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Students' Profile on Analytical Thinking Skills at Natural Science Courses: A Study towards Students of Madrasah Ibtidaiyah Professional Teacher Education

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Abstract

This study aims to describe the analytical thinking skills profile of students enrolled in the Madrasah Ibtidaiyah Teacher Professional Education Program (PPG MI) who are pursuing Natural Sciences (IPA) courses. The approach employed was descriptive quantitative, with multiple-choice questions developed based on the PPG Knowledge Test question grid in the field of science. The research subjects were students of Madrasah Ibtidaiyah PPG Study Program. The results indicated that, in general, the students demonstrated high analytical thinking skills, with an average score of 76.09%. A number of subjects, including the digestive system, the environment, and energy changes, demonstrated remarkably high scores. Conversely, subjects such as material changes and mechanical systems exhibited scores that remained in the moderate range. These findings suggest a necessity for the enhancement of phenomenon-based learning and the integration of contextual media to facilitate the development of students' analytical abilities. This study carries significant implications for the development of science learning strategies in the PPG MI programs and recommends further qualitative and longitudinal research to gain a deeper understanding of the factors that influence analytical thinking skills.

Keywords: : *Analytical Thinking Skills; Natural Sciences (IPA); Madrasah Ibtidaiyah Teacher Professional Education Program (PPG MI).*

INTRODUCTION

Science is defined as a systematic and logical discipline that studies the universe and its phenomena, enabling the discovery of new facts about nature (Gu et al., 2018; Qvit & Rubin, 2024). The fundamental purpose of science is to procure factual knowledge about the world through experimental testing and the collection of evidence. Consequently, in the learning process, it is recommended that an inquiry-based model be employed (Ibrohim et al., 2020). Science education in schools is imperative for fostering science literacy (Lamauskas, 2022), cultivating critical thinking skills, and honing problem-solving abilities that are invaluable in all spheres of life (Qvit & Rubin,

2024). The ability to solve complex problems and make appropriate decisions requires higher-order thinking skills (HOTS) (Fatahillah et al., 2021; Somasundaram & Latha, 2021). These competencies encompass analysis, evaluation, and creation (Fatahillah et al., 2021; Hasanah et al., 2020). Consequently, educators play a pivotal role in cultivating students' HOTS abilities. In the context of the scientific learning process, teachers play a pivotal role. Teachers who possess extensive knowledge in a specific scientific discipline can develop effective pedagogical approaches that increase student engagement in the subject and their motivation to pursue careers related to the sciences (Watson et al., 2024). Science teachers function as sources of knowledge, mentors, facilitators, and innovators, helping students develop scientific skills and critical thinking (Chi et al., n.d.; Cortes et al., 2024; Varg et al., 2022). Consequently, it is imperative that educators possess higher-order thinking skills (HOTS).

However, a number of studies have indicated that teachers' HOTS abilities in Indonesia remain comparatively limited, particularly with regard to conceptual understanding, the integration of HOTS into learning activities, and the creation of HOTS-based assessments. A significant number of educators at the elementary, junior high, and high school levels exhibit a lack of comprehension regarding the concept of HOTS, leading to challenges in articulating its definition (Anggraeni & Sole, 2020; Retnawati et al., 2018). Despite their awareness of the importance of HOTS, teachers' knowledge of HOTS, including how to teach it and their ability to solve HOTS-based problems, remains limited (Akbar, 2022; Anggraeni & Sole, 2020; Retnawati et al., 2018). Indeed, there is often a lack of comprehensive understanding among educators regarding Bloom's taxonomy, which serves as the foundational framework for the development of HOTS questions (Akbar, 2022).

