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Entrepreneurship-based systems of linear equations modelling to foster mathematical creativity in vocational high schools

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ABSTRACT

Mathematics learning in vocational high schools should support modelling and evidence-informed decision making, yet systems of linear equations in two variables (SLETV). This study examined how entrepreneurship-based SLETV tasks implemented through a UTAUT-based EEM learning model were associated with the development of students' mathematical creativity. A one-group pre-experimental pretest–post-test design involved 80 Grade 11 students from four vocational programmes at one school in West Jakarta. Through eight 90-minute meetings, students defined decision variables, formulated and solved SLETV, represented constraints, identified feasible regions, constructed objective functions, revised assumptions, and defended optimal decisions using structured worksheets and digital visualisation tools. Data were collected using a validated 50-item five-point mathematical creativity instrument, performance rubrics, student worksheets, and classroom observations. The mean score increased from 3.053 (SD = 0.512) to 3.922 (SD = 0.476), $t(79) = -47.229$, $p < .001$, with a very large within-participant effect (Cohen's d = 5.28) and a moderate normalised gain (g = 0.476). The results of this study indicate that the use of SLETV can enhance students' entrepreneurship-based mathematical creativity through the UTAUT-based EEM learning model in vocational schools, particularly the fluency indicator in constructing SLETV models.

KEYWORDS

Mathematical creativity; systems of linear equations; entrepreneurial event model; unified theory of acceptance and use of technology; entrepreneurship education

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INTRODUCTION

Mathematics education in vocational high schools should function as a tool for modelling, planning, and evidence-informed decision making rather than as a collection of procedures detached from everyday activity. This role is especially relevant in vocational education, where mathematics intersects with occupational competencies, business processes, resource allocation, and practical problem solving. Research on vocational mathematics indicates that curricular relevance and students' self-efficacy are strengthened when quantitative ideas are explicitly connected to vocational purposes, whereas decontextualised instruction can contribute to low engagement and fragmented understanding (Dalby & Noyes, 2022; Voss et al., 2023).

A persistent challenge in learning systems of linear equations in two variables (SLETV) and solving word problems is that students may successfully apply elimination or substitution procedures without adequately understanding the meanings of variables, coefficients,

equations, and ordered-pair solutions. This difficulty is closely related to students' limited ability to identify quantitative relationships, translate contextual information into algebraic representations, and interpret mathematical solutions in relation to the original problem situation (Krawitz et al., 2022; Soneira et al., 2023; Verschaffel et al., 2020). Contextual modelling requires a longer chain of reasoning: interpreting a situation, identifying varying quantities, selecting quantitative relationships, constructing equations, solving the system, and validating whether the solution is reasonable in context. Consequently, students' difficulties arise not only from computation but also from translating between real-world language and mathematical structure (Verschaffel et al., 2020).

In this study, an entrepreneurial decision refers to a mathematically defensible choice involving two products or services under conditions related to selling price, available capital, raw-material consumption, working time, market demand, production capacity, or expected profit. This context is particularly relevant to vocational mathematics because students are expected to connect formal mathematical concepts with practical decisions resembling those encountered in business and occupational settings. Accordingly, decision variables may represent quantities of products, service packages, design orders, or completed administrative tasks, whereas coefficients may represent unit prices, production costs, material requirements, processing time, or profit per unit. Such contextualisation helps students recognise that variables, coefficients, and equations carry specific vocational meanings rather than functioning merely as abstract mathematical symbols (Cevikbas et al., 2022; Krawitz et al., 2025).

Entrepreneurial decision-making provides an appropriate context for learning Systems of Linear Equations in Two Variables (SLETV) because two equations can represent two business conditions that must be satisfied simultaneously. The intersection of the two equations identifies a combination of products or services that satisfies both conditions, while substitution into the original equations enables students to verify whether the solution is mathematically correct and contextually meaningful. When these relationships are extended to inequalities, students can represent limitations involving capital, materials, labour time, demand, or production capacity. They can subsequently construct a feasible region, identify its vertices, formulate an objective function, and compare alternative solutions to determine an optimal business decision (Lu & Kaiser, 2022a).

From the perspective of mathematical modelling, this learning process requires students to move iteratively between the entrepreneurial situation and its mathematical representation. Students must identify relevant quantities, define decision variables and measurement units,

formulate relationships, solve or graph the model, interpret the resulting coordinates, and validate whether the proposed solution is reasonable in the original context. Contemporary research in mathematics education emphasises that modelling competence includes understanding real-world situations, mathematising contextual information, working with mathematical representations, interpreting results, and validating the adequacy of a model rather than merely applying predetermined computational procedures (Krawitz et al., 2025).

