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ETHNOMATHEMATICS OF JAVANESE CULTURE IN THE INQUIRY LEARNING MODEL

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Abstract

The research aims to develop an inquiry learning model based on Javanese cultural ethnomathematics. This research uses research and development methods with the Plomp development model. Research stages include:1) preliminary research, 2) development or prototyping phase, and 3) assessment phase. In this research, the development stage was carried out at the initial investigation stage and the design stage which included field observations, literature studies, focus group discussion, preparation of learning models and learning tools and continued with small-scale trials. Field observations were carried out through observing cultural sites and junior high schools at three provinces in Indonesia, Yogyakarta, West Java, and East Java. Data collection techniques in this research are interviews, observation and questionnaires.. The development results at the initial investigation stage generated a preliminary syntax for the inquiry learning model. The subsequent design stage produced a complete mathematics learning model based on Javanese cultural ethnomathematics, documented in a comprehensive book accompanied by learning tools. Trial results indicated that the developed inquiry learning model meets valid criteria and is suitable for classroom implementation. The significance of this research lies in its contribution to integrating local cultural knowledge into mathematics instruction through an inquiry-based pedagogical approach. By embedding Javanese ethnomathematical concepts into structured inquiry learning, this study provides an innovative model that supports contextualized learning and aligns with national curriculum demands for culturally relevant pedagogy. Furthermore, the model offers a practical framework for teachers to develop meaningful learning experiences that bridge formal mathematics with students' cultural environments.

Keywords: inquiry learning; ethnomathematics; Javanese culture; learning model.

Abstrak

Penelitian ini bertujuan untuk mengembangkan model pembelajaran inkuiri berbasis etnomatematika budaya Jawa. Penelitian ini menggunakan metode penelitian dan pengembangan dengan model pengembangan Plomp. Tahapan penelitian meliputi: 1) penelitian pendahuluan, 2) pengembangan atau pembuatan prototipe, dan 3) penilaian. Dalam penelitian ini, tahap pengembangan dilakukan pada tahap investigasi awal dan tahap desain yang meliputi observasi lapangan, studi pustaka, diskusi kelompok terfokus, penyusunan model pembelajaran dan perangkat pembelajaran dan dilanjutkan dengan uji coba skala kecil. Observasi lapangan dilakukan melalui observasi situs budaya dan sekolah menengah pertama di tiga provinsi di Indonesia, yaitu Yogyakarta, Jawa Barat, dan Jawa Timur. Teknik pengumpulan data dalam penelitian ini meliputi wawancara, observasi dan angket. Hasil pengembangan pada tahap investigasi awal menghasilkan sintaksis awal untuk model pembelajaran inkuiri. Tahap desain selanjutnya menghasilkan model pembelajaran matematika lengkap berbasis etnomatematika budaya Jawa, yang didokumentasikan dalam buku komprehensif disertai perangkat pembelajaran. Hasil uji coba menunjukkan bahwa model pembelajaran inkuiri yang dikembangkan memenuhi kriteria valid dan layak untuk diterapkan di kelas. Signifikansi penelitian ini terletak pada kontribusinya dalam mengintegrasikan pengetahuan budaya lokal ke dalam pembelajaran matematika melalui pendekatan pedagogi berbasis inkuiri. Dengan mengintegrasikan konsep-konsep etnomatematika Jawa ke dalam pembelajaran inkuiri terstruktur, penelitian ini menghasilkan model inovatif yang mendukung pembelajaran kontekstual dan selaras dengan tuntutan kurikulum nasional akan pedagogi yang relevan secara budaya. Lebih lanjut, model ini menawarkan kerangka kerja praktis bagi guru untuk mengembangkan pengalaman belajar bermakna yang menjembatani matematika formal dengan lingkungan budaya siswa.

