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Students' Mathematical Understanding Ability In Pie Chart Material At Seventh Grade

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Abstract

This study aims to analyze the mathematical understanding ability of seventh-grade students on pie chart material, describe the ability profile per indicator, and identify dominant student error patterns. Mathematical understanding is a fundamental competency encompassing students' ability to comprehend concepts, apply procedures, and use mathematical representations appropriately. Pie charts, as part of statistics learning, require an integrative understanding of percentages, angles, and visual data representation. This study employed a descriptive quantitative approach involving 18 seventh-grade students at SMP Negeri 5 Sa'dan selected via purposive sampling. The instrument was a mathematical understanding test consisting of four essay items measuring six main indicators. Results indicate that students' overall mathematical understanding falls into the moderate category, with a mean score of 58.7 (scale 0–100) and mean scores ranging from 2.50 to 2.83 across indicators (scale 0–4). The lowest indicator was classifying objects (\$2.50\$), while applying concepts in problem-solving yielded the highest score (\$2.83\$). The dominant errors were procedural (\$40\%\$), conceptual (\$35\%\$), and interpretive (\$25\%\$). These findings suggest that instruction should emphasize conceptual understanding of prerequisite concepts—particularly percentages and angle conversion—prior to procedural execution.

Keywords: mathematical understanding, pie chart, statistics, junior high school students)

INTRODUCTION

Mathematics is a fundamental subject in the educational system that plays a strategic role in developing students' logical, analytical, and systematic thinking skills. Mathematics learning aims not merely to transfer algorithmic knowledge, but to equip students with foundational mathematical understanding to solve real-world

problems (NCTM, 2000; Walle, 2010). Mathematical understanding is the primary foundation for students in constructing mathematical knowledge. Kilpatrick et al. (2001) define mathematical understanding as the ability to comprehend concepts, operations, and relations in an integrated manner. Operationally, Skemp (1976) distinguishes understanding into two

main forms: instrumental understanding, which is the ability to apply rules or procedures without knowing why, and relational understanding, which is the ability to connect concepts with mathematical structures as a whole. Within the curriculum context, this understanding ability is reflected in indicators such as restating concepts, classifying objects, providing examples and non-examples, presenting concepts in various representations, and applying concepts to problem-solving (Minarni et al., 2016).

In junior high school, statistics, specifically data presentation through pie charts, is an essential competency. Pie charts hold high practical value as they are frequently used in public reports, financial analysis, and opinion surveys (Nuraeni & Luritawaty, 2023). However, this material possesses complex characteristics because it requires mastering several prerequisite concepts simultaneously, such as proportion, percentage, central angles of 360 degrees, and visual data conversion (Istiqomah & Surya, 2022). Based on preliminary observations at SMP Negeri 5 Sa'dan, seventh-grade students still experience significant hurdles when solving pie chart problems. Major difficulties arise when converting raw data into percentages or angular degrees, sketching pie chart sectors with accurate proportions, and interpreting implicit information within the charts (Rahmawati & Permatasari, 2021). These obstacles stem from several factors, including weak mastery of basic arithmetic concepts such as percentages and fraction operations, conventional teaching strategies focused on formula execution, and minimal use of visual media during instruction (Hafiyusholeh et al., 2020; Wibowo et al., 2023). Therefore, this study aims to analyze the overall level of seventh-grade students' mathematical understanding ability in pie chart material, describe the profile of student achievement across each mathematical understanding indicator, analyze dominant error patterns committed by students, and identify factors influencing students' mathematical understanding as a basis for instructional evaluation.

This study employed a quantitative approach with a descriptive research design to explicitly describe the profile of students' mathematical understanding ability based on quantitative data obtained from formal test results. The study was conducted at SMP Negeri 5 Sa'dan during the even semester of the 2024/2025 academic year in May 2025. The research subjects comprised 18 seventh-grade students selected through purposive sampling, where the selection criteria required that students had received instruction on statistics and pie charts and actively attended the administration of the evaluation test. The gender distribution consisted of 10 male students (55.56%) and 8 female students (44.44%). The primary instrument used was the Mathematical Understanding Ability Test, consisting of four essay questions administered over a duration of 90 minutes. The test was designed to measure six indicators of mathematical understanding, which are restating pie chart concepts, classifying objects according to specific properties, providing examples and non-examples of a concept, presenting concepts in various mathematical representations, selecting and applying specific procedures or operations, and applying concepts or algorithms in problem-solving. Each essay item was scored using an analytic rubric on a scale of 0 to 4 for each indicator. Instrument validity was verified through content validity evaluated by academic experts and experienced mathematics teachers, face validity to ensure language clarity and readability of instructions, and reliability testing using Cronbach's Alpha, which yielded a coefficient of 0.78 and indicated high instrument reliability. Quantitative data were processed by calculating individual final

scores transformed to a 0 to 100 scale, categorizing students' ability levels into five standard categories (Very High for scores 81 to 100, High for 61 to 80, Moderate for 41 to 60, Low for 21 to 40, and Very Low for 0 to 20), calculating the mean score per indicator on a 0 to 4 scale, and categorizing student error types into procedural, conceptual, and interpretive errors (Wijaya et al., 2021).