This modelling orientation is especially important in vocational education because mathematical knowledge needs to be coordinated with practical constraints, occupational purposes, and evidence-based decision-making. The entrepreneurial context allows students from different vocational programmes to construct models that reflect their respective fields. For example, accounting students may focus on costs and profits, Retail Business students on prices and demand, Visual Communication Design students on service packages and production time, and Office Management students on workloads and processing capacity. Despite these contextual differences, the underlying mathematical structure remains comparable because each situation requires students to coordinate variables, equations, inequalities, graphs, and optimisation arguments (Krawitz et al., 2025; Lu & Kaiser, 2022a).

Entrepreneurship is therefore used as an authentic mathematical-modelling context rather than merely as a motivational storyline. The quality of students' work is not determined solely by the novelty or commercial attractiveness of a business idea, but by whether the proposed variables, assumptions, equations, constraints, feasible solutions, and optimal decisions are mathematically coherent and supported by evidence. This principle is consistent with recent research showing that mathematical creativity in modelling involves generating ideas, transforming representations, evaluating assumptions, and producing original yet mathematically valid solutions (Joklitschke et al., 2022; Lu & Kaiser, 2022a, 2022b). Through this approach, entrepreneurship-based SLETV activities can simultaneously strengthen vocational relevance, mathematical-modelling competence, representational flexibility, creativity, and students' capacity to justify practical decisions (Joklitschke et al., 2022; Lu & Kaiser, 2022b).

Creative mathematical activities are characterized by the following aspects: fluency, flexibility, originality, and elaboration; extending creativity to the generation, refinement, and evaluation of mathematical modelling approaches; and placing proof and justification as central practices for validating mathematical claims (Lu et al., 2025; Schindler & Lilienthal, 2022; Stylianides et al., 2024). Fluency concerns the generation of viable variables or models;

flexibility concerns movement among verbal, tabular, algebraic, and graphical forms; originality concerns assumptions that are novel yet defensible; elaboration concerns the completeness of the reasoning chain; and proof-oriented justification concerns evidence that a solution satisfies every constraint and is optimal. Recent scholarship similarly characterises mathematical creativity as a disciplinary capacity to generate, transform, evaluate, and justify mathematical representations rather than as novelty alone (Lu & Kaiser, 2022a, 2022b).

The entrepreneurship-based SLETV and linear-programming sequence was designed to address the gap between procedural performance and creative mathematical modelling. Students first defined decision variables and formulated equations in two variables; they then interpreted the intersection as a simultaneous solution before extending boundary equations to inequalities, a feasible region, an objective function, and an optimal decision. This sequence positions SLETV as a conceptual bridge: solving two linear equations explains how vertices arise from intersecting constraints, while the entrepreneurial context gives decision-making meaning to each symbol and coordinate.

Recent research on mathematical modelling emphasizes the importance of tasks that require interpretation, validation, revision, and discussion of mathematical arguments (Almeida, 2018; Schukajlow et al., 2018). Therefore, this article treats entrepreneurship not as a motivational add-on, but as a mathematical context for constructing SPLDV and linear programming models. Students are expected to go beyond numerical answers by explaining why their models are reasonable, how the solutions are obtained, and whether those solutions are appropriate for business decision making.

The Entrepreneurial Event Model (EEM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) were integrated as learning mechanisms supporting this modelling sequence. EEM constructs were translated into task functions: perceived desirability was developed by allowing students to select meaningful local products; perceived feasibility was supported through scaffolding and attainable modelling stages; and propensity to act was activated when students revised and publicly defended decisions. These task functions were grounded in the entrepreneurial-event tradition and its educational applications (Fayolle & Gailly, 2015; Krueger et al., 2000). UTAUT constructs supported the use of tables, digital worksheets, graphing or visualisation tools, and peer interaction. Performance expectancy emphasised usefulness, effort expectancy emphasised manageable procedures, social influence operated through group critique, and facilitating conditions referred to access to devices and learning resources (Al-Emran & Granić, 2021; Dwivedi et al., 2019; Venkatesh et al., 2003,

2012). Recent work in digital mathematics education likewise indicates that technology contributes when it is embedded in mathematical activity rather than added as instructional decoration (Engelbrecht & Borba, 2024).

