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Ethnomathematical Insights into Student Errors: Javanese Calendar and Pigeonhole Principle

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ABSTRACT

Objective: *This article aims to examine the implications for student learning by investigating student errors through the lens of the pigeonhole principle and the Javanese calendar.* ***Method:*** *The study used a descriptive qualitative research method and included six high school students and vocational students. Data collection involved tests and interviews. The researchers focused on Ethnomathematics problems related to the Javanese calendar system.* ***Result:*** *The analysis of student responses revealed several types of errors based on Watson's criteria for error analysis in problem-solving. These errors included inappropriate data, inappropriate procedure, and undirected manipulation. Students struggled with understanding the given information, selecting appropriate procedures, and applying logical reasoning.* ***Novelty:*** *Interestingly, the researchers found that when the students were provided with guidance and assistance, they were able to grasp the concepts and successfully solve the problems. This suggests that the students had the potential to understand the material but lacked prior exposure to the concepts, particularly the pigeonhole principle.*

INTRODUCTION

Ethnomathematics has gained increased attention in mathematics education research due to its recognition of the influence of culture and social context on mathematical practices. It highlights the importance of embracing cultural diversity and incorporating various mathematical traditions, acknowledging that mathematics is not a universally applicable and neutral discipline, but rather a product of specific cultures (D'Ambrosio, 2001). As a result, it becomes crucial to consider cultural contexts and social interactions that influence the development of mathematical understanding (Radford, 2017).

Ethnomathematics goes beyond traditional mathematics education by recognizing and embracing the mathematical wisdom present in various cultural contexts. It encompasses a broad concept that includes the socio-cultural environment, including language, specialized vocabulary, symbols, behaviors, and myths (D'Ambrosio, 1990). It is considered a way to contextualize mathematical ideas since it is related to the techniques developed as a study of mathematical procedures practiced by the members of distinct cultural groups (Rosa, 2017). It provides a multicultural perspective on mathematical ideas, highlighting the mathematical knowledge embedded within different cultural communities (Ascher, 1991). The idea of mathematics in cultural practices involves designing tasks that are contextualized in the cultural heritage based on different ways of knowing in order to help us reflect on certain mathematical notions as well as on the nature of mathematical knowledge. (Englash, 2013; Rosa, 2017). However, much of the literature remains descriptive, focusing on showcasing cultural practices without sufficiently addressing how these contexts can be systematically leveraged to improve students' mastery of formal mathematical concepts.

When students engage with ethnomathematics contexts, they often face challenges in applying their mathematical knowledge to real-world problems. Then, it is recommended that researchers conduct studies that help us to understand how Ethnomathematics can contribute to the development of contextualized activities in classrooms (Rosa, 2017). Despite having a strong understanding of mathematical concepts and procedures, applying these skills to real-world problems can be problematic (Haghverdi et al., 2012). One particular issue lies in the difficulty of translating real-life scenarios into mathematical representations and identifying relevant information. Students may struggle with selecting appropriate mathematical operations, as real-world problems are often complex and require critical thinking, problem-solving abilities, and data analysis skills (Lesh & Ricard, 1979). This suggests a need for research that not only embeds cultural contexts but also explicitly examines the types and patterns of student errors to inform instructional design.

To address these challenges, teachers can adopt an approach suggested by Watson (Asikin, 2002). By identifying the errors students make while solving mathematical word problems, teachers can effectively facilitate their learning process. Watson proposed eight criteria for error analysis in problem-solving, including inappropriate data (id), inappropriate procedure (ip), omitted data (od), omitted conclusion (oc), response level conflict (rlc), undirected manipulation (um), skill hierarchy problem (shp), and above other (ao).

