

**PROFIL PENALARAN MATEMATIS SISWA SMA DALAM MENYELESAIKAN
MASALAH JARAK DAN SUDUT PADA RUANG DIMENSI TIGA DITINJAU DARI
LEVEL BERPIKIR GEOMETRI VAN HIELE DAN TEORI KOGNITIF HAREL**



TESIS

diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar
Magister Pendidikan matematika

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**PROGRAM STUDI PENDIDIKAN MATEMATIKA
FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS PENDIDIKAN INDONESIA**

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LEMBAR HAK CIPTA
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Sebuah tesis yang diajukan untuk memenuhi salah satu syarat memperoleh gelar
Magister Pendidikan (M.Pd.) pada Fakultas Pendidikan Matematika dan Ilmu
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Penulis

ABSTRAK

Humam Nuralam, (2307631). Profil Penalaran Matematis Siswa SMA dalam Menyelesaikan Masalah Jarak dan Sudut pada Ruang Dimensi Tiga Ditinjau dari Level Berpikir Geometri van Hiele dan Teori Kognitif Harel.

Matematika secara fundamental terkait dengan proses matematis seperti eksplorasi, penalaran, dan komunikasi. Proses-proses tersebut merupakan keterampilan berpikir tingkat tinggi. Dalam beberapa tahun terakhir, penalaran matematis menjadi fokus utama dalam kurikulum matematika di berbagai negara, terutama sejak *Programme for International Student Assessment* (PISA) menekankan pentingnya kompetensi proses matematis dalam pengajaran dan pembelajaran, termasuk pemodelan, pemecahan masalah, dan penalaran. Penalaran matematis juga memiliki keterkaitan erat dengan pembelajaran geometri, sebagaimana ditunjukkan oleh berbagai penelitian. Geometri berperan penting dalam mengembangkan penalaran siswa. Namun, temuan empiris menunjukkan bahwa penalaran matematis dan penguasaan geometri siswa masih tergolong rendah. Penelitian ini bertujuan untuk mengkaji: (1) level berpikir geometri van Hiele siswa SMA dalam menyelesaikan masalah jarak dan sudut pada ruang dimensi tiga ditinjau dari Kemampuan Awal Matematis (KAM); (2) penalaran matematis siswa SMA dalam menyelesaikan masalah jarak dan sudut pada ruang dimensi tiga ditinjau dari KAM dan Teori Kognitif Harel; serta (3) profil penalaran matematis siswa SMA dalam menyelesaikan masalah jarak dan sudut pada ruang dimensi tiga ditinjau dari KAM, level berpikir geometri van Hiele, dan Teori Kognitif Harel. Penelitian ini menggunakan pendekatan kualitatif dengan metode fenomenologi hermeneutik. Data dikumpulkan melalui triangulasi observasi, tes, dan wawancara dengan subjek sembilan siswa kelas XII Program IPA. Hasil penelitian menunjukkan bahwa: (1) level berpikir geometri van Hiele siswa SMA dalam menyelesaikan masalah jarak dan sudut pada ruang dimensi tiga ditinjau dari KAM, yaitu siswa dengan KAM tinggi mampu mencapai level 4 (rigor), siswa dengan KAM sedang hanya mencapai level 1 (analisis), sedangkan siswa dengan KAM rendah berada pada level pra-0 (pravisualisasi); (2) penalaran matematis siswa SMA dalam menyelesaikan masalah jarak dan sudut pada ruang dimensi tiga ditinjau dari KAM dan Teori Kognitif Harel, yaitu siswa dengan KAM tinggi mampu mencapai seluruh indikator penalaran matematis, mulai dari *memorized reasoning*, *algorithmic reasoning*, *novelty*, *plausibility*, hingga *mathematical foundation*, yang ditunjukkan melalui *mental acts*, *ways of thinking*, dan *ways of understanding* yang sangat baik serta bervariasi; siswa dengan KAM sedang hanya mencapai indikator *memorized reasoning* dengan *mental acts*, *ways of thinking*, dan *ways of understanding* yang cukup baik tetapi belum memadai pada indikator lainnya; sedangkan siswa dengan KAM rendah tidak mampu mencapai indikator penalaran matematis dengan *mental acts*, *ways of thinking*, dan *ways of understanding* yang kurang memadai; (3) profil penalaran matematis siswa SMA dalam menyelesaikan masalah jarak dan sudut pada ruang dimensi tiga menunjukkan bahwa semakin kuat KAM yang dimiliki siswa, semakin tinggi pula capaian level berpikir geometri van Hiele, serta semakin lengkap indikator

