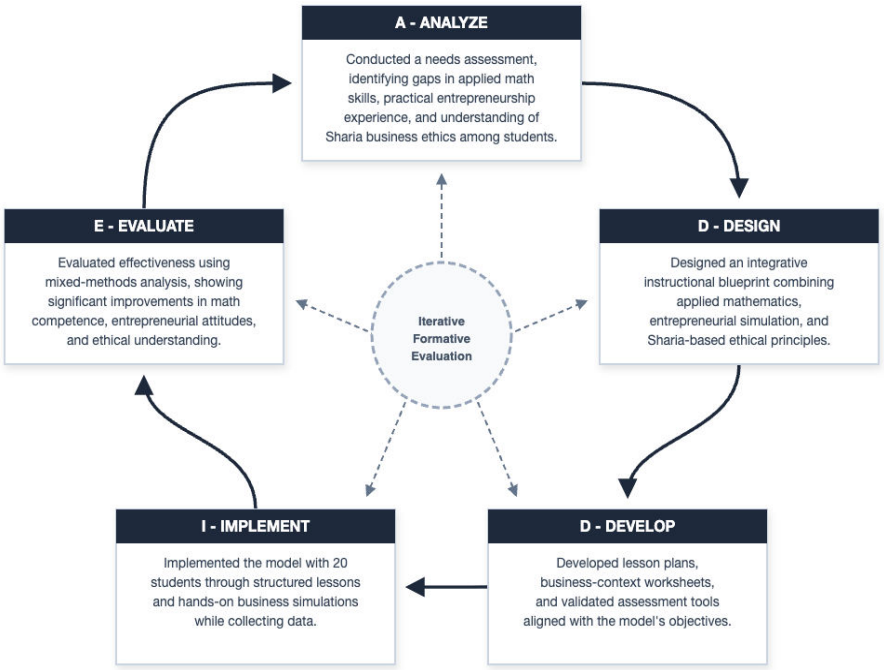

Figure 1. Research and Development Procedure Using the ADDIE Framework

Participants

The study was conducted at Pondok Pesantren Al Muslimun Lhoksukon, Aceh Utara. The intervention participants were 20 Grade IX female santri who completed all six learning meetings and both mathematics assessments. They were selected purposively based on their availability for the full program, readiness to undertake applied mathematics activities, and the pesantren's support for scheduled implementation. Five caregivers or teachers also completed the contextual needs survey; they served as informants and were not included in the pretest-posttest outcome sample.

Grade IX students were selected because they had already received basic mathematical knowledge needed for entrepreneurship-related calculations, such as arithmetic, percentage, profit and loss, pricing, and simple financial estimation. These competencies were necessary because the developed model required students to apply mathematical reasoning in business-related situations, including calculating capital,

determining selling prices, analyzing profit and loss, and evaluating transactions based on Sharia principles.

Development Procedure

The development of the Sharia-based mathematics-entrepreneurship learning model was conducted through five ADDIE stages: analysis, design, development, implementation, and evaluation. The stages of model development are summarized in Table 1. In the analysis stage, the researchers identified students' learning needs, existing mathematics learning practices, informal economic activities in the pesantren, and students' difficulties in applying mathematics to business contexts. Data were collected through observation, interviews with teachers, student questionnaires, and a review of relevant literature on pesantren entrepreneurship, applied mathematics, and Islamic economics. In the design stage, the researchers formulated learning objectives, designed the instructional flow, developed student worksheets, and prepared assessment instruments. The learning design integrated three main components: applied mathematics, entrepreneurship practice, and Sharia business ethics. These components were organized into contextual activities that connected mathematical concepts with business decision-making and ethical reflection.

Table 1. Stages of Model Development Based on the ADDIE Framework

ADDIE Stage	Main Activities	Output
Analysis	Identifying students' learning needs, *pesantren* context, applied mathematics competence, entrepreneurship learning problems, and Sharia ethics integration	Needs analysis and learning problem map
Design	Formulating learning objectives, instructional flow, mathematics-entrepreneurship tasks, project activities, and Sharia ethical components	Initial design of the learning model
Development	Preparing learning materials, student worksheets, entrepreneurship project tasks, and assessment instruments	Prototype of the learning model and research instruments
Implementation	Applying the model through six effective learning meetings involving mathematical problem-solving, entrepreneurship simulation, and Sharia-based reflection	Learning implementation data
Evaluation	Comparing pretest and posttest results and interpreting observation and interview data	Initial evidence of model effectiveness