Accordingly, this study examined how entrepreneurship-based SLETV linear-programming tasks implemented through a UTAUT-based EEM learning model were associated with the development of vocational high-school students' mathematical creativity. Its contribution is an operational learning trajectory that connects entrepreneurial meaning, technology-supported representation, SLETV-based optimisation, and five measurable dimensions of creativity within a single vocational mathematics intervention.

METHODS

Research Design

The primary design was a one-group pre-experimental pretest–post-test design used to obtain preliminary evidence of change following the intervention. Design-oriented activities—including scenario development, expert review of the learning sequence, classroom implementation, and reflection on students' responses—were used to construct and refine the intervention. This distinction is important: the quantitative component estimated within-group change, whereas qualitative evidence was used to explain how the learning trajectory operated.

The intervention comprised eight meetings over four weeks, with each meeting lasting 2 × 45 minutes. The same entrepreneurial scenarios, worksheets, meeting duration, creativity indicators, and scoring rubrics were used across the participant group to support consistency of implementation. Activities focused on five mathematical processes: defining decision variables, formulating linear equations in two variables, solving and interpreting SLETV, constructing the feasible region and objective function, and justifying an optimal decision.

Participants and Context

Participants were 80 Grade 11 students from Accounting, Retail Business, Visual Communication Design, and Office Management programmes at one private vocational high school in West Jakarta. The available classes were included as intact groups because their programmes offered relevant contexts, including business planning, cost calculation, design services, scheduling, and resource allocation.

The UTAUT-Based EEM Learning Model

The integrated model was implemented through four recurring learning phases. First, students selected or examined an entrepreneurial situation to establish task meaning. Second,

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the teacher used structured worksheets, worked examples, and digital representations to make the modelling process manageable. Third, groups constructed and revised SLETV and linear-programming models while comparing representations. Fourth, students presented and defended their decisions, and peer questions were used to test feasibility and optimality. Table 1 summarises how the theoretical constructs were translated into learning activities and observable evidence of creativity.

Table 1. Operationalisation of the UTAUT-Based EEM Learning Model

Construct	Operational learning function	Representative activity	Evidence of creativity
Perceived desirability (EEM)	Make the problem personally and vocationally meaningful	Select a local product or service and discuss why the decision matters	Fluency in proposing viable variables and contexts
Perceived feasibility (EEM)	Build confidence that the model can be constructed and solved	Use worked examples, prompting questions, and staged worksheets	Elaboration and defensible assumptions
Propensity to act (EEM)	Move students from an idea to a decision and public accountability	Revise, present, and defend a business decision	Proof-oriented justification
Performance expectancy (UTAUT)	Show that representations improve decision quality	Use tables, graphs, and comparisons of objective-function values	Representational flexibility and elaboration
Effort expectancy (UTAUT)	Reduce unnecessary procedural difficulty	Follow staged templates and receive focused feedback	More accurate coordination of equations and graphs
Social influence (UTAUT)	Use peers as sources of critique and modelling norms	Question another group's constraints and optimal point	Revision and justification
Facilitating conditions (UTAUT)	Ensure access to devices and materials	Use computers, calculators, worksheets, and visual media	Sustained modelling across representations

Figure 1 illustrates how the UTAUT-Based EEM learning model supports an SLETV-based modelling cycle. EEM strengthens task meaningfulness, perceived feasibility, and students' willingness to act, while UTAUT supports the effective use of digital representations, peer collaboration, and learning resources. Together, these mechanisms guide students in defining variables, formulating and solving systems, representing constraints and feasible regions, constructing objective functions, and justifying optimal decisions, thereby fostering fluency, representational flexibility, originality, elaboration, and proof-oriented justification.

