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Tebiras Sarong: A Number Theory Based Innovation Derived from the Menara Kudus Motif

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Abstract

This study aims to develop and evaluate Sarung Tebiras, an innovative reinterpretation of the Menara Kudus sarong that integrates number theory concepts to cultivate students' edupreneurial competencies. The research employed a 4D Research and Development (R&D) model consisting of the Define, Design, Develop, and Disseminate stages. Data were collected through expert validation forms, student response questionnaires, and edupreneurship assessments, and were analyzed using validation scoring, Likert-scale conversion, and feasibility testing. The development process produced a sarong design integrating number theory elements such as prime numbers, factorization, congruence, Euler's theorem, and modulo arithmetic into the traditional Menara Kudus motif. Expert evaluations from material, design, and edupreneurship specialists indicated that the product met the criteria of very worthy and worthy. Student responses indicated a positive reception, with an average score of 96%. The edupreneurship questionnaire yielded an average score of 39.21, categorized as very good. These results showed that Sarung Tebiras is feasible and effective as a culturally grounded innovative product that integrates mathematical concepts while enhancing students' edupreneurial development. The novelty and contribution of this study lie in demonstrating how integrating number theory concepts into the Menara Kudus sarong motif can produce a contextual learning product that enhances mathematical understanding and stimulates students' edupreneurial awareness.

Keywords: Ethnomathematics; Number Theory; Edupreneur; Menara Kudus Sarong

Abstrak

Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi Sarung Tebiras, sebuah reinterpretasi inovatif dari sarung Menara Kudus yang mengintegrasikan konsep teori bilangan untuk menumbuhkan kompetensi edupreneurial siswa. Penelitian ini menggunakan model Penelitian dan Pengembangan (R&D) 4D yang terdiri dari tahap Define, Design, Develop, dan Disseminate. Data dikumpulkan melalui formulir validasi ahli, kuesioner respons siswa, dan penilaian

edupreneurship, dan dianalisis menggunakan skor validasi, konversi skala Likert, dan uji kelayakan. Proses pengembangan menghasilkan desain sarung yang mengintegrasikan unsur-unsur teori bilangan seperti bilangan prima, faktorisasi, kongruensi, teorema Euler, dan aritmatika modulo ke dalam motif Menara Kudus tradisional. Evaluasi ahli dari spesialis material, desain, dan edupreneurship menunjukkan bahwa produk tersebut memenuhi kriteria "Sangat Layak" dan "Layak". Respons siswa menunjukkan penerimaan yang positif, dengan skor rata-rata 96%. Kuesioner edupreneurship menghasilkan skor rata-rata 39,21, yang dikategorikan "Sangat Baik". Hasil ini menunjukkan bahwa Sarung Tebiras layak dan efektif sebagai produk inovatif berbasis budaya yang mengintegrasikan konsep matematika sekaligus meningkatkan perkembangan edupreneurial siswa. Kebaruan dan kontribusi penelitian ini terletak pada bagaimana mengintegrasikan konsep teori bilangan ke dalam motif sarung Menara Kudus dapat menghasilkan produk pembelajaran kontekstual yang meningkatkan pemahaman matematika dan merangsang kesadaran edupreneurial siswa.

Kata Kunci: Etnomatematika; Teori Bilangan; Edupreneur; Sarung Menara Kudus

Introduction

The need to strengthen students' entrepreneurial mindset has become a critical concern in higher education, including in the field of mathematics education (Amalia & von Korflesch, 2021). This urgency is reinforced by Indonesia's demographic and economic landscape, in which university graduates continue to constitute a significant portion of the unemployment rate. Entrepreneurship education is therefore expected to equip students with creativity, adaptive problem-solving, and innovation skills competencies that are also fundamental in mathematics learning. In line with this, entrepreneurship in education (edupreneurship) emphasizes students' ability to think creatively, take initiative, and transform knowledge into meaningful products (Wijoyo & Haudi, 2021). Thus, integrating entrepreneurial values into mathematics learning becomes increasingly relevant and strategic.