In the development stage, the researchers produced learning modules, student worksheets, learning scenarios, assessment instruments, and supporting media. The learning materials emphasized contextual business problems, such as calculating production costs, determining selling prices, analyzing profit and loss, and evaluating transactions based on honesty, fairness, transparency, the prohibition of riba, and the avoidance of gharar. The materials were then appraised by specialists in mathematics education and Sharia economics to examine conceptual accuracy, mathematical correctness, contextual suitability, and alignment with Sharia values. Revisions were made based on this formative feedback before implementation.

In the implementation stage, the model was applied through six effective learning meetings with 20 Grade IX santri. The activities included an introduction to Sharia entrepreneurship, applied mathematics training, business-context problem solving, simple business simulations, transaction recording, price setting, profit analysis, and Sharia-based reflection. In the evaluation stage, formative evaluation was conducted during each meeting to monitor learning activities, while summative evaluation was conducted at the end of the program through pretest-posttest scores, preliminary expert appraisal results, readability testing, questionnaires, observations, and interviews.

Specification of the Developed Learning Model

The product was named the SME-Sharia Learning Model (Sharia Mathematics-Entrepreneurship Learning Model). It was designed as a contextual, collaborative, and ethically reflective learning model that connects mathematical reasoning with simulated business decisions. The model is grounded in constructivist learning, experiential learning, contextual mathematics, entrepreneurship education, and Islamic business ethics. Its five instructional phases are: (1) contextualizing a Sharia-relevant business problem; (2) quantifying costs, prices, profit, and other mathematical information; (3) simulating a halal business decision; (4) justifying the decision using mathematical evidence and Sharia principles; and (5) reflecting, revising, and transferring the learning to another business context.