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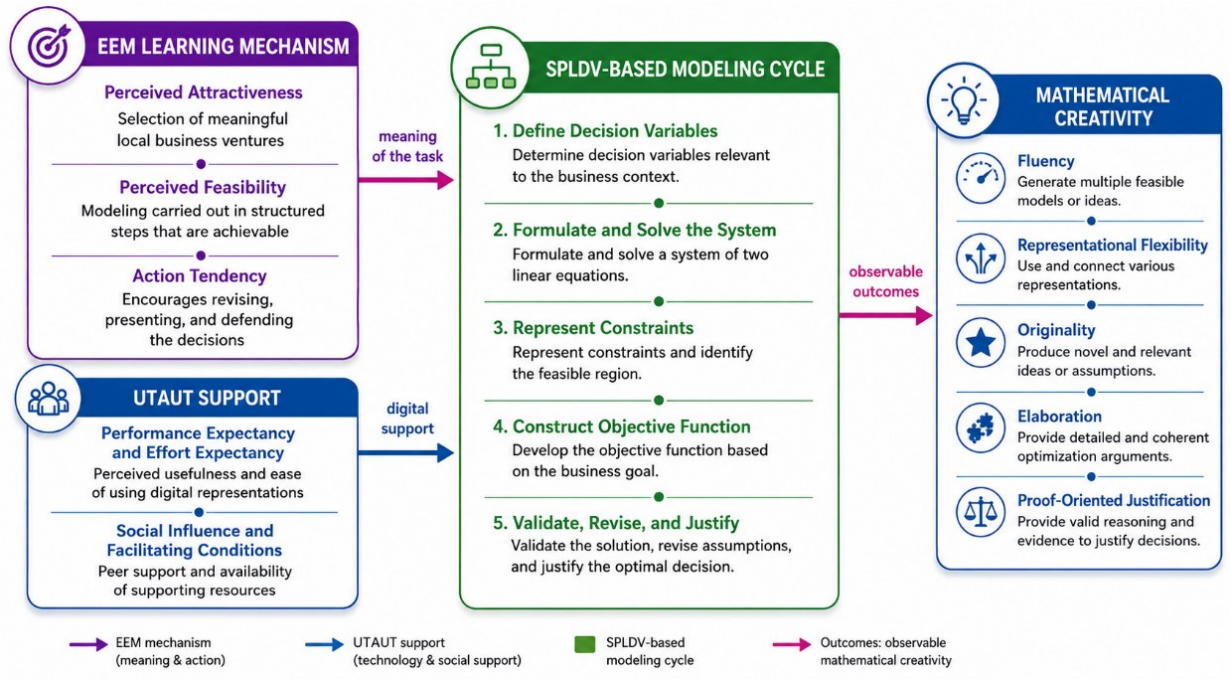


Figure 1. Operational Flow of the UTAUT-Based EEM Learning Model

Learning Trajectory

The learning trajectory progressed from informal entrepreneurial reasoning to formal optimisation. Each meeting generated observable evidence through worksheets, group discussion, or presentations. The trajectory organised task completion, observation, and assessment around how students defined symbols, coordinated representations, revised assumptions, and justified decisions.

Table 2 shows the learning trajectory over eight meetings, conducted in stages, from understanding the entrepreneurial context to optimal decision-making, which fosters increased mathematical creativity. In the initial stage, students select a local product or service, define variables, and construct equations from price, cost, or production target information. Next, students solve SLETV using multiple representations, transform business constraints into inequalities, determine feasible regions and corner points, and then construct objective functions to compare profit alternatives. In the final stage, students revise the model when there are changes in price, demand, or capacity, then integrate and maintain optimal decisions. Each stage integrates UTAUT-based EEM constructs with aspects of mathematical creativity, from desirability and modelling fluency to originality, model validation, social influence, and evidence-oriented justification.

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Table 2. Eight-Meeting Learning Trajectory

No	Entrepreneurial situation and focus	Student modelling activity	EEM–UTAUT/creativity emphasis
1	Select two local products or services; define decision variables	Define x and y, including the quantity and unit represented by each	Desirability; modelling fluency
2	Price packages, costs, or production targets; formulate equations	Translate verbal relationships into $ax + by = c$	Performance expectancy; coefficient meaning
3	Two conditions must be satisfied; solve SLETV	Use elimination, substitution, and graphs; check both equations	Effort expectancy; representational flexibility
4	Capital, material, or time limits; formulate inequalities	Test points and shade the feasible region	Facilitating conditions; contextual validation
5	Compare production alternatives; identify vertices	Solve SLETV formed by intersections of boundary lines	Fluency and representational coordination
6	Calculate profit; construct the objective function	Evaluate every vertex and explain the selected decision	Performance expectancy; elaboration
7	Change price, demand, or capacity; revise assumptions	Modify a constraint or objective function and re-evaluate the model	Feasibility; originality and model validation
8	Present the business decision; justify optimality	Defend the variables, constraints, feasible region, and optimal point	Propensity to act, social influence, and proof-oriented justification

Instruments

Data were collected using a 50-item mathematical creativity instrument administered across the four vocational programmes, supported by performance rubrics, student worksheets, and classroom observations. The instrument used a five-point scale and comprised 7 items on SLETV modelling fluency, 10 on representational flexibility, 14 on the originality of entrepreneurial assumptions, 10 on the elaboration of optimisation arguments, and 9 on proof-oriented justification. Representative tasks asked students to generate alternative product models, coordinate verbal, algebraic, and graphical representations, propose defensible constraints, explain the optimisation process, and demonstrate that a selected point was both feasible and optimal. Validity evidence was examined using corrected item–total correlations, and internal consistency was estimated using Cronbach's alpha. With $n = 80$ and $\alpha = .05$ (two-tailed), the critical correlation was $r = .220$; all 50 corrected item–total correlations exceeded this value.