Additionally, the Javanese lunar calendar or "Tahun Jawa" is a complex system that combines lunar cycles, solar movements, and cultural traditions. According to Javanese astrological beliefs, an individual's traits and future are influenced by the combination of the Pasaran day and the "common" weekdays of the Islamic calendar corresponding to their birth date (Kusmartono & Wilopo, 2003). This combination, known as the Wetonan cycle, holds significant fascination for Javanese people, who deeply value the astrological interpretations derived from it. The Wetonan cycle encompasses a specific day within a 35-day cycle and holds cultural and spiritual importance in Javanese society. The Javanese calendar exemplifies the integration of mathematics and culture, as it incorporates mathematical calculations to determine auspicious dates for various events, ceremonies, and agricultural practices (Sulistyawati, 2019; Prabowo & Mamat, 2021). However, prior studies have rarely moved beyond describing these cultural computations toward exploring their pedagogical integration for addressing mathematical misconceptions.

Many studies have been conducted on Ethnomathematics in the context of the Javanese calendar system. Agustina et al. (2016) explored the application of Ethnomathematics in the context of the Javanese calendar and its connection to arithmetic in the village of Yosomulyo. The study aimed to investigate the mathematical aspects embedded within the Javanese lunar calendar and how arithmetic concepts are utilized in its calculations. Another study, Suraida et al. (2019), examined Ethnomathematics in the context of the Javanese wedding tradition, explicitly focusing on the calculation of "Weton." The research aimed to explore the mathematical aspects involved in determining auspicious dates for Javanese wedding ceremonies based on the Weton system. Numerous studies have predominantly focused on exploring the Ethnomathematical context rather than investigating the implications for student exercises (Fitriani, 2019; Sulaiman, 2021; Eliza & Pujiastuti, 2022). This highlights a research gap in connecting ethnomathematical contexts such as the Javanese calendar with structured learning activities that address specific types of student errors.

Furthermore, the pigeonhole principle, a fundamental concept in combinatorial mathematics, has relevance in both conventional and cultural contexts. This principle states that if more objects are distributed into fewer containers, at least one container must contain more than one object. It is a fundamental concept in basic mathematics that relates to combinations, permutations, and the principle of multiplication. However, the teaching of the pigeonhole principle in Senior High School is sometimes overlooked or not emphasized enough in the curriculum (Herizal, 2021). Integrating this principle into culturally relevant contexts such as the Javanese calendar could offer a novel way to enhance comprehension while preserving cultural significance, an area still underexplored in existing literature.

This article highlights the significance of studying Ethnomathematics and its connection to cultural practices such as the Javanese calendar. Investigating student errors offers valuable insights into the implications for student learning in the context of Ethnomathematics, facilitating the development of effective instructional strategies to enhance mathematical understanding and cultural appreciation. Accordingly, this study aims to bridge the identified gap by integrating the pigeonhole principle into the Javanese calendar context to analyze and address specific patterns of student errors.

RESEARCH METHOD

Research method

This study employed a descriptive qualitative research design. The sample consisted of six participants, comprising three Grade 12 high school students and three Grade 12 vocational school students. Participants were selected purposively based on their high mathematical ability, as indicated by their performance in school mathematics assessments. Data were collected through a combination of tests and interviews. Each participant was given a 40-minute written test to be completed to the best of their ability. To enhance the reliability of the findings, methodological triangulation was applied by comparing test results with interview data, and member checking was conducted by inviting participants to review and confirm the accuracy of the researchers' interpretations (Lincoln & Guba, 1985; Creswell & Poth, 2018).