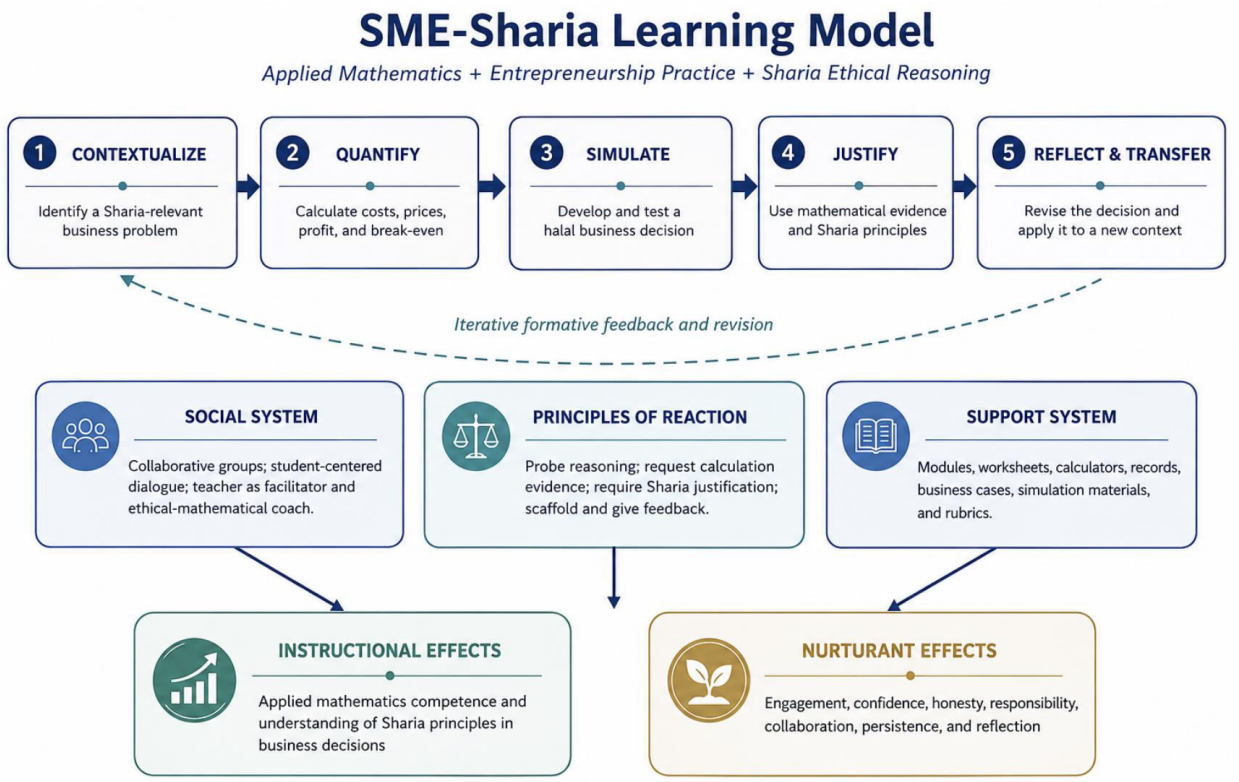

Figure 2. Structural Components and Instructional Syntax of the SME-Sharia Learning Model

The structural components of the model were specified to make the developed product explicit and reproducible. These components include the instructional syntax, social system, principles of teacher response, support system, instructional effects, and nurturant effects, as summarized in Table 2.

Table 2. Structural Components of the SME-Sharia Learning Model

Component	Specification	Operational Expression
Theoretical foundations	Constructivism, experiential learning, contextual mathematics, entrepreneurship education, and Sharia business ethics.	Students build concepts through business cases, simulation, collaborative problem solving, ethical justification, and reflection.
Instructional syntax	Five phases: contextualize; quantify; simulate; justify; reflect and transfer.	Each phase links a business problem to mathematical analysis and a Sharia-based decision.
Social system	Student-centered, collaborative, and dialogic; the teacher acts as facilitator	Santri work in small groups, share roles, present calculations,

Component	Specification	Operational Expression
	and ethical-mathematical coach.	and discuss ethical consequences.
Principles of reaction	Teachers probe reasoning, request calculation evidence, ask for Sharia justification, provide scaffolding, and give formative feedback.	Responses emphasize accuracy, transparency, fairness, responsibility, and revision rather than answer giving.
Support system	Learning modules, contextual worksheets, simple financial records, calculators, business-simulation materials, cases, observation sheets, and rubrics.	Resources support both mathematical problem solving and ethical evaluation.
Instructional effects	Improved applied mathematics competence and better understanding of Sharia principles in business decisions.	Measured primarily through the applied mathematics pretest-posttest and described through the Sharia-values questionnaire.
Nurturant effects	Entrepreneurial engagement, confidence, honesty, responsibility, collaboration, persistence, and reflective judgment.	Observed descriptively during group work, simulations, and interviews; not treated as inferentially proven improvement.

The model's instructional effects were distinguished from its nurturant effects. Applied mathematics competence was the only outcome tested inferentially. Entrepreneurial engagement, ethical awareness, and other readiness-related dispositions were treated as descriptive nurturant effects because the study did not use a baseline-comparison design for those constructs.

Instruments

Several instruments were used. First, the student needs-analysis questionnaire contained 10 closed-response items and two open-ended questions covering basic mathematics, prior use of mathematics in economic activities, entrepreneurial interest, understanding of Sharia principles, previous training, perceived obstacles, and expectations for the program. A seven-item caregiver survey, comprising five closed-response and two open-ended questions, examined students' entrepreneurial competence, existing institutional provision, major learning barriers, and support for mathematics-Sharia integration.

Second, expert appraisal sheets were used to assess the preliminary feasibility of the learning model, modules, and relevant assessment materials. One mathematics education

expert assessed five domains: curriculum alignment, accuracy of concepts and formulas, quality of practice tasks, the mathematics-business connection, and clarity of language and presentation. One Sharia economics expert assessed five domains: accuracy of Sharia concepts, integration of moral values, alignment with maqashid Sharia, contextualization in pesantren life, and balance between material and spiritual orientations. Each domain was rated on a four-point scale: 1=poor/not feasible, 2=fair/less feasible, 3=good/feasible, and 4=very good/very feasible.

Third, a readability questionnaire assessed five aspects of the modules: ease of language, clarity of instructions, relevance of examples, attractiveness of presentation, and material difficulty. The four anchors were 1=very difficult/unclear, 2=difficult/less clear, 3=fairly easy/clear, and 4=very easy/very clear. Equal-width interpretation intervals were used: 1.00-1.75=poor/difficult, 1.76-2.50=fair, 2.51-3.25=good/easy, and 3.26-4.00=very good/very easy to understand.