Students pursue entrepreneurial pathways for various reasons, including the need to meet living expenses, family influences, educational experiences, and expectations of financial independence (Parhana, 2019). Creating student edupreneurs can be done through entrepreneurial education. Entrepreneurial education is defined as the development of knowledge, interests, or entrepreneurial spirit in individuals through educational activities and training, both within and outside the educational system, to become successful entrepreneurs in the future (Linan, 2013).

An entrepreneurial spirit is essential for students because it enables them to become self-reliant and contribute to society by creating new jobs. This role demands strong creativity to keep a business growing and sustainable (Wahyuni et

al., 2021). The government also encourages students to develop an entrepreneurial mindset to strengthen the national economy (Perwita et al., 2024). Given the intense competition in the entrepreneurial world, development is necessary, including in the Muslim fashion sector. Sarongs are a type of clothing commonly owned by Muslims. Sarongs are traditional garments worn by Muslims to cover their body during prayer and other religious activities. Over time, they have continued to evolve, and various designs and motifs have emerged (Ni'mah, 2022).

Kudus Regency is one of the regions recognized for its sarong production. The area is also known for a wide range of crafts and traditional foods. Batik is one of the most prominent crafts among the local community. As a center of Islamic learning, Kudus inspired local artisans to develop Kudus batik sarongs (Mustika et al., 2018). These sarongs feature various distinctive elements, including local plant motifs, cigarette imagery, and the Menara Kudus. The emergence of motifs with unique meanings for Kudus residents has led to a surge in batik sarong production, prompting artisans to compete to create new designs (Azizah et al., 2021). Al-Hazmi, a local resident of Kudus, possesses the potential to create batik sarongs, crafting sarongs with motifs that embodied the city's identity (Noor, 2022). Umah (2023) also concluded that sarongs with batik motifs can be used as a medium for Islamic preaching, as seen in the Kaumnan batik sarong pattern.

Menara Kudus (Kudus Tower) is the center and most distinctive symbol of Kudus batik sarongs, boasting a unique and meaningful shape. A legacy steeped in history, makes local residents and outsiders alike enjoy wearing sarongs with this tower motif. The tower has a simple shape and can be associated with lines and shapes. In addition to lines and shapes, other studies have also noted that many batik sarong producers, such as those from Pekalongan, Tegal, Kudus, and Madura, use rectangular, perpendicular patterns on the left and right sides of coastal batik sarongs (Ishwara, 2013). These patterns can be linked to mathematics learning by incorporating the concept of ethnomathematics.

In recent years, global research on Ethnomathematics has increasingly emphasized the value of integrating local cultural practices with mathematics education to foster not only conceptual understanding but also socio-cultural and entrepreneurial competencies. For instance, a bibliometric study by Unveiling Emerging Trends and Potential Research Themes in Future Ethnomathematics Studies: A Global Bibliometric Analysis (2025) revealed a sharp rise in publications linking ethnomathematics with mathematics learning, cultural preservation, and student empowerment through creative-entrepreneurial outputs (Nasrum et al., 2025). Similarly, Modern Ethnomathematics Mainstreaming through Mathematics Entrepreneurship Using Mathematical Ornaments demonstrated that mathematical ornaments derived from parametric and geometric equations can be turned into

cultural products supporting a mathematics-to-entrepreneurship pipeline. (Parhusip et al., 2021). In a more recent experimental study, Integrating cultural contexts into mathematics: effects of culture-based worksheets on students' mastery of geometric transformations found that culture based worksheets significantly improved students' understanding of geometric transformation, suggesting that cultural embedding enhances comprehension and relevance (Khairunnisa et al., 2025).