RESULTS AND DISCUSSION

Based on the data gathered from the 18 students, the descriptive statistical analysis revealed an overall mean score of 58.7 with a standard deviation of 15.2, a median of 60.0, and a mode of 65.0, where the highest student score reached 88 and the lowest score was 25. This overall mean score places the mathematical understanding ability of students at SMP Negeri 5 Sa'dan in the moderate category. In terms of category distribution, 3 students (16.7%) achieved the Very High category, 7 students (38.9%) were in the High category, 6 students (33.3%) were in the Moderate category, 2 students (11.1%) fell into the Low category, and no students were in the Very Low category. Although 55.6% of students reached the High to Very High categories, 44.4% remained in the Moderate and Low categories. This aligns with findings by Minarni et al. (2016), indicating that the average mathematical understanding of junior high school students in Indonesia regarding basic statistics generally remains at a moderate level. A detailed examination across the six indicators on a scale of 0 to 4 revealed varying levels of performance. Indicator 6, which measures applying concepts in problem-solving, achieved the highest mean score of 2.83, as students were supported by contextual story-based problems that enhanced their motivation and analysis (Widyawati & Rusmining, 2021). Indicator 4, representing concepts in various representations, followed with a mean score of 2.78, where students performed well in converting tables into sketches but faced minor technical issues with angle calculations (Anggraini & Prahmana, 2022). Indicator 3, providing examples and non-examples, recorded a mean score of 2.72, driven more by practical everyday experience than formal memorization. Indicator 1, restating concepts, yielded a mean score of 2.61, with 55.6% of students demonstrating good conceptual definitions (Nuraeni & Luritawaty, 2023). Indicator 5, selecting and applying procedures, achieved a mean score of 2.56, where students struggled with multi-step conversions from percentages to central angles (Wibowo et al., 2023). Indicator 2, classifying objects according to properties, recorded the lowest mean score of 2.50, as students frequently struggled to determine which raw data types are best suited for pie charts versus bar or line graphs (Rahmawati & Permatasari, 2021). An examination of student response sheets revealed three primary error categories, where procedural errors were the most dominant at 40%, manifest in calculation mistakes in fraction operations and incorrect angle multiplications. Conceptual errors accounted for 35% of student mistakes, characterized by assuming the total degrees in a circle equals 100 or confusing percentage values directly with absolute frequency counts. Interpretive errors constituted 25% of student mistakes, mainly appearing as misread sector labels or failures to correlate visual proportions with underlying data values. The prevalence of procedural and conceptual errors demonstrates a close link between both domains. As emphasized by Skemp (1976) and Wijaya et al. (2021), students' procedural failures generally stem from fragile conceptual understanding of prerequisite material, leading students to memorize algorithmic steps without understanding the

underlying mathematical rationale behind using 360 degrees or 100 percent. Qualitative analysis and classroom observations further identified that mastery of prerequisite arithmetic operations, contextual instructional approaches, and the use of visual media were the primary factors influencing students' overall mathematical understanding (Hafiyusholeh et al., 2020).

CONCLUSION

Seventh-grade students' mathematical understanding ability in pie chart material at SMP Negeri 5 Sa'dan falls into the moderate category, with an overall mean score of 58.7. Indicator mean scores ranged from 2.50 to 2.83 on a 0 to 4 scale, where the highest achievement was observed in applying concepts in problem-solving and the lowest was in classifying objects according to properties. The most prevalent error type was procedural errors at 40%, followed by conceptual errors at 35%, and interpretive errors at 25%. These findings reveal a disconnect between technical application skills and core conceptual understanding, as instruction tends to emphasize instrumental problem-solving over fostering relational understanding. For mathematics teachers, it is recommended to strengthen foundational prerequisite concepts such as fraction operations, percentages, and angles before introducing statistical charts, while adopting the Concrete-Pictorial-Abstract approach and utilizing interactive visual media like GeoGebra to assist students in visualizing circle sectors. For future researchers, experimental studies are recommended to evaluate the effectiveness of Problem-Based Learning or targeted remedial strategies in reducing conceptual and procedural errors in statistical topics.

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