Fourth, an Applied Mathematics Competence Test was administered as the pretest and posttest. The test generated a raw total score from 0 to 10 and assessed five content domains: capital and production-cost calculation, selling-price determination, profit-and-loss analysis, simple break-even analysis, and interpretation of mathematical results for business decisions. Raw scores were multiplied by 10 for reporting on a 0-100 scale; this linear conversion does not alter the t statistic, p value, or standardized effect size. The mathematics education expert reviewed curricular alignment, mathematical accuracy, cognitive level, and the scoring rubric, while the Sharia economics expert reviewed the contextual and ethical suitability of the business cases.

Fifth, a post-intervention Sharia Values Integration Questionnaire contained 15 prompts: five items on understanding riba, profit-sharing, gharar, maysir, and transparency; five items on Islamic business conduct, including honesty, promise keeping, accurate measurement, ethical promotion, and customer treatment; and five open-ended business cases. The 100-point rubric comprised understanding of basic Sharia concepts (25 points), application of Islamic business ethics (25 points), case-analysis ability (30 points), and consistency of values in practice (20 points). Because the questionnaire was administered only after the intervention, it was used to describe a post-program profile and not to claim pre-post improvement in entrepreneurial readiness.

Sixth, the behavior observation sheet used a five-point scale to record honesty in product information, transparency in price determination, fairness in transactions, trustworthiness in maintaining product quality, and responsibility for commitments. Seventh, a five-question semi-structured interview guide explored understanding of riba, choices between doubtful and halal profit, excessive pricing, honesty in transactions, and

the meaning of blessing in business. Five santri were selected for post-intervention interviews to provide variation in classroom participation and test performance.

Data Collection Procedure

Data collection was conducted in four phases. During the analysis phase, all 20 santri completed the needs questionnaire and five caregivers completed the institutional survey. Classroom observation and informal economic-activity observation were combined with caregiver interviews to identify learning problems and establish the contextual basis for the model.

In the second phase, the mathematics education expert and Sharia economics expert appraised the model, modules, and assessment materials within their respective domains, and representative santri completed the readability questionnaire. The feedback was used formatively to revise explanations, practice tasks, contextual cases, and presentation before classroom implementation. Because only two completed domain-specific appraisal records were available, the ratings were analyzed descriptively rather than as coefficient-based content validation.

In the third phase, the model was implemented through classroom learning activities involving applied mathematics, entrepreneurship simulations, business case discussions, transaction recording, pricing practice, profit analysis, and Sharia-based reflection. Observation and documentation were conducted throughout the implementation process.

In the fourth phase, students completed the applied mathematics posttest and the Sharia-values questionnaire. Five selected santri participated in semi-structured interviews, while observations and caregiver feedback were used to contextualize engagement, ethical awareness, and the practical usability of the model.

Data Analysis

The data were analyzed using quantitative and qualitative approaches. Needs-analysis, expert-appraisal, readability, observation, and Sharia-values data were summarized using frequencies, percentages, and means. Expert and readability means were interpreted using the equal-width four-point intervals stated above. Applied mathematics scores were analyzed on the raw 0-10 scale and reported on the equivalent 0-100 scale. Participant-level totals were used to recalculate all descriptive and inferential results, including the number of students whose scores increased, decreased, or remained unchanged.

The normality of the paired difference scores was examined with the Shapiro-Wilk test because the outcome sample was small. The distribution did not significantly depart from normality (p=0,159), so a paired-sample t-test was used as the primary inferential analysis. The mean difference was accompanied by a 95% confidence interval. Statistical

significance was evaluated at alpha=0,05, but interpretation emphasized the magnitude and uncertainty of the change rather than significance alone.

Cohen's dz was calculated as the mean paired difference divided by the standard deviation of the paired differences. A Wilcoxon Signed-Rank Test was also conducted as a supplementary non-parametric analysis because of the small sample and the bounded 0-10 score range. This supplementary test was used as a robustness check rather than as a substitute for the prespecified paired t-test.

Qualitative data from observation, interviews, and field notes were analyzed thematically. The analysis focused on patterns of students' participation, entrepreneurial engagement, confidence, ethical reasoning, and responses during business simulations. The qualitative findings were used to support interpretation of the quantitative results, particularly in explaining students' learning engagement and readiness-related dispositions. These themes were descriptive and were not treated as evidence of pre-post improvement.