Ethnomathematics is a local wisdom combined with mathematical concepts (Faiza et al., 2023). Several batik sarong patterns have been found to be integrated with mathematical concepts (Hasanah et al., 2022). such as the patterns of Samarinda woven sarongs. For example, the bamboo shoot pattern, which is almost identical to the Hatta pattern, contains geometric concepts including parallel lines, squares, perpendicular intersecting lines, and rectangles. Furthermore, the squid pattern embodies the concept of mirroring or reflection. This discovery is a product of ethnomathematics and can therefore be used as an alternative learning medium for students (Nasiah & Toni, 2024). However, these studies generally focus only on identifying mathematical elements; few have developed them into innovative educational products, let alone products that strengthen students' entrepreneurial character.

Number Theory is one of the courses in the mathematics education study program. Many theoretical concepts can be used to find answers in working on problems. Formulas in number theory can also be used to create a shape, namely lines and shapes (Faiza et al., 2023). The shape of lines and shapes composed of formulas can form shapes that can be arranged to form a pattern of Menara Kudus image. Therefore, the author proposes the innovation of "Sarung Tebiras," a sarong design that applies number theory formulas as the foundation for developing the Menara Kudus motif. The objectives of this study are: 1) to determine the creation of "Sarung Tebiras" an innovation of the Kudus Tower sarong with the application of number theory as the development of the student's edupreneurial spirit; and 2) to determine the effectiveness of "Sarung Tebiras" an innovation of the Kudus Tower sarong with the application of number theory as the development of the student's edupreneurial spirit. At this stage, the link between student entrepreneurship and local cultural potential becomes highly relevant. Encouraging students to transform mathematical ideas into cultural products supports entrepreneurship education and simultaneously preserves local wisdom. Thus, integrating number theory into Kudus sarong motifs provides a meaningful approach that allows students to experience mathematics through product creation, creativity, and cultural appreciation.

Despite the richness of local textile motifs, no previous research has attempted to embed number theory formulas directly into the design of Menara Kudus sarongs. Previous studies have explored batik motifs as learning media, but they have not produced marketable cultural products that combine mathematical content with entrepreneurship development. This highlights a clear scientific gap, namely the absence of culturally grounded and mathematically informed textile innovations that also support the development of students' edupreneurial competencies. Therefore, this research develops and evaluates "*Sarung Tebiras*," an innovative Menara Kudus sarong design that incorporates Number Theory concepts. This study contributes to ethnomathematics, product-based learning, and entrepreneurship education by transforming abstract mathematical concepts into a functional cultural product that can be commercially applied while strengthening students' edupreneurial competencies.

Method

This study employed a Research and Development (R&D) approach using the 4D model by Thiagarajan, which consists of the Define, Design, Develop, and Disseminate stages (Thiagarajan et al., 1974). In this research, the 4D model was applied specifically to guide the development of "*Sarung Tebiras*," an innovative sarong design that integrates Number Theory concepts into the traditional Menara Kudus motif. The explanation of the method focuses directly on how each stage was implemented rather than providing extensive theoretical definitions.

The Define stage involved analyzing the needs of 79 Mathematics Education students, which revealed that Number Theory was often viewed as abstract and lacking real-life relevance. Learner characteristics also showed strong familiarity with sarong culture, guiding the selection of key Number Theory concepts to be integrated into the Menara Kudus sarong motif to support contextual and creative learning. The Design stage involved developing the initial prototype of "*Sarung Tebiras*" by creating the motif using Ibis Paint and arranging the layout in Canva. Mathematical elements were integrated with traditional Menara Kudus sarong patterns, followed by selecting Toyobo fabric and sublimation printing. Branding, packaging, and product specifications were prepared, along with the development of validation instruments and questionnaires for data collection. In addition to product design, this stage also included the development of research instruments, specifically the entrepreneurial spirit questionnaire. This instrument was structured based on components of an entrepreneurial mindset, such as creativity, initiative, resilience, problem-solving, and opportunity recognition, adapted from the framework proposed by (Dinh et al., 2022). The questionnaire comprised indicators reflecting cognitive, affective, and behavioral aspects of students'

entrepreneurial potential. Expert validation was conducted by an edupreneurship specialist to ensure the instrument's clarity, relevance, and suitability in measuring the extent to which Sarung Tebiras can foster students' entrepreneurial characteristics. This process strengthened the credibility of the assessment tool used in subsequent evaluations.