***Kata Kunci**: pembelajaran inkuiri, etnomatematika, budaya Jawa, model pembelajaran*

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INTRODUCTION

The role of mathematics is not only to improve quantitative numeracy skills but also in the formation of analytical, synthesis, evaluation and problem solving abilities (Duran & Dökme, 2016). In fact, relatively many students have difficulty in identifying problems, which in the end results in errors in solving problems. Thus, a learning model is needed that further encourages student activity in understanding the material and emphasizes the active role of students in learning activities, and one of the appropriate learning models is the inquiry learning model (Gholam, 2019). Inquiry learning is an educational approach that promotes student engagement through practical activities and the formulation of conclusions based on general principles through the formulation of questions (Priansa, 2017). Inquiry-based learning (IBL) is an approach that is centered around the students and is motivated by their natural curiosity and inquiries. In other words, this learning approach necessitates that students independently locate and acquire the necessary knowledge by means of inquiries or investigations. Inquiry itself is an activity of asking questions, asking for information and investigating.

The inquiry learning model incorporates student engagement through the completion of inquiry-based activities. Inquiry-based learning can be described as progressing through five interconnected stages: the initial phase of orientation, followed by conceptual development, the process of investigation, the drawing of conclusions, and finally the stage of reflective discussion (Pedaste et al., 2015). The investigation phase consists of exploration or experimentation that culminates in data interpretation; the conceptualization phase consists of questioning and hypothesis generation; and the discussion phase comprises reflection and communication (Pedaste et al., 2015). This learning model's primary objective is to foster the development of intellectual abilities, critical thinking, and scientific problem-solving. Furthermore, students are instructed in the independent resolution of non-routine issues, which nurtures their creative abilities. By being given non-routine problems, students can solve problems in everyday life skillfully based on existing knowledge. Therefore, in learning activities, it is necessary to relate to problems related to the surrounding environment, one of which is the surrounding culture.

Ethnomathematics provides insight into mathematics as a cultural product (D'Ambrosio & Domite, 2007) Ethnomathematics, as defined by D'Ambrosio (1985), encompasses mathematical activities carried out by individuals belonging to various cultural groups, including indigenous peoples, working groups, professional classes, and age-specific groups of children. In accordance with the cultural diversity of students and their daily mathematical practice.

According to Francois (2010), broadening the scope of ethnomathematics helps situate mathematics within the cultural context of students, making it more accessible and meaningful. Ethnomathematics can be viewed as an educational practice that assigns cultural and intellectual value to mathematics and its teaching. Integrating ethnomathematical perspectives into classroom instruction is believed to enhance learners' performance and deepen their understanding of mathematical concepts (Sunzuma, Zezekwa, Gwizangwe, & Zinyeka, 2021a). This approach not only provides a more inclusive and

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holistic view of mathematics but also enhances students' mathematical abilities by contextualizing mathematical concepts in familiar cultural practices and artifacts.

Ethnomathematics can be defined as a body of research that establishes connections between social fields, cultural backgrounds, and mathematics or mathematics education (Kabuye Batiibwe, 2024). Students utilize the environment's culture as a resource for learning, thereby enhancing the enjoyment and significance of their academic pursuits. In line with Sirate's (2012) research that the application of ethnomathematics can motivate and stimulate students to be able to overcome boredom and difficulties in learning mathematics so as to improve student learning outcomes. This is certainly very suitable to be applied to mathematics learning (Rudhito, Kristanto, & Melissa, 2020). It is possible that relatively many students start to experience boredom, on the other hand teachers also begin to feel the need to create a new, more innovative learning atmosphere to foster student learning motivation (Puspitarini & Hanif, 2019).

Student failure in mathematics can be attributed to the absence of cultural context in its instruction, which is justified under the guise that the subject is universal and abstract. Conversely, students cultivate a thirst for knowledge and experience an increase in self-assurance when they are exposed to diverse cultural connections and engage in collective reflection on them (Amit & Abu Qouder, 2017) Indonesia is a culturally diverse nation, Javanese culture being one of them. Javanese culture, which is prevalent among the Javanese people, particularly in Central Java, Yogyakarta, and East Java, has its roots in Java (Irawanto, Ramsey, & Ryan, 2011). An examination of Javanese culture encompasses various domains, including literature, language, the kingdom, architecture, the calendar, and art (Krisdiana, Astuti, Murtafiah, & Fisabilillah, 2025). By relating the concept of geometry to the study of architecture, this research centers on Javanese culture.