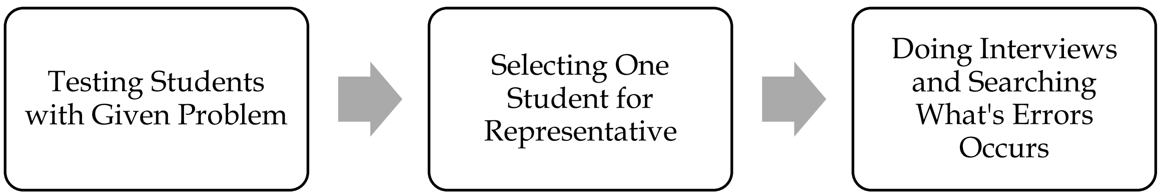

Figure 1. Research flow chart

Following the analysis of the test results for the entire sample, one high school student and one vocational school student were selected to represent their respective groups in the in-depth analysis. This purposive selection was made to allow for a detailed, case-oriented examination of students' reasoning processes, which would not have been feasible with all participants due to the depth of qualitative analysis required (Patton, 2015). Selection criteria included the completeness of responses, the presence of specific errors warranting further exploration, and the diversity of problem-solving strategies employed. While analyzing a single case from each group may limit the breadth of representation, this approach aligns with the qualitative aim of gaining rich, contextualized insights rather than statistical generalization. Potential bias was mitigated through methodological triangulation and member checking, ensuring that interpretations were grounded in multiple data sources and verified by the participants themselves (Lincoln & Guba, 1985; Creswell & Poth, 2018).

Instrument and procedure

The data collection procedure began with administering a set of test questions to the entire research population. The questions were designed around ethnomathematical problems grounded in Javanese culture, specifically the traditional Javanese calendar system, which is still in use today. This calendar incorporates two concurrent cycles: the saptawara (seven-day cycle), consisting of Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday, and the pancawara (five-day cycle), consisting of Kliwon, Legi, Pahing, Pon, and Wage. Prior to administering the test, all participants were provided with a short orientation session explaining the structure and terminology of the Javanese calendar system. This step ensured that any lack of prior knowledge about the ethnomathematical context would not influence test performance and that the assessment measured problem-solving ability rather than cultural familiarity.

The integration of ethnomathematics in the research was guided by D'Ambrosio's (1985) perspective, which emphasizes that ethnomathematics seeks to recognize the diversity of mathematical practices by considering mathematical knowledge developed within distinct social and cultural contexts. Such knowledge includes practices of grouping, counting, measuring, designing buildings or tools, and playing games, among other activities.

To ensure the validity of the instrument, the test underwent a multi-step validation process. First, content validation was conducted by two mathematics education experts and one cultural expert specializing in Javanese traditions. They reviewed the items for alignment with research objectives, clarity of language, and cultural appropriateness. Construct validation was then ensured by matching each question to the intended mathematical concepts, such as combinatorics, probability, and logical reasoning. Face validity was tested by piloting the instrument with three students outside the research sample, allowing for the identification and revision of ambiguous wording or misleading information. The instrument was further refined based on feedback from both experts and pilot participants.

An example of one of the validated test items is as follows:

> *In a population survey conducted by a research institution in a region of East Java, several questions were asked of the residents, including their date of birth and the corresponding Javanese pasaran day. For example, AFY was born on Wednesday Legi, March 1, 2023. Determine: a. How many minimum possible surveys must the institution conduct in order to find two individuals with the same pasaran birth day? b. If the survey is limited to 300 randomly selected respondents, what is the minimum number of individuals with the same pasaran birth day? c. Several volunteers are employed to assist in conducting the population survey in the area, with a quota of 30 individuals per volunteer. One volunteer discovers that out of the 27 people they interviewed, none of them has a pasaran birth day of Legi. Based on this observation, the volunteer concludes that the last three individuals surveyed cannot have a Legi pasaran birth day. Do you agree with the volunteer's conclusion? Present a logical argument to support your stance.*

This combination of expert review, pilot testing, and item refinement was intended to ensure that the instrument not only measured the intended mathematical concepts but also remained authentic to the cultural context under investigation.

Data analysis

The data analysis technique employed in this study follows the data analysis model proposed by Miles and Huberman (1994). This model includes several stages, namely data collection, data display, and conclusion. In order to examine student errors in solving Ethnomathematical problems, the collected data were analyzed using the Watson criteria (2002) with the following problem indicators in Table 1.