Ethical Considerations

This study was conducted by considering ethical principles in educational research. The implementation was carried out after obtaining permission from the pesantren. Students participated in the learning activities as part of the educational program, and the data were used only for research purposes. The students' identities were not reported in the article, and all findings were presented in aggregate form to protect participants' confidentiality.

Results and Discussion

Results

This section presents the results of the development and initial evaluation of the SME-Sharia Learning Model. The findings are organized into five parts: needs analysis, model development and preliminary expert appraisal, implementation of the learning model, improvement in applied mathematics competence, and supporting descriptive findings on entrepreneurial engagement and Sharia ethics integration.

Needs Analysis

The needs analysis involved 20 santri and five caregivers. Twelve santri (60%) reported sufficient mastery of basic mathematics, but 15 (75%) stated that they rarely or never used mathematical concepts in economic activities. Only three santri (15%) considered themselves highly capable of calculating production costs or determining selling prices, whereas 14 (70%) described themselves as less capable. Four of the five caregivers (80%) likewise rated students' basic entrepreneurial knowledge as relatively low.

The needs analysis also showed that students' interest in entrepreneurship was relatively high. Sixteen students, or 80%, stated that they were interested or highly interested in entrepreneurial activities. However, students' understanding of Sharia-based business principles was still limited. Thirteen students, or 65%, reported difficulty understanding concepts such as the prohibition of riba. At the same time, 17 students, or 85%, already recognized the importance of Sharia economic principles. This pattern indicates that students had initial entrepreneurial interest and ethical awareness, but still needed structured learning to connect mathematical reasoning, business decisions, and Islamic business values.

The main challenges were financial management and pricing: seven santri (35%) identified difficulty managing business finances, and eight (40%) reported difficulty setting competitive selling prices. Three of the five caregivers (60%) identified limited understanding of business mathematics as the principal obstacle. Eighteen santri (90%) had never participated in structured entrepreneurship training, and 14 (70%) rated the available entrepreneurship learning, where present, as only fair or poor. All caregivers supported integrating mathematics and Sharia principles into entrepreneurship education. These findings indicated a clear gap between entrepreneurial interest and the capacity to make mathematically reasoned, ethically grounded business decisions.

Model Development and Preliminary Expert Appraisal

Based on the needs analysis, the SME-Sharia Learning Model was developed by integrating applied mathematics, entrepreneurship practice, and Sharia business ethics. The model translated these three content domains into a five-phase instructional syntax: contextualizing a Sharia-relevant business problem; quantifying the mathematical information; simulating a halal business decision; justifying the decision mathematically and ethically; and reflecting, revising, and transferring the learning. The explicit model specification, including its social system, principles of reaction, support system, instructional effects, and nurturant effects, is presented in Figure 2 and Table 2.

Table 3. Results of Preliminary Expert Appraisal and Readability Test

Appraisal Component	Assessment Aspect	Score	Interpretation
Mathematics expert appraisal	Curriculum suitability	4.00	Very good
Mathematics expert appraisal	Accuracy of concepts and formulas	4.00	Very good
Mathematics expert appraisal	Quality of exercises	3.00	Good
Mathematics expert appraisal	Connection between mathematics and business	4.00	Very good
Mathematics expert appraisal	Clarity of language and presentation	3.00	Good

Mathematics expert appraisal	Mean score	3.60	Very good
Sharia economics expert appraisal	Accuracy of Sharia concepts	4.00	Very good
Sharia economics expert appraisal	Integration of moral values	4.00	Very good
Sharia economics expert appraisal	Suitability with maqashid Sharia	3.00	Good
Sharia economics expert appraisal	Contextualization with pesantren life	4.00	Very good
Sharia economics expert appraisal	Balance between worldly and spiritual orientation	4.00	Very good
Sharia economics expert appraisal	Mean score	3.80	Very good
Student readability test	Ease of language	3.50	Very good
Student readability test	Clarity of instructions	3.60	Very good
Student readability test	Relevance of examples	3.80	Very good
Student readability test	Attractiveness of presentation	3.30	Very good
Student readability test	Level of material difficulty	3.40	Very good
Student readability test	Mean score	3.52	Very easy to understand

The developed product consisted of the SME-Sharia model specification and four instructional modules: introduction to business mathematics, financial management in halal business, Sharia economic principles in entrepreneurship, and halal business development. The modules were supported by student worksheets, project-based activities, pretest and posttest instruments, observation sheets, interview guides, and assessment rubrics. The learning materials emphasized contextual problems related to students' daily environment, including production-cost calculation, selling-price determination, profit-and-loss analysis, and evaluation of transactions based on honesty, fairness, transparency, and the avoidance of riba and gharar.