Combination of inquiry learning model and ethnomathematics-based mathematics learning, besides being able to improve students' under-standing and mathematical problem-solving abilities, it will certainly in-crease students' motivation and provide an understanding of the culture in their area (Choeriyah, Qohar, & Subanji, 2021). Ethnomathematics is a form of mathematics that is influenced on culture. So, the hope is that in addition to understanding mathematics, students can also understand the culture. Further, the learning outcomes and memory of students who used ethnomathematics-based learning were higher than those of students who used conventional learning (Suratno, Wahyudi, & Afandi, 2023)

The purpose of mathematics is for students to understand mathematics and its culture (Deda, Disnawati, Tamur, & Rosa, 2024). However, students can do mathematics and find mathematical concepts from the ways, ideas, and techniques of certain mathematical cultures to deal with problems in the realities of students' lives. By applying ethnomathematics in mathematics learning, it is expected that students can better understand mathematics and its culture. Teachers are also easier to instill cultural values themselves in students. With ethnomathematics-based learning, apart from being able to learn mathematics contextually, students can also understand culture and can grow character values (Utami & Sayuti, 2020).

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An ethnomathematics-based learning model is a learning model that links cultural elements in learning activities (Rosa & Orey, 2011). So that the ethnomathematics-based inquiry learning model is a learning model that emphasizes the activities of understanding and formulating a problem, collecting, organizing and solving problems, and the problems given are related to the surrounding culture. The results of Abdulah, Mastur, & Sutarto (2015) research related to the ethnomathematics-based inquiry learning model, it showed that students were more active in working to find formulas, understanding the formulas that would be used to solve problems, discussing and solving problems and presenting the results of discussions in front of the class. In addition, the teaching and learning process with this learning model is able to create a pleasant learning atmosphere (Herawaty, Widada, Nugroho, & Anggoro, 2019). From the explanation above, a research was conducted that aims to determine the effectiveness of the ethnomathematics-based inquiry learning model.

Some of the previous studies have evaluated inquiry-based learning models and their impact on students' active and self-directed learning. Besides, some studies have centered on ethnomathematics-based learning, proving its effectiveness in bringing the mathematical concepts closer to the students through the use of the cultural elements(Vitantri & Syafrudin, 2022). Nevertheless, the current research mostly considers these two methods separately. A few studies that combine ethnomathematics with inquiry-based learning usually only at the level of learning materials or activities without elaborating a fully structured and validated learning model with systematic syntax, tools, and development stages(Priyatna & Marsigit, 2024).

On top of that, the majority of the ethnomathematics studies take into account cultural practices in general, rather than specific cultural sites. There is a scarcity of research that develops an inquiry-based learning model which is not only culturally relevant to Javanese ethnomathematics but also constructed through a rigorous educational design framework. No earlier research conveys the creation of an inquiry-based model whose stages are the most natural and direct line with the Javanese cultural contexts authentically sourced from the field observation in different provinces.

The novelty of this research lies in the development of an inquiry learning model that is comprehensively integrated with Javanese ethnomathematics, not just by including cultural examples, but by building the entire model framework based on cultural principles; the application of the development model to produce a validated learning syntax along with cultural-based learning tools and materials; and the design of the model based on the results of direct observations at cultural sites in Yogyakarta, West Java, and East Java, thus providing a level of cultural authenticity that has not been widely achieved by previous research.

Therefore, the objective of this research is to develop and validate an inquiry learning model based on Javanese cultural ethnomathematics, complete with syntax, learning tools, and supporting materials suitable for mathematics learning in schools.

METHOD

The research and development (R&D) approach is used to produce an inquiry learning model based on Javanese ethnomathematics and examine its

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feasibility, validity, and potential effectiveness. This study employs the R&D design using the Plomp educational development model (Siswanto & Peni, 2023), which consists of (1) preliminary research, (2) development or prototyping, and (3) assessment (Barthakur et al., 2022).