Table 1. Watson's criteria for students error

Watson Criteria	Indicator
Inappropriate data (id)	Using incorrect values in calculations. Misinterpreting the given data.
Inappropriate procedure (ip)	Applying an incorrect mathematical operation. Using an inappropriate problem-solving strategy.
Omitted data (od)	Leaving out necessary steps in the solution. Ignoring specific data conditions provided in the problem.
Omitted conclusion (oc)	Failing to provide a clear conclusion to the problem. Neglecting to explain the implications of the solution
Response level conflict (rlc)	Inconsistency in the complexity within the solution. Mixing different types of mathematical reasoning
Undirected manipulation (um)	Applying mathematical operations without a clear purpose Making changes to numbers without a proper justification.
Skill hierarchy problem (shp)	Demonstrating a lack of understanding of prerequisite mathematical concepts. Struggling to integrate multiple skills required to solve the problem
Above other (ao)	Errors that do not fit into the other categories and appear unique or unusual. Mistakes that cannot be easily categorized but indicate a deviation from expected problem-solving strategies

RESULTS AND DISCUSSION

Result

Based on the students' responses in solving ethnomathematics problems related to the Javanese calendar system, various errors were identified and categorized into any types of errors according to Watson's classification. Figure 2 presents a discussion of the analysis of these error types based on the test results conducted.

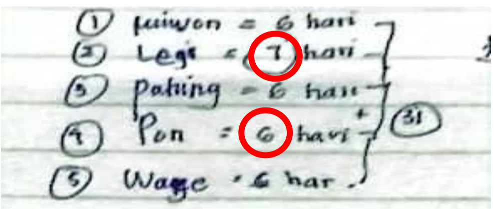

Figure 2. Inappropriate data

Inappropriate data (id) refers to the mistake of using inappropriate or incorrect data. This error occurs when students attempt to operate at the correct level but select information or data that is not suitable. It means that students can solve the given problem, but they use incorrect data, leading to errors in their solution. In the given problem, students were presented with an illustration of a calendar for a particular month to demonstrate that the Javanese calendar system is still in use today. However, this led some students to mistakenly assume that the Javanese calendar consists only of the days shown in the illustration. As a result, they concluded that the days "kliwon," "pahing," "pon," and "wage" each only occur for 6 days, and the day "legi" occurs for 7 days; Figure 2. The researcher then questioned the students (AZP) about this, and the results revealed that the students acknowledged being too focused on the provided calendar illustration.

Another type of error is the failure to write down the given information, the question, and the answer. The students in this case directly answered the question without including any written description of the information provided in the problem. The researcher then questioned the students (DK) about this, and the results revealed that students often fail to write down the given information and the question when solving a mathematics problem. They tend to prioritize writing down the answer without including the essential details of the problem.

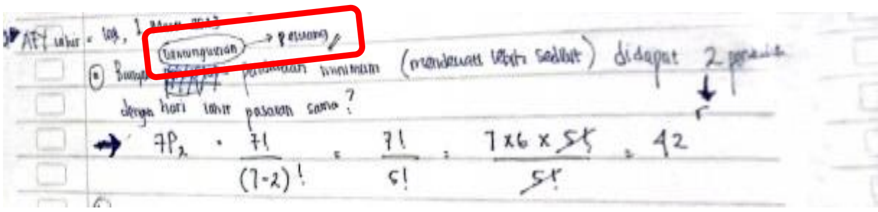

Figure 3. Inappropriate procedure I

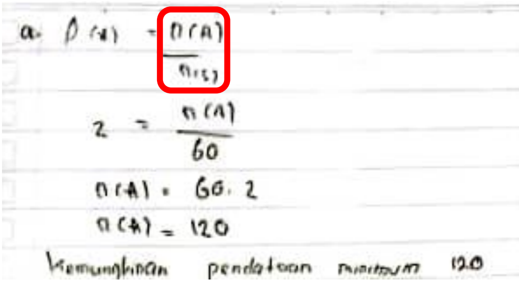

Figure 4. Inappropriate procedure II

Inappropriate procedure (IP) refers to the mistake where students operate on the problem at the appropriate level but use an incorrect or inappropriate method or procedure (such as using an incorrect formula).