Table 3 shows that all 50 items of the mathematical creativity instrument met the validity criteria because the corrected total item correlation value for each dimension was above the $r > .220$ limit. The five dimensions of SLETV modelling fluency, representational flexibility, entrepreneurial assumption originality, optimization argument elaboration, and proof-oriented justification also had Cronbach's alpha values between 0.847 and 0.901, so all

items were retained. Overall, the alpha value of 0.938 indicates that the instrument has very high internal consistency and is suitable for measuring students' mathematical creativity.

Table 3. Item Validity and Internal Consistency of the Mathematical Creativity Instrument

Dimension	Items	Corrected item–total *r*	Cronbach's α	Decision
SLETV modelling fluency	7	0.412–0.789	0.847	Retained
Representational flexibility	10	0.398–0.812	0.892	Retained
Originality of entrepreneurial assumptions	14	0.421–0.834	0.901	Retained
Elaboration of optimisation arguments	10	0.387–0.798	0.878	Retained
Proof-oriented justification	9	0.405–0.756	0.856	Retained
Overall	50	—	0.938	Very high internal consistency

Note. Retention criterion: $r > .220$ at $\alpha = .05$, two-tailed, $n = 80$.

Data Analysis

Pretest and post-test scores were summarised using the mean, standard deviation, minimum, and maximum. Mean-score categories were defined using equal-width intervals on the five-point scale: 1.00–1.80, very low; 1.81–2.60, low; 2.61–3.40, moderate; 3.41–4.20, high; and 4.21–5.00, very high. A paired-samples t test was used to examine mean change, and Cohen's *d* was calculated as $|t|/\sqrt{n}$ to report the standardised within-participant effect (Lakens, 2013). The relevant distributional assumption concerns the paired difference scores. Because the available analysis record did not contain a normality statistic, the inferential result is interpreted cautiously and should be supplemented in the final author-verified file with a Q–Q plot or a Shapiro–Wilk result.

Reported normalised gain was interpreted using the conventional categories of low (< .30), moderate (.30–.69), and high (≥ .70) commonly used in gain-score practice (Hake, 1998). Because normalised gain is sensitive to pretest level, it was reported alongside raw change and Cohen's *d* rather than treated as the sole indicator of improvement (Nissen et al., 2018). Evidence from worksheets and observations was analysed descriptively according to the five creativity dimensions and the modelling processes of interpretation, mathematisation, representation, validation, revision, and justification (Cevikbas et al., 2022; Lu & Kaiser, 2022a).

RESULTS AND DISCUSSION

Initial Profile and SLETV Difficulties

The four vocational programmes generated different yet mathematically relevant interpretations of the entrepreneurial situations. Accounting students tended to foreground costs

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and profit; Retail Business students emphasised price and demand; Visual Communication Design students focused on products or design services; and Office Management students highlighted time, documentation, and work capacity. This diversity broadened the assumptions available for modelling, while the common SLETV structure enabled comparisons across contexts.

Initial responses showed that students could name business quantities but often failed to assign them precise mathematical meanings. A recurring pattern was the use of x and y as empty symbols followed immediately by arithmetic operations. Another was the presentation of an ordered pair without explaining the two equations it satisfied or the business meaning of each coordinate. These responses support the interpretation that the initial difficulty concerned contextual mathematisation and validation, not elimination or substitution alone (Verschaffel et al., 2020). Initial mathematical creativity was therefore assessed through the quality of modelling actions—generating, representing, revising, and justifying—rather than through the attractiveness of a business idea.

Representative Learning Episodes

To avoid reproducing all eight meetings descriptively, Table 4 synthesises three representative episodes that capture the principal changes in students' work. Each episode is organised around a central finding, empirical evidence, interpretation, and its connection to the integrated learning mechanisms.