Preliminary Research

This stage consists of field observations, literature review, and focus group discussions (FGD). Field observations were carried out at ten Javanese cultural sites and ten junior high schools across Yogyakarta, Central Java, and East Java. Data were collected on cultural objects, learning environ-ments, teaching practices, and curriculum implementation. Results from observations were used as inputs for FGD involving mathematics teachers, cultural practitioners, and education experts to identify cultural elements relevant to mathematical concepts.

Development/Prototyping Phase

This stage includes designing the learning model syntax, developing learning tools (lesson plans, student worksheets, instructional materials, and learning media), and constructing research instruments. All products—including instruments—were subjected to expert validation. Revisions were made based on validator feedback. Small-scale trials were conducted in three junior high schools using Grade 7 students selected through simple random sampling. The trials tested practicality, clarity, and applicability of the model.

Assessment Phase

This stage evaluates the validity, practicality, and initial effectiveness of the developed learning model based on quantitative and qualitative data obtained from instruments.

Research Instruments and Validation

1. Observation Sheet

Observation sheet to identify cultural objects containing mathematical elements and to observe learning implementation in schools. The indicators are: presence of two-dimensional geometric shapes; presence of three-dimensional geometric objects; relevance of cultural objects to mathematical concepts; teacher activities and instructional process; student engagement indicators.

Data collection technique are: Direct observation at three cultural sites (Yogyakarta Palace, Keraton Train Museum, Ratu Boko) using structured checklists; Secondary data (official websites, digital archives, brochures) for other cultural sites; Classroom observation in ten junior high schools, using clarifying and reflection question formats.

Expert validation was conducted by lecturers and ethnomathematics specialists reviewing content, construct clarity, and alignment with research aims.

2. Interview Guidelines

Interview guidelines explore perceptions of teachers, principals, and cultural site managers on ethnomathematics-based instruction. The indicators are: understanding of inquiry learning; understanding of ethnomathematics; needs and constraints in mathematics instruction; feasibility of integrating cultural contexts.

Data collection technique are: Semi-structured interviews conducted during school visits and FGDs; interviews were audio-recorded and transcribed verbatim. Validation by expert review for question clarity, relevance, and linguistic accuracy.

3. Model Validation Instrument

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Purpose expert validation questionnaire to assess the validity of the learning model book, syntax, and learning tools. The indicators are: content feasibility; presentation quality; linguistic appropriateness; relevance of cultural integration; coherence of inquiry syntax; practicality of implementation. Data collection used questionnaire completed by three experts in mathematics education, media development, and ethnomathematics.

4. Student Response Questionnaire

The practicality test was conducted with the objective of assessing both the usability and the level of acceptance of the developed learning model. The indicators are: clarity of learning instructions; attractiveness of cultural content; difficulty level; engagement and motivation; usability of learning tools. Data collection technique: Administered to Grade 7 students after small-scale trials in three junior high schools.

Data Analysis

The data analysis techniques in this study were adapted to the characteristics of each instrument. Data from the observation sheets were analyzed by assigning scores to each indicator, then averaging them to obtain achievement level categories, and reinforced with qualitative interpretations based on field notes. Interview data were analyzed using thematic content analysis techniques, starting from the transcription process, coding, grouping themes, and extracting meaning to understand the patterns and trends of the information that emerged. Data from the expert validation questionnaire were analyzed by calculating the coefficient to determine the level of validity of each item, accompanied by percentage calculations and descriptive categorization to assess the overall feasibility of the model. Meanwhile, student response questionnaire data were analyzed by calculating the average score for each indicator, then interpreted based on the practicality classification to determine whether the learning model met practical criteria and could be used in the learning process.

RESULT AND DISCUSSION

Preliminary Research Stage

The preliminary stage of the study was conducted through observation, followed by a focus group discussion (FGD). The observations targeted ten cultural heritage sites across Java Island, specifically within the provinces of Yogyakarta, Central Java, and East Java. These sites include the Yogyakarta Palace, the Yogyakarta Palace Carriage Museum, Prambanan Temple, the Ratu Boko archaeological complex, the Kekayon Puppet Museum in Yogyakarta, the Surakarta Palace, Borobudur Temple, Dieng Temple, the Trowulan archaeological site, and the Wringin Lawang Gate. Direct field observations were carried out at the Yogyakarta Palace, the Carriage Museum, and the Ratu Boko site. For the remaining cultural sites, information was gathered through secondary sources such as official websites, YouTube channels, brochures, and other digital materials.