The Develop stage included expert validation and revision of the prototype, involving six validators in material, design, and edupreneurship. After incorporating their feedback, a limited trial with nine Mathematics Education students was conducted to assess practicality, clarity, aesthetics, and entrepreneurial potential. During this stage, the entrepreneurial characteristics questionnaire based on (Pelipa & Marganingsih, 2020) was refined and validated to ensure its suitability for measuring students' entrepreneurial development through the Sarung Tebiras product. The Disseminate stage was carried out after the product met the criteria for feasibility and effectiveness. The final prototype was introduced in classroom learning activities and shared through social media platforms, particularly Instagram (@al_mumtazkudus), to reach a wider audience. The dissemination also involved presenting the sarong to students who had participated in the trial to observe how the product functioned within a learning and entrepreneurial context.

Data collection in this study included expert validation, student response questionnaires, the entrepreneurial characteristics questionnaire, and documentation. Quantitative data were analyzed using Likert scale conversion and feasibility percentage calculations, while qualitative data from expert comments and student feedback were used to revise and refine the product. The combination of these procedures ensured that the development of Sarung Tebiras was systematically evaluated both as an educational product and as an instrument to enhance students' entrepreneurial characteristics.

The data analysis technique involves the following stages: 1) validating the "sarong tebiras" design with validators; 2) converting data obtained from experts into a Likert scale and determining the feasibility percentage; 3) determining the feasibility percentage and good category, and concluding its effectiveness. The feasibility percentage can be calculated using the formula (Purwanto, 2013):

$$Eligibility\ percentage = \frac{\sum observation\ score}{\sum maximum\ score} \times 100\%$$

criteria for assessing feasibility conclusions with the following formula (Purwanto, 2013):

Table 1. Score Categories in Likert Scale

No.	Score Range	Category
1.	$\bar{X} > X_i + 1,8 S_{Bi}$	Very Worthy
2.	$X_i + 0,6 S_{Bi} < \bar{X} \leq X_i + 1,8 S_{Bi}$	Worthy
3.	$X_i - 0,6 S_{Bi} < \bar{X} \leq X_i + 0,8 S_{Bi}$	Less Worthy
4.	$X_i - 1,8 S_{Bi} < \bar{X} \leq X_i - 0,6 S_{Bi}$	Not Worthy
5.	$\bar{X} \leq X_i - 1,8 S_{Bi}$	Very Not Worthy

Information:

\bar{X} = Average value

X_i = Ideal average

S_{Bi} = Ideal standard deviation

And then criteria for assessing effective conclusions with the following formula (Purwanto, 2013):

Table 2. Score Categories in Likert Scale

No.	Score Range	Category
1.	$\bar{X} > X_i + 1,8 S_{Bi}$	Very Good
2.	$X_i + 0,6 S_{Bi} < \bar{X} \leq X_i + 1,8 S_{Bi}$	Good
3.	$X_i - 0,6 S_{Bi} < \bar{X} \leq X_i + 0,8 S_{Bi}$	Less Good
4.	$X_i - 1,8 S_{Bi} < \bar{X} \leq X_i - 0,6 S_{Bi}$	Not Good
5.	$\bar{X} \leq X_i - 1,8 S_{Bi}$	Very Not Good

Information:

\bar{X} = Average value

X_i = Ideal average

S_{Bi} = Ideal standard deviation

Results

The procedures carried out in this research and development use the 4D learning development model. This model adopts the learning development model of Thiagarajan et al. (1974), et al which includes 4 stages, namely define, design, develop and disseminate. The data results of each stage of the research and development procedure carried out are as follows: the first stage is the Define stage. a) Initial Final Analysis. At this stage, a preliminary study questionnaire was given to 79 students of UIN Sunan Kudus mathematics education related to teaching materials for Number Theory learning, data was obtained from several questions asked.