Table 4. Representative Empirical Episodes across the Learning Trajectory

Episode	Main finding	Empirical evidence	Interpretation and mechanism
Defining variables and equations	Symbols became connected to decisions and units	Initially: "x and y." Later: "x = number of food packages; y = number of beverage packages," followed by explanations of coefficient units	Meaningful product choices supported perceived desirability; structured tables strengthened performance expectancy and modelling fluency
Constructing and revising constraints	Students distinguished boundary equations from inequalities that define a feasible region	Groups tested points, rejected combinations exceeding capital or time, and introduced assumptions such as minimum demand or changes in capacity	Scaffolding supported feasibility; revision required originality to remain mathematically consistent
Defending an optimal decision	Arguments developed beyond reporting the largest value	Groups compared all vertices and answered questions such as "Does this point satisfy every constraint?" and "Why is this point optimal?"	Peer critique activated social influence and propensity to act; justification coordinated graphs, SLETV, and objective-function values

The first episode indicates that fluency developed as students generated several viable product or service pairs and attached measurable meanings to x and y. The important change was not merely an increase in contextual ideas but a transition from undefined symbols to decision variables with explicit units. This transition made coefficients interpretable and reduced the tendency to manipulate numbers without constructing a model. The finding is consistent with research showing that authentic modelling requires learners to coordinate contextual meanings with mathematical representations (English & Watson, 2018).

The second episode captures the conceptual transition from exact equations to resource constraints. Initially, students drew boundary lines without being able to explain which side should be shaded. Testing feasible and infeasible points transformed the inequality sign into a statement about a business condition rather than a graphical convention. When price, capacity, or demand changed, students revised the model and examined the resulting change in the feasible region or objective function. Originality therefore became mathematically accountable: an assumption was treated as creative only when it could be represented consistently and tested against the context. This relationship between openness and model credibility is central to creativity-demanding modelling (Carreira & Baioa, 2018; Lu & Kaiser, 2022b).

The third episode shows that proof-oriented justification developed through public argumentation. Students who initially stopped after calculating one large objective-function value gradually began to compare all vertices, verify every constraint, and interpret the selected point as a production decision. Peer questions exposed incomplete arguments and prompted revision.

Classroom discussion connected the entrepreneurial context, the formulation of simultaneous SLETV models, the extension to inequalities, and the comparison of alternative solutions. As illustrated in Figure 2, this sequence positioned creativity within a disciplined modelling process: students proposed a business context, formalised simultaneous conditions, constructed a feasible region, and justified an optimal decision. The pattern supports research that treats validation and classroom discussion as essential components of mathematical modelling rather than optional final steps (Gürel, 2023; Czocher, 2018).

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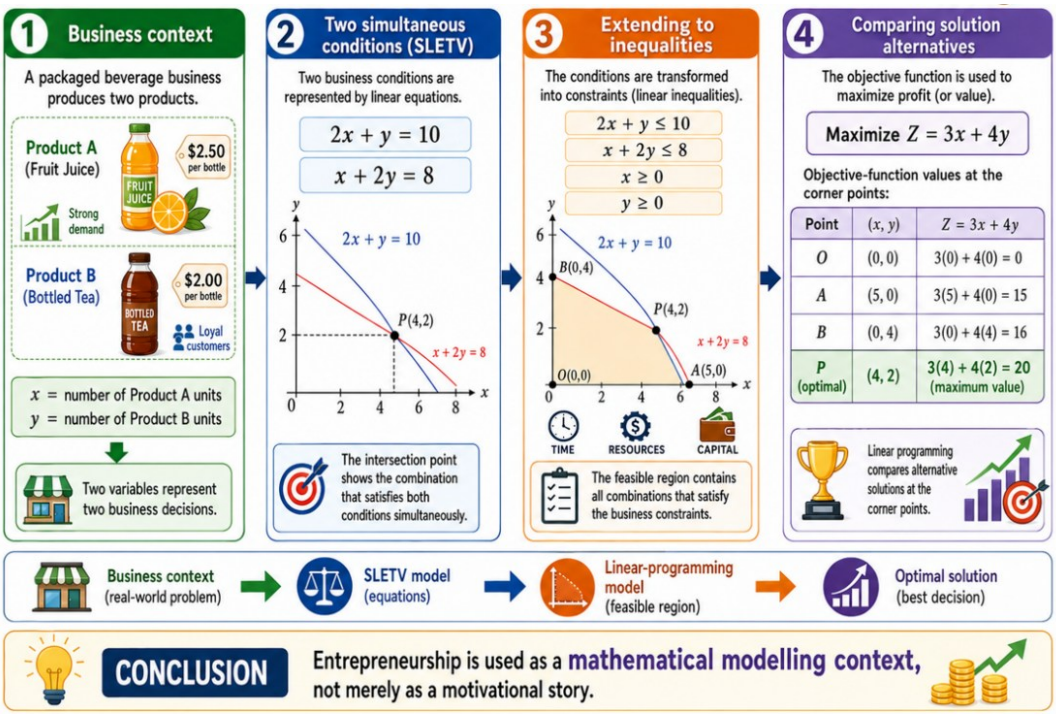