Observation of cultural sites is focused on identifying geometric objects that can be explored from heritage objects at cultural sites. Based on the observations, the identification of two-dimensional and three-dimensional geometric objects was obtained. The identified flat geometric objects are rectangle, square, rhombus, triangle, trapezoid, parallelogram, circle, octagon. The objects of spatial geometry

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that can be identified from heritage objects at cultural sites are cubes, blocks, rectangular pyramids, prisms, cones, tubes, and spheres.

Field observations carried out in schools have been carried out in ten junior high schools from three provinces. Observation is focused on gathering information through clarifying and reflection questions. The clarification questions are intended to find out the details of the implementation of learning as well as what obstacles were experienced in the implementation of learning. Reflection questions are intended to explore information related to the competence of understanding students' mathematical concepts based on the learning that has been carried out. In addition, it is also to dig up information related to students' social competence which tends to decrease due to learning. The data on the results of clarification and reflection based on the results of school observations are contained in Table 1.Field observations carried out in schools have been carried out in ten junior high schools from three provinces. Observation is focused on gathering information through clarifying and reflection questions. The clarification questions are intended to find out the details of the implementation of learning as well as what obstacles were experienced in the implementation of learning. Reflection questions are intended to explore information related to the competence of understanding students' mathematical concepts based on the learning that has been carried out previously. In addition, it is also to dig up information related to students' social competence which tends to decrease due to learning. The data on the results of clarification and reflection based on the results of school observations are contained in Table 1.

Table 1. School observation results

No	School	obstacles encountered	Concept understanding category	Relatively low social competence
1	SMP N 9 Yogyakarta	Unstable network, low internet data quota	medium	cooperation, responsibility, accuracy
2	SMPN 1 Mlati Sleman	Unstable network, low internet data quota	medium	cooperation, responsibility
3	SMP Kesatuan Bangsa Bantul	Unstable network, low internet data quota	medium	cooperation, responsibility
4	SMP N 2 Prambanan, Klaten	Unstable network, low internet data quota	medium	responsibility, self-confident, accuracy
5	SMPN 19 Purworejo	Unstable network, low internet data quota	medium	cooperation, responsibility
6	SMPN 6 Purworejo	Unstable network, low internet data quota	medium	cooperation, responsibility
7	SMP N 1 Donorojo, Pacitan	Unstable network, low internet data quota	medium	accuracy, cooperation, self-confident
8	SMP Muhammadiyah 6 Manisrenggo	Unstable network, low internet data quota	medium	discipline, tanggung jawab, accuracy
9	SMP Taman Dewasa Ibu Pawiyatan, Yogyakarta	Unstable network, low internet data quota, low learning motivation	low	cooperation, responsibility, discipline, concern
10	SMP PGRI Gendaran, Pacitan	Unstable network, low internet data quota	medium	discipline, responsibilit, accuracy, self-confident

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It is known in Table 1 that all schools carry out learning through various platforms, but experience various obstacles, including unstable internet network conditions and internet data quotas that are not always owned by students, resulting in learning not running smoothly. The condition of students' conceptual understanding competence is in the moderate category which tends to be low, this is the impact of learning that is less than optimal. In addition to the condition of understanding the concept, through reflection questions, information related to students' social competencies that need to be improved can also be obtained, including cooperation, responsibility, accuracy, self-confidence, discipline and concern.