Before implementation, the model and learning modules received documented preliminary appraisals from one mathematics education expert and one Sharia economics expert. The mathematics appraisal mean was 3.60 and the Sharia economics appraisal mean was 3.80; both fell within the 3.26-4.00 interval and were therefore interpreted as very good/very feasible. The readability mean was 3.52, indicating that the modules were very easy to understand. These results provided formative feasibility evidence for implementation, but they do not constitute coefficient-based content validity because the panel was small, the experts evaluated different domains, and common item-level ratings were unavailable.

Implementation of the Learning Model

The model was implemented with 20 Grade IX female santri at Pondok Pesantren Al Muslimun Lhoksukon through six effective learning meetings. The implementation followed the sequence of the four developed modules and combined brief conceptual explanation, interactive discussion, group work, business simulation, and Sharia-based reflection.

In the first module, students learned to calculate the cost of production and selling prices through the case of pesantren cake production. In the second module, students analyzed break-even points using the example of a herbal drink business. In the third module, students discussed cases related to riba in cooperative loans and evaluated them from a Sharia perspective. In the fourth module, students designed a simple halal business plan. The use of contextual student worksheets helped students connect mathematical formulas, business decisions, and Sharia values in a concrete learning experience.

The implementation process showed that the model could be applied in the pesantren learning context. Students participated actively in group discussions, solved business-related mathematical problems, evaluated ethical cases, and reflected on the relationship between entrepreneurship and Islamic values. Therefore, the implementation stage provided practical evidence that the model was not only feasible in terms of content, but also applicable in classroom learning.

Improvement in Applied Mathematics Competence

Students' applied mathematics competence was measured using a pretest and posttest. The test assessed the application of mathematics to entrepreneurship-related contexts, including cost calculation, pricing, profit and loss, break-even analysis, and interpretation for business decisions. Raw scores ranged from 0 to 10 and were converted to a 0–100 reporting scale.

Table 4. Descriptive Statistics of Applied Mathematics Competence

Test	N	Mean (0–100)	Standard Deviation (0–100)	Mean Gain
Pretest	20	59.5	6.9	-
Posttest	20	78.5	15.7	19.0

The mean pretest score was 59.5, while the mean posttest score increased to 78.5 on the 0–100 reporting scale. These values are equivalent to raw means of 5.95 and 7.85 on the original 0–10 scale. The mean gain was 19.0 points on the reporting scale. Of the 20 students, 17 students (85%) showed improvement, two students obtained lower scores, and one student showed no change. This pattern indicates that most students demonstrated better applied mathematics competence after participating in the intervention.

Before conducting inferential analysis, the normality of the difference scores was examined using the Shapiro–Wilk test. The result showed that the difference scores were normally distributed, with p=0,159. Therefore, the paired-sample t-test was used as the main statistical test. The normality test result is presented in Table 5.

Table 5. Normality Test of Difference Scores

Variable	Shapiro–Wilk p-value	Interpretation
Difference between posttest and pretest scores	0.159	Normally distributed

The paired-sample t-test, conducted on the raw 0-10 scores, showed a statistically significant mean increase, $t(19) = 5.729$ and $p < .001$. The raw mean difference was 1.90 points (95% CI [1.21, 2.59]), equivalent to 19.0 points on the 0-100 reporting scale (95% CI [12.1, 25.9]). Cohen's dz was 1.28, conventionally interpreted as a large within-group standardized change. The results are presented in Table 6.

Table 6. Paired-Sample t-Test Results for Applied Mathematics Competence

Comparison	Mean Difference	t	df	p-value	Effect Size
Posttest – Pretest	19.0 (95% CI: 12.1-25.9)	5.729	19	< .001	dz = 1.28

Within this preliminary one-group design, the results show that participation in the SME-Sharia learning activities was associated with higher applied mathematics scores. The large standardized change and confidence interval indicate an educationally meaningful pattern, but the absence of a comparison group prevents attribution of the change solely to the model.