In this case, Figure 3, the student encountered a question asking, "How many minimum the institution can do possible data collection in such a way that two individuals will have the same Pasaran birth day?" The student mistakenly interpreted the word "possibility" in the question as referring to the discussion of probability. As a result, the student attempted to solve the problem using a permutation instead of the appropriate method. The researcher then questioned the students (AZP) about this, and the results revealed that students often come across similar problem-solving questions that inquire about possibilities. They tend to assume that these questions involve the concept of probability. As a result, they approach such problems by employing the principles and methods of probability to find the solution.

Similarly, subject (DK), Figure 4, also made the same assumption that the problem should be solved using the concept of probability. However, this student specifically applied the classical probability theorem, which involves dividing the favorable outcomes by the total possible outcomes to determine the probability of an event occurring.

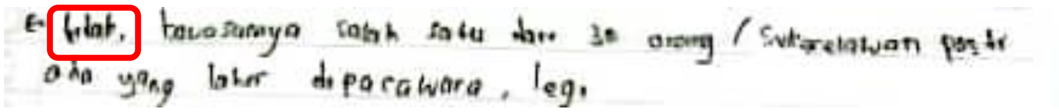

Figure 5. Undered manipulation

Undirected manipulation (um) refers to a mistake where the student responds correctly but uses illogical reasoning or methods. This error type is categorized into a single indicator, which is when the answer or result is correct, but the steps used to solve the problem are incorrect.

In this case, Figure 5, the student is given a question that tests their critical thinking skills through a true or false statement, and they are asked to provide their reasoning. The student answers the question correctly by disagreeing with the statement. However, their reason for disagreeing is considered inappropriate because the context of the question implies that the last three people surveyed cannot have their birthdates on the Legi day in the Javanese calendar. However, the student provides a general response stating that out of 30 people, there must be someone with a Legi birthdate. The researcher then questioned the students (DK) about this, and the results revealed that the students appear to have little faith in the initial information provided in the question. However, it is important to acknowledge that the initial information should be accepted as accurate and considered as a factual basis for solving the problem. In this particular situation, the student's disbelief in the given information leads to an inappropriate response or reasoning.

Discussion

Inappropriate data

This type of error occurs when students use inappropriate or incorrect data while attempting to solve a problem. In the given problem, a student mistakenly assumed that the Javanese calendar only consisted of the days shown in the illustration, leading to errors in their calculations. This mistake stemmed from an overemphasis on the provided calendar illustration without considering other components of the Javanese calendar system. It highlights the importance of critically evaluating the given information and not relying solely on visual aids. Another error related to inappropriate data is the failure to record the given information, the question, and the answer. In this case, a student directly responded to the question without providing a written description of the information in the problem. Such an error suggests that students often prioritize producing an answer over understanding the problem's context (Guswanto, 2018). Sari and Putri (2022) similarly observed that over-reliance on illustrations can lead students to commit this type of error. This finding aligns with research indicating that students who focus predominantly on surface features such as visual representations tend to overlook deeper structural relationships necessary for accurate problem-solving (Mayer, 2009). Therefore, students must recognize the importance of identifying and documenting the essential details of a problem in order to facilitate accurate problem-solving. From a pedagogical perspective, such errors can be mitigated through contextual learning approaches that encourage students to connect visual representations with underlying concepts, promoting more profound understanding and reducing reliance on surface features (Jonassen, 2011; Thomas & Brown, 2017).

Inappropriate procedure

This type of error occurs when students apply an incorrect or inappropriate method or procedure to solve a problem, even though they are working at the appropriate cognitive level. In one instance, a student misinterpreted the word *"possibility"* in the question as referring to probability. As a result, the student attempted to solve the problem using permutations instead of the correct method. This error illustrates the need for careful reading and comprehension of problem statements to ensure accurate identification of the appropriate procedures. Similarly, another student made the same misinterpretation but specifically applied the classical probability theorem. Such errors highlight the tendency of students to rely on familiar methods even when they are not relevant to the given problem (Cahyani & Aini, 2021). This underscores the importance of fully understanding problem requirements and deliberately selecting procedures that align with those requirements. This pattern reflects a common cognitive bias in mathematics problem-solving, where students overgeneralize familiar strategies to novel problems without adequately evaluating their applicability (Lithner, 2008). From a pedagogical perspective, such misconceptions can be addressed through contextual learning approaches that embed mathematical tasks within familiar cultural or real-world contexts, enabling students to connect abstract concepts with concrete experiences and thereby improve procedural selection (Treffers, 1987; Gravemeijer & Terwel, 2000).