Based on the results of a preliminary study questionnaire conducted by the researcher, it was shown that the material taught in the course was disconnected from the concepts of students' daily lives. This resulted in students lacking interest and having a short-term memory for number theory materials such as prime

numbers, factorization, congruence, Euler's theorem, Fermat's theorem, and modulo arithmetic. Lecturers never linked the material to other disciplines such as science, technology, and culture. Consequently, students received little functional value from the course. b) Student Analysis, obtained regarding their educational background, domicile, customs, initial level of understanding of the material, and obstacles they may face in learning. In addition, information was also collected regarding the entrepreneurial spirit of prospective teacher students. Based on interviews, it was found that the students were around 20 years old or classified as teenagers. They said that their current interest was in Muslim fashion. Seeing this condition, a design was developed for one of the Muslim fashions, namely sarongs, which are definitely used every day by male students for worship. On the other hand, the majority of students were from Kudus and Pati districts which are known for their religious communities. c) Task Analysis, task or material analysis was carried out by identifying the main material that needs to be included in the pattern, collecting and selecting relevant material. The material patterns presented were prime numbers, factorization, congruence, Euler's theorem, Fermat's theorem, and modular arithmetic. d) Concept Analysis, concept analysis was carried out by identifying the characteristics of the Kudus tower sarong pattern, designing and compiling the "Sarung Tebiras" design, which combines the Kudus tower sarong pattern with symbols in the Number Theory material. e) Instructional Objective Specifications, the product compiled refers to the KKN curriculum. The KKN curriculum includes Graduate Profile Achievements (CPL) and Course Profile Achievements (CPMK), which encompass four competencies: attitudes, knowledge, general skills, and specific skills. The current KKN curriculum utilizes an inquiry-based approach to learning.

The next stage is the design stage. In this stage, it begins with a) designing the product using the application for the pattern using Ibis Paint and the layout on Canva. The "Sarung Tebiras" has a full batik thread pattern from top to bottom on the right and left sides. Between the threads are symbols and numbers in number theory materials such as prime numbers, divisibility, modulo, factorization, and congruence. Meanwhile, in the center of the sarong are the Kudus tower, the logo of the mathematics tadaris and the institution's logo. The base color of the sarong is chosen with a black base color and all other forms of patterns with orange. Here is the final design of the "Sarung Tebiras".

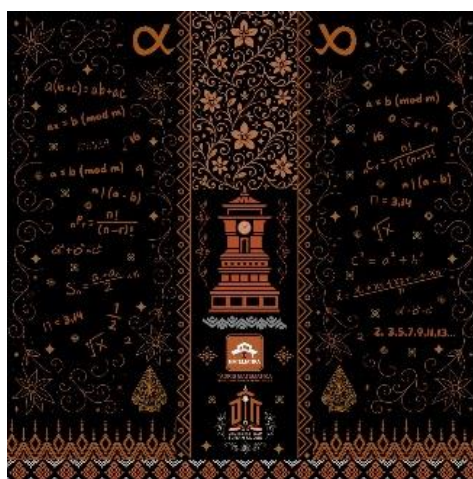


Figure 1. Final design of "Sarung Tebiras"

b) fabric selection, the type of fabric used is Toyobo fabric. The printing technique for "Sarung Tebiras" uses a sublimation printing technique. Sewing the fabric to form a sarong with a size of 125 x 205 cm. To form the size of the sarong requires a fabric with a length of 280 cm and a width of 150 cm. c) brand creation, the brand of "Sarung Tebiras" is "Al-Mumtaz: The Beauty of Numbers, the Perfection of Motifs". d) packaging creation, the manufacture of packaging cardboard is designed using cardboard with a size of 25 cm × 20 cm × 4 cm. e) instrument preparation, this research instrument consists of four types of questionnaires, where three types of questionnaires will be validated by experts including material experts, edupreneurship experts, designer experts and one questionnaire for students.