As a supplementary analysis, the Wilcoxon Signed-Rank Test was conducted to confirm the robustness of the result, considering the small sample size. The Wilcoxon result also showed a significant improvement, with 17 positive ranks, two negative ranks, and one tie. The test produced Z=-3.582, $p < .001$, and an effect size of r=0.80, indicating a large effect. The results are presented in Table 7.

Table 7. Supplementary Wilcoxon Signed-Rank Test Results

Indicator	Positive ranks	Negative ranks	Ties	Z	p-value	Effect size	Interpretation
Result	17	2	1	-3.582	< .001	r = 0.80	Large effect

The consistency between the paired-sample t-test and the Wilcoxon Signed-Rank Test strengthens the evidence that students' applied mathematics competence improved after the intervention.

Supporting Descriptive Findings on Entrepreneurial Engagement and Sharia Ethics Integration

In addition to the mathematics test, supporting data were collected through the post-intervention Sharia-values integration questionnaire, observation, and interviews. These data were used to enrich interpretation of the learning process and to describe students' entrepreneurial engagement and ethical reasoning after participating in the model. Because no baseline readiness measure was administered, the findings in this subsection are descriptive and are not evidence of a statistically demonstrated increase in entrepreneurial readiness.

The post-intervention Sharia-values integration questionnaire produced a mean of 78 out of 100, corresponding to the 'proficient' category in the study rubric; 15 students (75%) scored above 70. The profile combined understanding of core Sharia concepts, application of Islamic business ethics, case analysis, and consistency between stated values and intended practice. Because no baseline version of this measure was administered, the result is reported only as a descriptive post-program profile.

Observation during business simulations showed that 17 of 20 students (85%) consistently demonstrated honesty in explaining products and transparency in price calculation. Trustworthiness, fairness, and responsibility were also evident in group task allocation and simulated transactions. Interviews with five selected santri supported these observations. One student explained that mathematics was important so that profit would not be taken arbitrarily, while another reported feeling more secure in trading after understanding which practices were halal and prohibited. These statements illustrate perceived learning relevance but are not treated as evidence of statistically established readiness change.

These supporting findings indicate positive patterns of ethical awareness and entrepreneurial engagement during implementation. They complement the applied mathematics results by showing how students used honesty, transparency, fairness, and responsibility in simulated business decisions. Nevertheless, because entrepreneurial readiness and Sharia ethics integration were not examined through validated pretest-posttest instruments, these findings are supporting descriptions and should not be interpreted as definitive evidence of improvement in those constructs.

Discussion

The findings indicate that the SME-Sharia Learning Model has potential as an integrative instructional model for entrepreneurship education in the pesantren context. The model demonstrated preliminary feasibility through expert appraisal and readability testing, practicality through classroom implementation, and preliminary effectiveness through improvement in applied mathematics competence. The explicit specification of its

syntax, social system, principles of reaction, support system, instructional effects, and nurturant effects strengthens its reproducibility as an R&D product. At the same time, the limited appraisal panel and one-group design require cautious interpretation.

The needs analysis showed a clear gap between students' entrepreneurial interest and their practical competence in using mathematics for business purposes. Although students showed interest in entrepreneurship, they still needed support in calculating production costs, determining selling prices, estimating profit and loss, and evaluating business decisions. This finding is consistent with studies showing that school-level entrepreneurship learning often remains conceptual and insufficiently connected to experiential economic practice (Kolajo et al., 2026). It also supports the view that entrepreneurship education should develop financial literacy, opportunity recognition, experimentation, adaptability, and entrepreneurial mindset through embedded classroom activities (Hadley, 2026).

The implementation showed that contextual and active learning could make mathematics more concrete and meaningful. Through cases involving food production, herbal drinks, pricing, cooperative loans, and halal business planning, students used mathematical reasoning to address realistic business problems. This aligns with evidence that entrepreneurship education is more effective when learners engage in authentic problem solving, simulation, reflection, and iterative feedback (Hadley, 2026). It also resonates with research showing that community-based entrepreneurship education can strengthen engagement, skill development, and social capital (Mion et al., 2026).

