Students' Difficulties in Solving AKM Numeracy Problems in Algebra: An Analysis Based on Learning Styles

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Abstract
This study explores junior high school students' numeracy skills in solving AKM-equivalent algebra problems based on their learning styles: visual, auditory, and kinesthetic. Using a qualitative case study design, nine students were selected through a learning style questionnaire and a numeracy test. Data were gathered using tests, interviews, and document analysis. The findings reveal that students with different learning styles demonstrate distinct strengths and challenges at each cognitive level (knowing, applying, and reasoning). High-proficiency students were able to solve problems across all levels, often using strategies aligned with their learning preferences. Moderate-proficiency students commonly faced difficulties in applying-level tasks due to conceptual misunderstandings, while low-proficiency students struggled across all levels, particularly with comprehension and focus. Despite these difficulties, students employed various successful strategies such as sketching, verbalizing, or imagining scenarios. The study highlights the importance of adaptive instruction that integrates learning style-based strategies. Practical recommendations are provided for educators to design inclusive numeracy instruction that enhances students' mathematical understanding and problem-solving abilities.
Keywords: numeracy skills, learning styles, AKM, algebra, student difficulties

Introduction

Numeracy skills are essential in education, playing a crucial role in everyday life. Generally, numeracy is defined as the ability to understand, interpret, and apply mathematical concepts to solve problems in various contexts (Dieckmann, 2008; Pusmendik, 2023). The Indonesian government has established numeracy competency assessments through the Minimum Competency Assessment (AKM), which evaluates students' abilities across three cognitive levels: knowing, applying, and reasoning (Pusmendik, 2023). One of the content areas assessed in AKM is algebra, which requires conceptual understanding, problem-solving skills, and the ability to apply appropriate solution strategies.

Algebra was selected as the focus of this study because it is a foundational topic in mathematics that frequently appears in AKM and other standardized assessments. According to the Cambridge Dictionary, algebra involves using symbols and letters to represent numbers and express general rules. In education, algebraic thinking is a prerequisite for learning more advanced mathematical concepts. Research shows that students often struggle to interpret and apply algebraic concepts, particularly when these are embedded in real-world problem contexts (Pulungan, 2022; Fauzi, 2021). The selection

of algebra content in this study is supported by the AKM blueprint and curriculum analysis, which show that algebra is one of the key focus areas in both instructional and assessment practices.

Despite efforts to improve numeracy through curriculum development and AKM implementation, national assessment results indicate that more than 50% of students do not meet the minimum competency threshold in numeracy (Kemendikbud, 2023). This finding highlights ongoing challenges in enhancing students' mathematical literacy. One contributing factor to students' difficulties in numeracy is their learning style. Each student has different tendencies in understanding, processing, and applying information based on their learning style—whether visual, auditory, or kinesthetic (Widayanti, 2013).

Several studies suggest that aligning instructional strategies with students' learning styles can improve learning outcomes, including numeracy skills (Fleming, 2001; Waluyo & Pujiastuti, 2023; Susanti & Aminah, 2024). For instance, visual learners benefit from diagrams and spatial representations, auditory learners from verbal explanations, and kinesthetic learners from physical activities and manipulatives. However, research that directly connects learning styles with students' success in solving AKM-equivalent problems remains limited. Most studies focus on learning styles in general or numeracy performance without considering their interaction.

Therefore, this study aims to fill this gap by exploring how students with different learning styles approach and experience difficulties in solving AKM-equivalent algebra problems. The research questions guiding this study are: (1) How do students' numeracy skills in solving AKM-equivalent algebra problems vary based on their learning styles? (2) What difficulties do students face in solving algebraic numeracy problems based on their learning styles? (3) What factors contribute to students' difficulties in solving AKM-equivalent algebra problems?

Method

This study employed a qualitative approach with a case study design to explore students' numeracy profiles in solving AKM-equivalent algebra problems based on their learning styles. The qualitative method was chosen to allow in-depth exploration of students' experiences and difficulties in a real classroom context (Creswell & Poth, 2016).

The research was conducted in a junior high school in Bandung Regency involving 27 students. Participant selection was carried out in two stages. First, students completed a

learning style questionnaire adapted from Fleming's VARK model (2001), consisting of 13 multiple-choice items that categorized preferences into visual, auditory, and kinesthetic styles. The instrument was validated through a Focus Group Discussion (FGD) with a school counselor to ensure its suitability for junior high school students.

Second, students were given a numeracy test adapted from the AKM framework. The test consisted of 6 algebra-based contextual problems, with each AKM cognitive level—knowing, applying, and reasoning—represented by 2 items. These items were developed and validated through expert review by mathematics education lecturers to ensure content and construct validity.

Based on the combined results of the questionnaire and numeracy test, nine students were selected using purposive sampling to represent a combination of three learning styles and three levels of numeracy proficiency (high, moderate, low). The learning style categorization was based on the highest score trend in the questionnaire, and numeracy level classification followed an assessment rubric adapted from AKM standards. The data collection process used four instruments: (1) the VARK-based learning style questionnaire, (2) the AKM-based numeracy test, (3) semi-structured interviews, and (4) document analysis. Interviews were conducted in two rounds: the first to confirm students' dominant learning styles (especially for those with mixed results), and the second to explore their thought processes and difficulties when solving numeracy problems. Document analysis involved reviewing the AKM blueprint and school curriculum documents to validate the alignment between the test content and national standards.

Data analysis followed Miles and Huberman’s interactive model (2014), including data reduction, data display, and conclusion drawing. Triangulation of data sources and methods was used to enhance the credibility and trustworthiness of findings.