Figure 2. Sequence of Entrepreneurship-Based Mathematical Creativity Activities

Quantitative Change in Mathematical Creativity

Table 5 shows an increase in students' mathematical creativity scores after the intervention. The average score increased from 3.053 on the pretest, which is in the moderate category, to 3.922 on the post-test, which is in the high category, with a mean difference of 0.868. The standard deviation also decreased from 0.512 to 0.476, indicating slightly more consistency between post-test results across students. These findings suggest that after the intervention, students' mathematical creativity abilities improved both in terms of average achievement and score stability.

Table 5. Descriptive Statistics for Pretest and Posttest Scores

Measurement	N	Mean	SD	Minimum	Maximum	Category
Pretest	80	3.053	0.512	1.760	4.438	Moderate
Post-test	80	3.922	0.476	2.738	4.986	High
Difference	80	0.868	0.164	0.398	1.220	Increased

The quantitative change was consistent with the qualitative pattern. Early work frequently contained only final answers without units or reasons, whereas later work more often included variable definitions, coefficient meanings, reasons for inequality signs, vertex comparisons, and contextual interpretations. The addition of these elements indicates a shift from procedural solution production towards a more complete modelling cycle in which mathematical results are explained and validated.

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Table 6. Normalised Gain by Creativity Dimension

Dimension	Pretest mean	Post-test mean	Difference	Normalised gain	Category
SLETV modelling fluency	3.202	4.050	0.848	0.503	Moderate
Representational flexibility	3.061	3.901	0.840	0.459	Moderate
Originality of entrepreneurial assumptions	2.930	3.863	0.933	0.471	Moderate
Elaboration of optimisation arguments	3.046	3.913	0.866	0.469	Moderate
Proof-oriented justification	3.026	3.881	0.854	0.459	Moderate
Overall	3.053	3.922	0.868	0.476	Moderate

Table 6 shows that all dimensions of mathematical creativity experienced a moderate increase, with an overall normalized gain of 0.476. The highest increase occurred in SLETV modelling fluency with a gain of 0.503, indicating the strongest development in students' ability to build and develop models. Originality of entrepreneurial assumptions had the largest score difference, at 0.933, despite its gain value of 0.471. Meanwhile, representational flexibility and proof-oriented justification achieved the lowest gains, at 0.459 each, so both aspects still require strengthening in subsequent learning. These dimensions require the coordination of several mathematical objects—equations, inequalities, graphs, vertices, and objective-function values—so their development demands more than the generation of contextual ideas. This pattern accords with evidence that modelling competence and creativity are related but multidimensional constructs (Lu & Kaiser, 2022a, 2022b).

Originality increased from the lowest pretest mean (2.930) to 3.863. Classroom evidence suggests that this growth emerged when students revised assumptions such as minimum demand, promotional prices, or production capacity and then represented those changes mathematically. The distinction is important: novelty without model consistency does not constitute mathematical creativity. By contrast, a defensible alteration to a constraint or objective function demonstrates originality together with disciplinary control.

Proof-oriented justification remained among the dimensions with the smallest gain (g = 0.459). Students could often identify a promising point before they could demonstrate that it satisfied every constraint and yielded a better value than all other vertices. This finding explains why presentation prompts and peer critique should be retained in subsequent implementations. It also supports literature identifying validation as one of the most demanding stages of modelling (Czocher, 2018; Krawitz et al., 2025).

Pedagogical Implications

For mathematics teachers, the findings support a three-layer instructional sequence: contextual openness, mathematical structuring, and justification. Students may select products

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and assumptions, but each choice must be translated into variables, relationships, constraints, and a defensible decision. Teacher questioning should repeatedly require students to explain the meaning of symbols, the units represented by coefficients, and the reasons a point is classified as feasible.

In task design, entrepreneurial situations should contain genuine decision points rather than decorative business vocabulary. Product combinations, resource limits, and changing assumptions can generate several defensible models, while the SLETV-to-linear-programming sequence preserves mathematical coherence. Tasks should also incorporate conditions requiring revision so that originality is assessed through changes to equations, inequalities, or objective functions.