The statistical results provide preliminary evidence of improvement in applied mathematics competence. Scores increased by an average of 19.0 points on the 0-100 reporting scale, with a 95% confidence interval from 12.1 to 25.9 points; 17 of 20 students improved. The paired t-test, large Cohen's dz, and supplementary Wilcoxon result were mutually consistent. This pattern accords with studies showing that entrepreneurial learning can strengthen problem solving, decision making, creativity, and practical competence when mathematical concepts are embedded in authentic economic tasks (Alimorad, 2025). Nevertheless, the design establishes a within-group change over time, not causal superiority over another instructional approach.

The integration of Sharia values gave the model a strong contextual identity. This finding is consistent with Gümüşay's (2014) view that entrepreneurship in Islamic contexts should combine socioeconomic, ethical, and religio-spiritual dimensions. Embedding the prohibition of riba and gharar, alongside honesty, fairness, transparency, and responsibility, connected religious formation with mathematical and entrepreneurial decision making. It also reflects the broader expectation that entrepreneurship education

should cultivate ethical responsibility and socially responsible innovation rather than focus narrowly on profit (Enebe & Palmer, 2026).

Interview findings showed that students began to perceive mathematics not merely as a school subject, but as a useful tool for making accountable business decisions and avoiding careless profit-taking. This shift suggests that the model helped connect mathematical reasoning, entrepreneurship, and ethical decision-making in a meaningful way. Such learning is important because entrepreneurship education should help students transform knowledge into practical judgment, confidence, and responsible action (Hadley, 2026; Martínez-Gregorio et al., 2021; Wang et al., 2023).

The findings also imply that teachers and pesantren administrators need to support integrative learning that connects mathematical concepts, business practice, and Sharia-based reflection. This requires teachers' innovative capacity to adapt, create, and guide contextual learning, as entrepreneurship, creativity, resilience, and inquisitiveness are important for educational change (Rorije & Vanlommel, 2026). In addition, broader collaboration involving pesantren, teachers, local business actors, Islamic economic institutions, and community partners may strengthen entrepreneurship education ecosystems, especially when supported by facilities, stakeholder involvement, and digital readiness (Sultono et al., 2025).

Several limitations constrain interpretation. First, the study involved only 20 students from one pesantren and used a one-group pretest-posttest design, so maturation, testing effects, and other concurrent influences cannot be ruled out. Second, the two experts reviewed different disciplinary domains and did not provide common item-level ratings; CVR, CVI, and Aiken's V therefore could not be calculated. Third, the applied mathematics dataset contained total scores only, preventing estimation of Cronbach's alpha, McDonald's omega, KR-20, item difficulty, or discrimination. Fourth, the readability sample size was not documented in the available records. Fifth, entrepreneurial readiness and Sharia ethics integration were not measured with validated baseline and post-intervention instruments. Future studies should use a larger multidisciplinary panel, retain item-level validation and response data, pilot the instruments, report reliability and item-analysis evidence, employ a comparison group, and assess readiness and ethical internalization longitudinally.

Conclusion

This study developed the SME-Sharia Learning Model using the ADDIE framework and provided preliminary evidence of feasibility, classroom applicability, and improvement in applied mathematics competence in a pesantren context. Documented expert-appraisal means were 3.60 for mathematics education and 3.80 for Sharia economics, while readability averaged 3.52 on a four-point scale. Among 20 Grade IX

female santri, applied mathematics scores increased from 59.5 to 78.5 on the 0-100 reporting scale, with a mean difference of 19.0 points (95% CI [12.1, 25.9]), $t(19) = 5.729$, $p < .001$, and $dz = 1.28$. Seventeen students improved, two declined, and one remained unchanged. Descriptive observations and interviews indicated active engagement and the use of honesty, transparency, fairness, and avoidance of riba and gharar during simulated business decisions, but these findings do not constitute inferential evidence of increased entrepreneurial readiness.

The model demonstrates how applied mathematics, entrepreneurship practice, and Sharia ethical reasoning can be organized into a coherent five-phase learning process for santri. Its explicit syntax and structural components may support adaptation by teachers, pesantren administrators, and curriculum developers. However, the small single-site sample, absence of a control group, limited validation panel, unavailable item-level reliability data, and lack of validated pretest-posttest readiness measures mean that broader effectiveness claims would be premature. Additional validation, instrument piloting, and controlled multi-site implementation are required.

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