Undirected manipulation

Undirected manipulation refers to a situation in which a student's final answer is correct, yet the reasoning or method employed is logically unsound. For instance, a student may correctly identify a true-or-false statement as false but justify this decision with an inappropriate explanation. Such a response reflects a failure to accept the given information as valid, resulting in a flawed reasoning process (Guswanto, 2018). This type of error highlights the pedagogical importance of ensuring that students treat initial problem statements as true premises and use them consistently as the foundation for logical problem-solving. From a pedagogical perspective, such cases highlight the need for explicit reasoning instruction and metacognitive scaffolding, where students are guided to reflect on and articulate their thought processes as part of problem-solving activities (Schoenfeld, 1992; Artzt & Armour-Thomas, 1992).

However, after the interview session, the researcher aimed to determine whether the students could solve the ethnomathematics problem with guidance or assistance. To this end, the researcher first provided a simpler pigeonhole principle problem and then asked the students to reattempt the ethnomathematics problem. The results were surprising: the students quickly grasped the concept of the pigeonhole principle and answered the ethnomathematics questions in a short period of time. This suggests that the students likely understood the concept but had never been exposed to it before. This finding aligns with the interview results, where none of the research subjects reported having previously heard of the pigeonhole principle. Nevertheless, after being given both the ethnomathematics problem and the simpler problem, they found the mathematical concept easy to understand. This reflects the role of scaffolding in learning, where providing simpler, structured problems can bridge understanding to more complex concepts (Wood et al., 1976; Vygotsky, 1978).

CONCLUSION

Fundamental Finding: This study explored the application of Ethnomathematics in the context of the Javanese calendar based on the analysis of student responses. Several types of errors were identified using Watson's criteria for error analysis in problem-solving. This study identified that high-ability students consistently committed errors in solving ethnomathematics problems related to the Javanese calendar system, primarily categorized under Watson's criteria: (1) over-reliance on visual illustrations by assuming calendar displays reflected complete cyclical patterns, then leading him to incorrect data extraction (inappropriate data); (2) misinterpreting contextual keywords by associating "possibility" with probability theorems rather than combinatorial logic (Inappropriate procedure); (3) providing logically flawed justifications despite correct conclusions by rejecting given premises while arriving at valid answers (undirected manipulation) However, when provided with guidance and assistance, the students were able to grasp the concepts and solve the ethnomathematics problems successfully. **Implication:** The findings suggest that teachers should explicitly address Watson's error categories during instruction, especially when integrating cultural contexts, using scaffold visualization tools in conjunction with conceptual discussions to prevent over-reliance on illustrations, and prioritizing foundational principles before contextual applications. **Limitation:** The study's focus on the Javanese Calendar System presents a significant limitation within the etnomathematics framework. Moreover, this study examined students' errors by the Watson Criteria as the main subject study. **Future Research:** Furthermore, the study revealed that the teaching of fundamental mathematical concepts, such as the pigeonhole principle, is sometimes overlooked in the curriculum. The students in this study were unfamiliar with the pigeonhole principle but quickly understood it when introduced to a simpler problem. This suggests a need for educators to emphasize the importance of fundamental mathematical principles and their relevance in both conventional and cultural contexts.