The findings from the observations were assessed and utilized as a foundation for conducting focus group discussions. Formulating the syntax of the inquiry learning model was the primary objective of the FGD. The learning and learning tools utilized incorporate aspects of Javanese culture, as the aforementioned learning model is founded upon ethnomathematics of Javanese culture. There are two distinct categories of FGD questions: exploratory questions and reflection questions. Inquiries regarding the learning models implemented in educational institutions for mathematics instruction, the extent to which the inquiry learning model was utilized, the challenges encountered during the inquiry learning process, and understanding of ethnomathematics and its internalization in mathematics education are among the reflection questions. Investigative inquiries aim to uncover details pertaining to the technical execution of the inquiry learning model, the syntax necessary for an effective inquiry learning model, and ethnomathematics gleaned from the Javanese Culture website and its application in the learning process.

Development Stage

The guided inquiry learning model is identified as the type of inquiry learning that will be implemented in the classroom, as determined by the outcomes of the FGD discussions. The teacher assumes a significant role in facilitating the learning process through investigation in this particular type. The instructor assumes responsibility for several tasks, including identifying the research topic to be explored, formulating pertinent inquiries, specifying the necessary procedures or steps for students to follow, advising students on data analysis, and distributing columnar worksheets that enable students to independently complete and contribute to the formation of conclusions. Table 2 provides a syntax outline for the inquiry learning model in the context of learning.

Table 2. Syntax of the inquiry learning model

No	Syntax	Learning steps
1.	Orientation	– Start learning through video conference – Displaying videos with cultural site content to create a conducive and fun atmosphere for learning – Delivering the material to be studied and learning objectives – Orienting students to learning using the inquiry learning model – Organizing students into several groups

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No	Syntax	Learning steps
2.	Formulate the problem	– Directing students to a problem that requires solving related to field geometry and spatial geometry using image media of cultural sites – Students analyze the problem and determine the formulation of the problem
3.	Formulating a hypothesis	– Students develop hypotheses or temporary answers.
4.	Collecting data	– Students collect information from various sources needed to test the hypotheses that have been prepared
5.	Test the hypothesis	– Students carry out investigations to prove the hypotheses that were prepared previously – Students discuss to connect their prior knowledge with the knowledge that has been obtained in relevant sources
6.	Formulating conclusions	– In order to reach precise conclusions, students articulate the results of hypothesis testing that support the findings they have acquired.
7.	Communicating results	– Students explain again and convey the results of the investigation

Figure 1 is a picture of one of the temples in the Prambanan Temple Complex located in Yogyakarta, Indonesia. From the pictures of the temple, various geometrical objects and space geometry can be identified. Examples include isosceles triangles and rectangles. Subsequently, students compute the volume and surface area of the geometric object representing each identified shape, as well as the area and perimeter of the geometric object of the plane, in accordance with the process of identifying geometric objects using their individual and collective creativity.

Figure 1. Ethnomathematical objects in geometry objects

Figure 2, add the Borobudur Temple Complex which is located in Magelang, Central Java, Indonesia. An example of a geometric object that can be identified from the figure is a cone. According to a study by (Kurniawan & Hidayati, 2020), the Borobudur Temple was constructed utilizing sophisticated mathematical methods. Space configu-retions contain unique mathematical concepts that have the potential to produce enduring and aesthetically pleasing structures.

Figure 2. Ethnomathematical objects in spatial geometry objects

The incorporation of cultural artifacts into educational materials will facilitate students' comprehension and identification of concepts. This occurs as a result of the instructor assisting

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pupils in formulating their experiences and subsequently integrating that into their mathematical education. Facilitating inquiry learning with ethnomathematics entails the teacher providing guidance to students regarding their comprehension and application of the concepts of area, perimeter, volume, surface area, and their corresponding calculations. Therefore, by adopting an ethnomathematical-based inquiry learning model, an engaging learning environment can be established, fostering an elevated culture that enhances student engagement and motivation in learning tasks (Asnawati, K.D., & Muhtarulloh, 2015).