The third stage is the development stage. After creating the sarong design using number theory, the next stage is expert validation by a material expert validator, a designer validator, and an edupreneur expert validator. This stage is carried out to determine the level of validity of the developed media. The following data shows the results of the material expert validation assessment.

Table 2. Data from the Results of the Material Expert Validation Assessment

Subject Matter Expert	Assessment Aspects												Σ
	Objective			Efficiency			Technical Quality			Practical and Flexible			
	1	2	3	4	5	6	7	8	9	10	11	12	
1	4	3	4	4	4	3	4	4	4	3	4	3	44
2	4	4	3	4	4	3	3	3	3	3	4	4	42
Σ													86
\bar{X}												43	
Score Range												$\bar{X} > 40,8$	
Category												Very Worthy	

The overall average result of the material expert assessment was 40.8, so the validation in terms of material is in the "Very Suitable" category. The following data is the results of the designer expert validation assessment.

Table 3. Expert Designer Validation Assessment Results Data

Expert Designer	Assessment Aspects									Σ
	Aesthetics / visual design					product functionality				
	1	2	3	4	5	6	7	8	9	
1	3	3	4	3	3	3	4	3	3	29
2	4	4	3	3	3	3	3	4	3	30
Σ										59
\bar{X}										29,5
Score Range										25,2 < \bar{X} ≤ 30,6
Category										Worthy

The overall average rating from the design experts was 29.5, thus design validation falls into the "Feasible" category. The following data shows the results of the edupreneur expert validation assessment.

Table 4. Data from the Edupreneur Expert Validation Assessment Results

Edu Pren eur expe rt	Assessment Aspects													Σ
	Innovation			Proactive		Risk taking			Aggressive competition			Autonomy		
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1	4	4	3	3	4	4	4	4	4	3	4	3	3	47
2	4	4	4	4	3	4	3	3	3	3	4	4	3	45
Σ														92
\bar{X}														46
Score Range														\bar{X} > 44,2
Category														Very Worthy

The overall average assessment of edupreneur experts was 44.2, thus validating edupreneurship in the "Very Feasible" category. The following is data from a limited-scale field trial conducted on nine mathematics education students at UIN Sunan Kudus.

Table 5. Limited Scale Development Trial Results Data

Assessment Indicators	Average (%)	Information
Objective	95%	Positive student response
Efficiency	100%	Positive student response
Technical Quality	95%	Positive student response
Practicality	100%	Positive student response
Innovation	90%	Positive student response
Proactive	95%	Positive student response
Total Average (%)	96%	Positive student response

Based on the data obtained, students' responses to the Kudus Tower sarong design using number theory patterns were positive, with an average percentage of 96%. According to the interpretation criteria adapted from Purwanto, percentages above 80% fall into the "very good" category, indicating highly positive student responses (Purwanto, 2013). This conclusion adds to the results of similar studies by several previous researchers that it is necessary to develop both business products and learning media that can encourage students' entrepreneurial spirit (Rahmawati & Nugrahani, 2019).

The final stage is the dissemination stage. After the development stage is completed, the dissemination stage is continued, which is the final stage of the research (Lestari, 2018). The sarong product is marketed, among other ways, through social media platforms like Instagram at https://www.instagram.com/al_mumtazkudus/ or @al_mumtazkudus. The Al_Mumtaz "Sarung Tebiras" has also been worn by several people. The following is an example of the use of the Al_Mumtaz "Sarung Tebiras" by one of the customers.