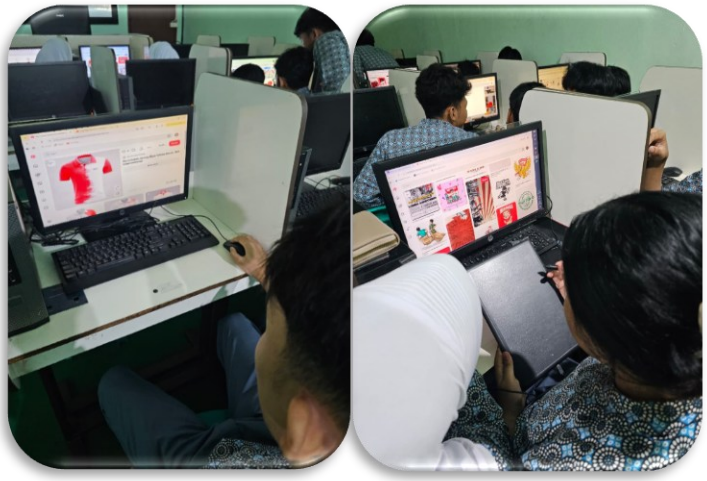


Figure 3. Individual and Collaborative Student Work Using Digital Visuals and Tablets to Develop Product Ideas

For technology use, the UTAUT-supported EEM framework provides a practical design check. A tool should demonstrably support students' mathematical performance, remain sufficiently manageable not to displace mathematical attention, receive peer and teacher support, and be available in the classroom. Figure 3 shows that digital visual exploration can support product conceptualisation; however, its mathematical value emerges only when the resulting ideas are transformed into structured models. Technology acceptance is therefore a condition supporting participation, not a substitute for mathematical reasoning (Al-Emran & Granić, 2021; Engelbrecht & Borba, 2024).

Creativity assessment should distinguish modelling fluency, representational flexibility, originality, elaboration, and proof-oriented justification. A visually appealing or commercially attractive idea should not receive a high mathematical creativity score when the model is

incoherent, assumptions remain implicit, or the optimal decision is unsupported by evidence. This distinction enables a common mathematical standard to be applied across different vocational programmes.

Limitations and Potential Contributions

This study has several limitations. First, the single-group pre-test and post-test design cannot rule out the effects of testing, maturation, teacher support, or other temporal explanations; consequently, observed improvements should be interpreted as changes within a single group rather than causal evidence of intervention effectiveness. Second, participants were drawn from an intact class at a single vocational school, which limits transferability to other schools, regions, and vocational programs. Third, the four-week intervention and the lack of a delayed post-test prevent conclusions about retention and transfer of learning.

Despite these limitations, this study offers several potential contributions. Conceptually, it connects the meanings of entrepreneurship, technology acceptance, mathematical modelling, and mathematical creativity within a single instructional framework. Instructionally, it provides a trajectory of eight operational encounters that positions SLETV as a bridge from simultaneous conditions to inequality, feasible domain, objective function, and optimal decision. Methodologically, it translates mathematical creativity into five observable dimensions and combines score changes with classroom episodes, worksheets, and performance evidence. Contextually, this study demonstrates how general mathematical structures can support vocationally relevant tasks in Accounting, Retail Business, Visual Communication Design, and Office Management. Therefore, it can inform the design, observation, and assessment of vocational mathematics activities, where creative ideas must remain mathematically coherent, contextually defensible, and supported by evidence.

Future studies should employ multi-school quasi-experimental or randomized designs, report implementation fidelity and inter-rater agreement, validate the instrument through confirmatory factor analysis, measure UTAUT-based EEM constructs directly, include delayed post-tests, and examine whether outcomes differ by vocational program, prior achievement, and access to digital resources.

CONCLUSION

The results of this study indicate that the use of SLETV can enhance students' entrepreneurship-based mathematical creativity through the UTAUT-based EEM learning model in vocational schools, particularly the fluency indicator in constructing SLETV models.

The learning trajectory positions SLETV as a conceptual foundation for optimization by linking variable definitions, simultaneous equations, intersections, constraints, feasible regions, objective functions, and optimal decisions. The EEM construct makes tasks meaningful, achievable, and action-oriented, while the UTAUT construct supports the productive use of representations, digital tools, peer interactions, and classroom resources. The strongest improvement occurred in modelling fluency, while evidence-oriented justification remains relatively challenging.

This study provides an operational framework linking entrepreneurial context, technology acceptance, and mathematical creativity through observable learning activities. Future research is expected to replicate the intervention in several vocational high schools, using a comparison group or a more robust quasi-experimental design.

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