During the design phase, the following tasks are accomplished: developing a learning model book, creating a compilation of learning tools (including a Learning Implementation Plan), instructional materials, learning media, student activity sheets, assessment instruments, and research instruments. In addition, research instruments, learning tools, and product development were validated. The purpose of compiling the learning model book is to provide direction for the application of learning models. The aforementioned learning model is the inquiry learning model, which is grounded in the ethnomathematics of Javanese culture. The compiled learning model book includes two subtitles. The theoretical framework of this study is organized into two main parts. The opening part of the discussion examines the inquiry-based learning framework, encompassing the definition of learning models, the fundamental ideas underlying inquiry learning, its key principles, the sequence of stages in its implementtation, and the goals it seeks to achieve. This part also examines mathematics education within the context of the Industrial Revolution 4.0, the notion of ethnomathematics, and specifically the ethnomathematics embedded in Javanese cultural practices.

The second section focuses on the structure of the learning model itself. It discusses the model's syntax, the social system that supports its implementation, the underlying learning principles, the support mechanisms required, as well as the instructional outcomes and the accompanying impacts generated through its application.

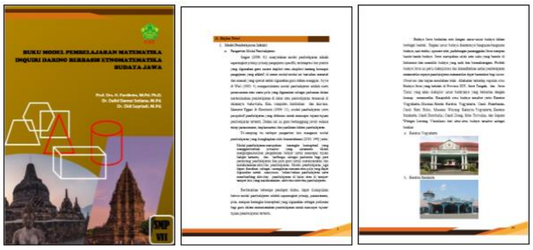

Figure 3. The learning model book display

Figure 3 presents an example of a textbook layout that applies an inquiry-oriented mathematics learning approach, which is anchored in the ethnomathematical traditions of Javanese culture.

Assessment Stage

Following the completion of the model book's preparation, the learning model book underwent validation. The process of validation involves evaluating the viability of linguistic, presentation, and content components. A summary of the results obtained from calculating the percentage of validity based on the outcomes of the validity calculation for the learning model book is presented in Table 3.

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Table 3. The validity of the learning model book

Indicator	Percentage of validity (%)	Category
Content eligibility	80,2	Very valid
Presentation	78,9	Valid
Language	82,1	Very valid

The percentage value of validity in Table 3 falls within the valid and very valid categories, indicating that the learning model book is both valid and practical for implementation during the trial stage of learning model deve-lopment. The objective of the product trial is to ascertain the viability of the product under development. The feed-back and criticism gathered during the trials served as a foundation for revi-sions that ensured the final product was truly suitable for educational purposes.

During the trial phase, both small-scale and large-scale trials were conducted. At present, seventh-grade pupils from SMP N 1 Donorojo, Pacitan; SMP Muhammadiyah 6 Manisrenggo, Klaten; and SMP Taman Dewasa Ibu Pawiyatan Yogyakarta are participating in a small-scale trial. The learning progression throughout the trial is illustrated in Figure 4.

Figure 4. Display of learning during the trial

Learning applies an ethno-mathematical-based inquiry learning model as well as learning tools that have been developed. Learning is facilitated by the mathe-matics teachers of each school. During the trial run, the researcher acted as an observatory to ensure that all stages of the learning model had been imple-mented. The trial was assessed for feasibility by users through a questionnaire with the ave-rage percentage of product feasibility obtained by 79.1%. The inquiry-based learning model grounded in Javanese ethnomathematics meets the established criteria of feasi-bility and is thus considered appropriate for application in educational settings.

The study show that the inquiry learning model based on Javanese cultural ethnomathematics was able to meet the criteria of validity, practicality, and feasibility of implementation in mathematics learning. Conceptually, these findings are in line with the theoretical basis that places inquiry learning as an approach that emphasizes exploration, reasoning, and knowledge construction activities through a syste-matic investigative process (Pedaste et al., 2015). Thus, the results of this study can be said to support the hypothesis that the integration of cultural elements in the framework of inquiry learning can strengthen students' understanding of concepts and learning motivation.

The findings of this study show an increase in student involvement, clarity of flow of thought, and understanding of geometric concepts through direct association with cultural objects such as temple buildings, gates, and historical artifacts. These results are in line with the basic concept of ethnomathematics which views mathematics as a product of culture (D'Ambrosio & Domite, 2007) and with constructivist theory which emphasizes that learning is more meaningful when it is associated with the contextual experience of students. In

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addition, these results are consistent with the research of (Sunzuma et al., 2021) which found that the use of ethnomathematical approaches improves concept retention and student participation. Thus, this study reinforces the theoretical study that the integration of culture into the inquiry process encourages the emergence of deeper cognitive processes and improves problem-solving orientation.