Figure 2. View of Al Mumtaz "Sarung Tebiras" by Customer

After the development of the design of the Kudus tower sarong using the number theory pattern is complete, which is already at the dissemination stage, the next step is to measure the effectiveness of the use of the "Sarung Tebiras" innovation as a development of student edupreneurs. The aspects explored in measuring the effectiveness of the use of the "Sarung Tebiras" innovation as a development of student edupreneurs are the characteristics that must be possessed to become an entrepreneur student (entrepreneurship student) according to Pelipa and Anna Marganingsih, namely: 1) Emotional intelligence, able to manage emotions; 2) Have a strong determination and intention so as not to give up easily; 3) Discipline, including completing assignments on time; 3) Have a strong desire to be able to overcome obstacles and barriers; 4) Believe in one's abilities, meaning being able to control anxiety and doubt in business; 4) Dare to take risks and make wise decisions; 5) Never give up; 6) Honest, in order to gain the trust of business partners; 7) Creative and innovative, the products created are different from

existing ones; 8) Proficient in managing financial administration; 9) Be sincere and grateful for what you have obtained (Pelipa & Marganingsih, 2020).

After the Mathematics Education students of UIN Sunan Kudus who took the Entrepreneurship course completed the edupreneurial characteristics questionnaire, the data were collected and analyzed. This questionnaire was designed to measure the extent to which *Sarung Tebiras* stimulated students' entrepreneurial characteristics after engaging with the product. The instrument assessed several key indicators adapted from (Pelipa & Marganingsih, 2020), including initiative, creativity, emotional intelligence, risk-taking, discipline, resilience, honesty, and the ability to identify opportunities. The average score obtained from the questionnaire was 39.21. Based on the conversion criteria for five-point Likert scale interpretation according to Purwanto (2013), this score falls within the category $X > 37.4$, indicating that students' entrepreneurial characteristics were in the "Very Good" category. The results of the questionnaire indicate that the "Sarung Tebiras" product can be said to be effective in developing the edupreneur spirit in students.

Discussion

The findings from the preliminary analysis align with the study by Rico et al. (2021) which concluded that Education for Sustainable Development (ESD) requires an interdisciplinary approach. Science, culture, and mathematics education need to be connected to sustainability issues so that students not only master the concepts but can also apply them in real-life situations (Rico et al., 2021). In line with earlier studies, the packaging mockup project can serve as an innovative learning model in design and entrepreneurship education. This model can equip students with practical skills that are relevant to the workforce and the creative industry. It is further explained that a packaging mockup is a visual model or representation of a packaging design created to show how the actual product will look before mass production (To, 2024). Creating innovative sarong designs enables students to cultivate entrepreneurial skills, strengthen soft skills through real industry experience, build confidence to start a business, gain access to capital and mentoring, develop an early entrepreneurial mindset, become agents of local development, and help reduce unemployment. Students need early exposure to entrepreneurial opportunities through entrepreneurship courses so they can channel their creativity and innovation effectively (Rahmawati & Nugrahani, 2019).

The expert validation categorized *Sarung Tebiras* as "Very Worthy" and "Worthy," indicating that the product meets high feasibility standards for educational use. According to Purwanto (2013), products that achieve a score above

85% fall into the “very worthy” category, meaning that the content, design, and instructional relevance exceed minimum quality requirements, while scores within the “worthy” range remain suitable for implementation with minor refinements. Interpreting these findings critically, the higher ratings from material and edupreneurship experts suggest strong alignment between the product’s mathematical accuracy and entrepreneurial value, whereas the slightly lower design score indicates areas where visual or aesthetic aspects can be further improved. This variation demonstrates that developing ethnomathematics based products requires balancing pedagogical correctness, cultural representation, and design innovation. Therefore, the validation results not only confirm feasibility but also guide future revisions for enhancing the product’s visual and functional quality (Sugiyono, 2013).