penalaran matematis yang ditunjukkan melalui *mental acts*, *ways of thinking*, dan *ways of understanding* yang lebih baik dan bervariasi.

Kata Kunci: Penalaran Matematis, Masalah Jarak dan Sudut, Ruang Dimensi Tiga, Level Berpikir Geometri van Hiele, Teori Kognitif Harel

ABSTRACT

Humam Nuralam (2307631). Profile of High School Students' Mathematical Reasoning in Solving Distance and Angle Problems in Three-Dimensional Geometry: Perspectives from van Hiele Levels of Geometric Thinking and Harel's Cognitive Theory.

Mathematics is fundamentally related to mathematical processes such as exploration, reasoning, and communication. These processes constitute higher-order thinking skills. In recent years, mathematical reasoning has become a central focus of mathematics curricula across various countries, especially since the Programme for International Student Assessment (PISA) emphasized the importance of mathematical process competencies in teaching and learning, including modeling, problem-solving, and reasoning. Mathematical reasoning is also closely related to the learning of geometry, as shown by numerous studies. Geometry plays a crucial role in developing students' reasoning abilities. However, empirical findings indicate that students' mathematical reasoning and mastery of geometry remain relatively low. This study aims to examine: (1) the van Hiele levels of geometric thinking of high school students in solving distance and angle problems in three-dimensional geometry, viewed from their Prior Mathematical Ability (PMA); (2) the mathematical reasoning of high school students in solving distance and angle problems in three-dimensional geometry, viewed from their PMA and Harel's Cognitive Theory; and (3) the profile of students' mathematical reasoning in solving distance and angle problems in three-dimensional geometry, viewed from their PMA, van Hiele levels of geometric thinking, and Harel's Cognitive Theory. This research employed a qualitative approach using a hermeneutic phenomenological method. Data were collected through triangulation of observations, tests, and interviews involving nine twelfth-grade science program students. The findings reveal that: (1) regarding the van Hiele levels of geometric thinking in solving distance and angle problems in three-dimensional geometry based on PMA, students with high PMA reached level 4 (rigor), students with medium PMA reached level 1 (analysis), whereas students with low PMA were at pre-level 0 (previsualization); (2) regarding mathematical reasoning based on PMA and Harel's Cognitive Theory, students with high PMA achieved all indicators of mathematical reasoning—ranging from memorized reasoning, algorithmic reasoning, novelty, plausibility, to mathematical foundation—demonstrated through excellent and varied mental acts, ways of thinking, and ways of understanding; students with medium PMA achieved only the memorized reasoning indicator, with fairly good mental acts, ways of thinking, and ways of understanding, but were inadequate in other indicators; whereas students with low PMA were unable to achieve any mathematical reasoning indicators, showing inadequate mental acts, ways of thinking, and ways of understanding; (3) the profile of mathematical reasoning in solving distance and angle problems in three-dimensional geometry indicates that the stronger the students' PMA, the higher their van Hiele level of geometric thinking, and the more complete their mathematical

reasoning indicators, as demonstrated through better and more varied mental acts, ways of thinking, and ways of understanding.

Keywords: Mathematical Reasoning, Distance and Angle Problems, Three-Dimensional Geometry, Prior Mathematical Ability, van Hiele Levels of Geometric Thinking, Harel's Cognitive Theory

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