Several key findings can be identified. First, the development of the model through the Plomp framework resulted in a systematic and contextual inquiry learning syntax with Javanese culture, starting from orientation to communication of results (Sari et al., 2025). Second, the validity of the model—both in terms of content, language, and presentation—is in the category of valid to very valid, which indicates the feasibility of the model to be implemented(Hendriana et al., 2025). Third, the results of the practicality test show that students view this model as clear, interesting, and relevant to daily life (Khasanah, Prahmana, Adiputra, Khalil, & Pepkolaj, 2025). Fourth, teachers reported an increase in students' motivation and activities during the inquiry process, especially when dealing with cultural artifacts that they had known before (Prahmana et al., 2025). This shows that the model is not only technically valid, but also effective at the initial implementation stage (Zuliana et al., 2023).

The developed model has several advantages. First, the product is in the form of a complete model along with learning tools, so that it is easily replicated by other teachers. Second, authentic cultural integration provides added value not found in conventional mathematics learning. Third, this model is in line with the demands of the national curriculum to implement contextual, active, and character-oriented learning.

However, this study has some limitations. First, the trial was carried out on a limited scale so that it did not reflect the complexity of the classroom conditions more broadly. Second, the long-term effectiveness of the model has not been tested, especially in relation to its impact on higher-level thinking abilities (HOTS). Third, the application of the model requires teachers' readiness to understand the cultural elements and stages of inquiry, so that not all teachers can directly apply it without training.

The results of this study are consistent with the research of Mumpuni and Marsigit (2022) and Sari et al. (2025) which suggests that ethnomathematical approaches can improve students' mathematical representations. These results are also in line with research of Asnawati et al. (2015) and Hendriana et al. (2025) which found that inquiry with the help of cultural context was able to improve students' understanding of flat building materials. The study also reinforces the findings of Priyatna and Marsigit (2024) and also Khasanah et al. (2025) which states that culture-based teaching materials increase learning achievement and motivation.

On the other hand, this study provides an important difference compared to studies that only examine the effectiveness of culture-based learning or inquiry (Prahmana et al., 2025). This research brings together the two approaches in a structured and validated model, thus offering a new contribution to the development of culture-based mathematics learning models (Zuliana et al., 2023).

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This research has significant theoretical and practical implications. Theoretically, this study confirms that cultural integration in inquiry learning can strengthen the relationship between local context and mastery of mathematical concepts. This research also expands the realm of ethnomathematics by providing a systematic learning framework, not just the use of cultural examples. Practically, this model can be an alternative for teachers in overcoming low motivation and understanding of geometry concepts, especially for students who are used to abstract learning. In addition, the use of cultural artifacts has the potential to support cultural preservation and strengthen character education, especially the values of local Javanese wisdom. The main contribution of this research lies in the provision of a model that is tested and ready to be applied, so that it can be used by schools or further developed in further research.

CONCLUSION AND SUGGESTION

The research was conducted with the purpose of designing and validating an inquiry-oriented learning model grounded in Javanese ethnomathematics, and the findings confirm that this goal was effectively accomplished. The development process included initial investigation, model design, and assessment. The development resulted in a structured inquiry syntax enriched with authentic cultural elements, along with supporting learning tools and a validated model book. During the evaluation stage, it was confirmed that the learning model fulfilled the standards of validity, practicality, and feasibility, making it appropriate for implementation in mathematics education. The main contribution of this study lies in providing a culturally integrated inquiry model that connects mathematical concepts with Javanese cultural artifacts, thereby strengthening contextual understanding and supporting culturally responsive mathematics learning.

Further research is recommended to examine the long-term effectiveness of this model in broader and more diverse school settings, including its impact on higher-order thinking skills and student motivation in advanced classroom practices. Future research could also explore adapting the model to other cultural contexts, expanding it to a wider range of mathematics topics, and integrating it with digital learning platforms to increase scalability and accessibility.

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