Results and Discussion

This study aims to analyze how students with different learning styles—visual, auditory, and kinesthetic—experience success and difficulties in solving AKM-equivalent numeracy problems in algebra. Each learning style group is explored based on three levels of numeracy proficiency: high, moderate, and low.

RQ 1: How is students’ numeracy ability in solving AKM-equivalent algebraic content questions viewed from their learning styles?

The findings show varied numeracy abilities across the three learning styles:

- Visual learners with high numeracy skills demonstrated fluency across all cognitive levels by effectively using visual representations such as sketches and structured tables. Those with moderate skills were able to complete knowing and applying tasks but struggled with reasoning-level problems, particularly when visual cues were absent. Low-proficiency visual learners found it difficult to identify problem elements and often showed hesitation in selecting appropriate strategies.
- Auditory learners with high proficiency could verbalize problems, rephrase them internally, and solve tasks confidently across all levels. Moderate-level auditory learners performed better in reasoning than applying tasks—contrary to earlier findings—mainly due to insufficient understanding of applied concepts such as discounts. Low-level auditory learners were less responsive when problems lacked opportunities for verbal reinforcement, leading to misinterpretation of instructions.
- Kinesthetic learners with high and moderate skills successfully handled reasoning-level problems by visualizing or imagining real-world contexts. They often processed problems sequentially or associated tasks with physical actions. However, they faced difficulties in applying-level problems when the content was too abstract. Low-level kinesthetic learners showed limited ability to engage with the tasks when concrete representations or manipulatives were not available.

These results support prior studies (Fleming, 2001; Marifah et al., 2020; Amir, 2015) and provide new insight that challenges the assumption that kinesthetic learners naturally perform better at application-level tasks, as noted by Rosidi et al. (2022).

RQ 2: What difficulties do students face in solving algebraic numeracy problems based on their learning styles?

The study identified three main areas of difficulty:

1. Understanding problem instructions: Visual learners struggled when problems lacked diagrams or a structured layout. Auditory learners found it hard to focus without reading aloud or hearing explanations. Kinesthetic learners struggled to interpret abstract content when they couldn't associate it with physical experiences.
2. Applying key concepts: Many students with moderate to low proficiency across all styles had difficulty applying concepts such as discounts due to weak conceptual understanding. This was especially prominent in auditory and kinesthetic learners.
3. Learning environment mismatch: The classroom setup often did not support students' dominant learning styles. Visual learners lacked visual aids, auditory

learners lacked verbal interaction, and kinesthetic learners lacked movement or activity-based instruction. These environmental mismatches made comprehension and problem-solving more difficult.

Despite these difficulties, students also demonstrated strengths:

- Visual learners used sketching or organizing information visually.
- Auditory learners benefited from restating questions or discussing aloud.
- Kinesthetic learners created real-life mental scenarios or mimicked actions related to the problem.

These strengths show that students actively use learning-style-aligned strategies to support their understanding, highlighting the importance of recognizing and reinforcing these tendencies in instruction.

RQ 3: What Factors Contribute to Students' Difficulties in Solving AKM-Equivalent Algebraic Numeracy Problems?

The study found three interrelated contributing factors:

1. Weak conceptual foundations: especially in applying-level tasks such as calculating discounts or interpreting ratios, limited students' ability to solve problems effectively.
2. Focus and attention issues: particularly in environments that did not align with students' learning styles. Kinesthetic learners struggled in static settings, while auditory learners became distracted in silent contexts without verbal prompts.
3. Instructional misalignment: teachers often used uniform instructional methods that failed to address the diverse learning preferences of students. As a result, some students lacked the support they needed to engage meaningfully with numeracy content.

These findings align with prior research (Denggot, 2023; Susanti & Aminah, 2024), which highlights the critical role of responsive and adaptive teaching strategies.

Practical Recommendations for Teachers:

- Visual learners benefit from diagrams, graphic organizers, and opportunities to sketch while solving.
- Auditory learners need verbal explanations, oral processing, and structured discussions.
- Kinesthetic learners require manipulatives, movement-based activities, or scenario enactment.

By integrating these strategies into classroom instruction, teachers can better support students' numeracy development and reduce difficulties in AKM-equivalent problem solving.

Conclusion and Suggestion

This study has provided an in-depth analysis of students' numeracy difficulties in solving AKM-equivalent algebra problems, viewed through the lens of learning styles. Key conclusions include:

1. Numeracy skills vary by learning style and proficiency level.
    - High-proficiency students, regardless of learning style, could solve problems at all cognitive levels.
    - Moderate-proficiency students showed differentiated challenges: visual learners struggled with reasoning, while auditory and kinesthetic learners faced difficulties in applying tasks.
    - Low-proficiency students consistently struggled with interpreting instructions and executing basic operations.
2. Difficulties encountered by students included:
    - Misinterpreting instructions, especially when unsupported by visual or verbal cues.
    - Inability to apply mathematical concepts like discounts (particularly among moderate auditory and kinesthetic learners).
    - Weakness in constructing coherent reasoning for multi-step problems.
3. Contributing factors to these difficulties were:
    - Poor conceptual understanding.
    - Inconsistent focus and concentration, especially in tasks lacking multimodal supports.
    - Mismatch between learning style and instructional format (e.g., purely textual problems for visual learners).
4. Practical recommendations:
    - Teachers should assess and incorporate students' learning styles in instructional planning.
    - Classrooms should support multimodal learning by integrating visual, auditory, and kinesthetic elements.

- Emphasis should be placed on reinforcing basic mathematical concepts before introducing contextualized problems.

This study contributes a novel perspective to understanding numeracy by showing how individual learning styles intersect with problem-solving in real-world algebra tasks. These insights can inform more inclusive and effective mathematics instruction aligned with AKM and broader educational goals.

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