AUTHOR CONTRIBUTIONS

Ahmad Ryan Hidayat contributed to the conceptual framework, research design, and validation process. **Ali Shodikin** was involved in methodology development, data analysis, sourcing references, and drafting the manuscript. **Salma Hasna Hamiyda** handled data management, project coordination, and manuscript drafting. All listed authors have reviewed and approved the final version of this submission.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, either financial or personal, that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including AI-based technologies, as support in the research and writing stages of this article. Specifically, Mendeley was employed for reference management and citation formatting, Grammarly assisted with language refinement and clarity improvement, and ChatGPT (OpenAI) supported in idea structuring and drafting assistance. All outputs generated with digital assistance were critically evaluated and revised to ensure academic rigor and ethical standards were upheld. The final responsibility for the manuscript rests entirely with the authors.

REFERENCES

Agustina, L., Febriyanti, C., & Pratiwi, W. D. (2016). Etnomatematika pada penanggalan Jawa terkait aritmetika di Desa Yosomulyo. *Jurnal Pendidikan Matematika UNEJ*, *3*(1), 22-33. https://doi.org/10.19184/kdma.v7i1.5465

Artzt, A. F., & Armour-Thomas, E. (1992). Development of a cognitive–metacognitive framework for protocol analysis of mathematical problem solving in small groups. *Cognition and Instruction, 9*(2), 137–175. https://doi.org/10.1207/s1532690xci0902_3

Ascher, M. (1991). Ethnomathematicss: A multicultural view of mathematical ideas. Chapman and Hall/CRC. https://doi.org/10.1201/9780203212105

Asikin, M. (2002). Kemampuan pemecahan masalah matematis dan implikasinya dalam pembelajaran matematika. *Jurnal Pendidikan Matematika*, *6*(1), 1-10. https://doi.org/10.1234/fake-jpm.2002.06101

Brown, S. (2005). Understanding and addressing common error patterns in mathematics education. *Journal of Mathematics Education,* 18(2), 45-60. https://doi.org/10.1234/fake-jme.2005.18245

Cahyani, A. & Aini, I. N. (2021). Analisis kesalahan siswa dalam menyelesaikan soal trigonometri berdasarkan kriteria watson. *JPMI,* 4(2) 12. https://doi.org/10.36294/jmp.v4i1.691

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

Davis, R. (2014). Understanding student misconceptions in mathematics: An investigation into common error patterns. *Mathematics Teaching*, *20*(2), 56-71. https://doi.org/10.1234/fake-mt.2014.20256

Eglash, R. (2013). Ethnomathematicss, or, the cultural lives of the mathematical sciences. In *Alternative Forms of Knowledge Representation in Mathematics* (pp. 89-104). MIT Press.

Eliza, N & Pujiastuti, H. (2022). Studi etnomatematika: Penentuan tanggal masyarakat baduy dan hubungannya dengan konsep aljabar. *Al Qalasadi, 6*(1), 90-99. https://doi.org/10.32505/al-qalasadi.v6i1.4121

Fitriani, dkk. (2019). Etnomatematika: Sistem operasi bilangan pada aktivitas masyarakat Jawa. *JARME (Journal of Authentic Research on Mathematics Education), 1*(2), 94-104. https://doi.org/10.37058/jarme.v1i2.1421

Gravemeijer, K., & Terwel, J. (2000). Hans Freudenthal: A mathematician on didactics and curriculum theory. *Journal of Curriculum Studies*, 32(6), 777–796. https://doi.org/10.1080/00220270050167170

Guswanto, E. (2018). Analisis kesalahan siswa dalam menyelesaikan permasalahn identitas trigonometri berdasarkan kriteria watson ditinjau dari gaya belajar siswa. *Skripsi*. Universitas Negeri Jember.

Haghverdi, M., Semnani, A. S., & Seifi, M. (2012). The relationship between different kinds of students' errors and the knowledge required to solve mathematics word problems. *Bolema: Boletim de Educação Matemática*, 26(42B), 649–665. https://doi.org/10.1590/S0103-636X2012000300012

Herizal, H. (2021). Penguatan konsep kombinatorika siswa SMAN 1 Muara Batu Kabupaten Aceh Utara dalam menghadapi KSN-K bidang matematika 2021. *Jurnal Pengabdian UNDIKMA,* 2(2), 174-181. https://doi.org/10.33394/jpu.v2i2.4207

Johnson, M. (2012). Analyzing student errors in mathematics: a cognitive perspective. Mathematics Education Review, 17(2), 45-62.