After establishing the product’s feasibility through expert validation, a small-scale preliminary trial was conducted to obtain initial user responses from university students. Although this stage involved only nine participants, such a limited sample size is appropriate for early testing within design-based research. Tessmer & Martin (2013) emphasizes that small groups are effective for formative evaluation because they help identify usability issues and guide product refinement before broader trials. Likewise, Plomp & Nieveen (2013) note that the purpose of early-stage field tests is not statistical generalization but the collection of practical feedback to strengthen the product’s readiness. Therefore, the involvement of nine students in this trial should be interpreted as a preliminary step, with larger samples recommended for future effectiveness studies.

Based on the data obtained, it can be concluded that students' responses to the Kudus Tower sheath design using number theory patterns were positive, with an average percentage of 96%. This conclusion adds to the results of similar studies by several previous researchers that it is necessary to develop both business products and learning media that can encourage students' entrepreneurial spirit (Rahmawati & Nugrahani, 2019). The effectiveness of the "Sarung Tebiras" innovation in developing student edupreneurs is measured by key entrepreneurial traits outlined by Pelipa & Marganingsih (2020). These include emotional intelligence, strong determination, discipline, resilience, self-confidence, risk-taking ability, persistence, honesty, creativity and innovation, financial management skills, and gratitude. These characteristics collectively shape the entrepreneurial mindset promoted through the "Sarung Tebiras" program.

Globally, strengthening students’ entrepreneurial mindset has become a strategic priority in higher education, as it is considered essential for developing 21st-century competencies. International studies have shown that the entrepreneurial mindset is shaped by key attributes such as innovativeness, creativity, and risk-taking tendencies (Zemlyak et al., 2022). Entrepreneurship

education has also been proven to influence students' perceptions of business opportunities by enhancing their attitudes, self-efficacy, and readiness to engage in entrepreneurial activities (Wardana et al., 2020). In addition, institutional support such as the learning environment and campus culture plays a critical role in fostering entrepreneurial intentions among university students worldwide (Galvão et al., 2025). The purpose of the "Sarung Tebiras" design is to dissuade people who think mathematics is difficult and complicated, as mathematical formulas are deeply relevant to everyday life, especially for teenagers. Good images, graphs, diagrams, and other forms of representation are essential for communicating something. This way, problems that initially seemed difficult and complex can be solved more easily (Sabirin, 2014).

The study shows that integrating local cultural identity with mathematical content offers a promising direction for ethnomathematics-based innovation. As an innovative learning medium, the Sarung Tebiras not only enriches students' cultural awareness but also fosters meaningful engagement with mathematical concepts through authentic, context-based experiences. However, the limited number of student respondents in this preliminary trial suggests that broader field implementation is still necessary. Future research should therefore expand testing to larger and more diverse groups of students, explore variations of Number Theory integration in other cultural products, and examine the long-term impact of such products on students' entrepreneurial development. Further refinement of the entrepreneurial assessment instrument and deeper investigation of commercialization potential are also recommended to support the sustainability of learning innovations like Sarung Tebiras.

Conclusion

This study developed Sarung Tebiras through the 4D model and produced a prototype that integrates Number Theory with the traditional Menara Kudus motif. Expert assessments in material quality, design, and edupreneurship confirmed that the product is feasible. The preliminary trial also showed that Sarung Tebiras can strengthen students' edupreneurial spirit. Students displayed clear signs of creativity, initiative, and opportunity recognition, supported by the questionnaire results. These outcomes show that the product can function as a contextual mathematics learning tool and as a trigger for entrepreneurial awareness.

The study provides both theoretical and practical contributions. Theoretically, it shows that linking number theory with cultural motifs is an effective way to contextualize abstract mathematical ideas and aligns with current perspectives in ethnomathematics and entrepreneurship-based learning. Practically, the positive expert reviews and student responses indicate that

culturally grounded learning products like Sarung Tebiras can enhance creativity, real-world problem-solving, and entrepreneurial awareness. This suggests that educators and institutions can adopt similar cultural innovations to strengthen entrepreneurship education and build meaningful connections between academic learning and community-based creativity.

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