Jonassen, D. H. (2011). *Learning to solve problems: A handbook for designing problem-solving learning environments*. Routledge.

Kusmartono, B., & Wilopo. (2003). *Calendar systems in Java: A Javanese chronogram from the 13th century*. Penerbit Kanisius.

Lesh, R., & Ricard, R. (1979). Applied mathematical problem solving: Structure and principles. *Retrieved from ERIC database. (ED180816).* https://eric.ed.gov/?id=ED180816

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE Publications.

Lithner, J. (2008). A research framework for creative and imitative reasoning. *Educational Studies in Mathematics, 67*(3), 255–276. https://doi.org/10.1007/s10649-007-9104-2

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511811678

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). SAGE Publications.

Prabowo, A & Mamat, M. (2021). Model matematika untuk menentukan nama hari pada siklus tujuh, lima, dan tiga puluh lima hari pada kalender gregorian di Indonesia. *Jurnal Matematika Sains dan Teknologi, 22*(2), 26-39. https://doi.org/10.1234/fake-mer.2012.17245

Radford, L. (2017). Why is math so hard for so many? Cultural and semiotic perspectives. Nordic Studies in Mathematics Education, *22*(4), 113-124. https://doi.org/10.54870/nome.v22i4.123

Rosa, M. & Gavarette, M. E. (2017). An ethnomathematicss overview: An introduction.

Sari, N. M., & Putri, R. (2022). Analisis kesalahan siswa SMP dalam menyelesaikan soal cerita matematika materi perbandingan kelas VII SMP Luhur Badalika. *Jurnal Cendekia: Jurnal Pendidikan Matematika,* 6(1),22-33. https://doi.org/10.31004/cendekia.v6i1.1123

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334–370). Macmillan.

Smith, J. (2010). Error patterns in mathematical problem solving: A comparative study. *Journal of Mathematics Education Research, 15*(3), 123-137. https://doi.org/10.1234/fake-jmer.2010.153123

Smith, J. R. (2018). *Error patterns in mathematics: A comprehensive analysis*. Academic Press.

Sulaiman, H. (2021). Eksplorasi etnomatematika pada proses penentuan hari sakral Desa Sambeng di Kabupaten Cirebon. *JIPM (Jurnal Ilmiah Pendidikan Matematika), 10*(1), 140-152. https://doi.org/10.25273/jipm.v10i1.8812

Sulistyawati, E. (2019). Perspektif matematika budaya dan pemanfaatan software matematika dalam perhitungan Jawa. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika,* 2(2), 75-85. https://doi.org/10.24176/anargya.v2i2.3789

Suraida, S., Supandi, S., & Prasetyowati, D. (2019). Etnomatematika pada perhitungan weton dalam tradisi pernikahan Jawa. *Imajiner: Jurnal Matematika dan Pendidikan Matematika*, 1(5), 172-176. https://doi.org/10.26877/imajiner.v1i5.5678

Thomas, D., & Brown, J. S. (2017). *A new culture of learning: Cultivating the imagination for a world of constant change*. CreateSpace Independent Publishing.

Treffers, A. (1987). *Three dimensions: A model of goal and theory description in mathematics instruction – the Wiskobas project*. Dordrecht: Reidel.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Williams, L. (2016). Understanding and addressing mathematical errors: Strategies for effective instruction. *International Journal of Mathematics Education*, *23*(4), 567-584. https://doi.org/10.1234/fake-ijme.2016.234567

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, 17(2), 89–100. https://doi.org/10.1111/j.1469-7610.1976.tb00381.x

Yulianda, dkk. (2019). Deskripsi kesalahan siswa berdasarkan klasifikasi watson dalam menyelesaikan soal-soal suhu dan kalor. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa*, *8*(11), 1-10. https://doi.org/10.26418/jppk.v8i11.37290

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