According to Arafah, previous studies, have demonstrated that prospective physics teachers' analytical skills in solving higher-order thinking questions are still unsatisfactory in terms of their ability to analyze, evaluate, and create (Arafah et al., 2022). A study of 50 prospective physics teachers revealed that their ability to evaluate and create was found to be substandard (Nasir & Afkar, 2023). A similar conclusion was reached in a study of 44 prospective chemistry teachers, which found that the ability of these teachers to formulate HOTS questions, encompassing analysis, evaluation, and creation, was also substandard (Hidayati et al., 2022). In the context of evaluating critical thinking skills, a study was conducted on 38 prospective chemistry teachers, revealing poor critical thinking abilities (Pratiwi et al., 2023). Among prospective elementary school teachers, higher-order thinking skills were categorized as adequate



(Ramadhani et al., 2021). A similar trend is observed in the critical thinking skills of prospective elementary school teachers, which also tend to fall into the low category (Julianto et al., 2023). According to the findings of Ramdiah et al. (2019), biology teachers in Banjarmasin have demonstrated a satisfactory comprehension of HOTS; however, the implementation of this pedagogical approach in their daily teaching activities remains deficient. A correlation between these cognitive abilities and teachers' science competencies has been demonstrated (Ramdiah et al., 2019).

Teachers require specific and ongoing training in teaching HOTS, including practical examples and teaching methods relevant to science subjects (Ismail et al., 2017). The teacher education program is a post-baccalaureate program that follows the completion of an undergraduate degree. It is important to note that this program features distinct competency standards when compared to the bachelor's program. Analytical thinking skills represent a critical component of the graduation requirements for the teacher education program. This phenomenon is evident in the indicator grid presented in the UKMPPG questions, where the question type corresponds to C4 in Bloom's taxonomy, categorizing as analytical thinking. Analytical skills are classified at the intermediate level in Bloom's Taxonomy, where students are expected to break down information into its component parts, recognize the relationships between these parts, and understand the structure of a concept or problem (Larsen et al., 2022). This skill is critical for developing higher-order thinking skills, such as identifying assumptions, distinguishing facts from opinions, and evaluating arguments (Larsen et al., 2022).

Students' analytical skills of teacher education program can be measured to create a foundation for evaluation and continuous improvement in the learning process. This is because teacher education program graduates are prepared to teach in schools and are working as teachers. Therefore, it is crucial for these students to possess strong higher-order thinking skills. This study aims to examine the analytical thinking skills of students in Madrasah Ibtidaiyah Professional Teacher Education Program (PPG MI) specializing in science course.

METHODS

This research used a descriptive quantitative method. Descriptive research plays an important role in education by providing fundamental knowledge and insights into various educational phenomena. It helps educators and researchers understand the



current state of education, identify areas in need of improvement, and develop strategies to enhance teaching and learning (Daga, 2020; DeHart, 2024; Flinders & Richardson, 2006). The subjects of this study were students of Madrasah Ibtidaiyah Teacher Professional Education Program (PPG MI) at UIN Sunan Kalijaga Yogyakarta. The research instrument was a multiple-choice question based on the Teacher Professional Education Knowledge Test (UPPPG) exam grid, containing question type C4 with difficulty levels ranging from low to high. The score obtained was calculated using the following analysis, $(\text{Number of correct answer frequencies from respondents' choices}) / (\text{Number of respondents}) \times 100\%$. Unanswered question items were given a score of zero. This technique was used to avoid students answering randomly or guessing (Sumaryanta, 2015). Furthermore, the obtained results were then grouped into categories, as shown in the following table:

Table 1. Percentage of Analytical Thinking Ability

Category	Percentage
Very High	$80\% < P \leq 100\%$
High	$60\% < P \leq 80\%$
Mediun	$40\% < P \leq 60\%$
Low	$20\% < P \leq 40\%$
Very Low	$0\% < P \leq 20\%$

(Arikunto, 2009)

RESULTS AND DISCUSSION

Analytical Thinking Skills Profile of PPG MI Students

This section presents the research results obtained from the data collection process related to the analytical thinking skills of students in Madrasah Ibtidaiyah Professional Teacher Education (PPG MI) at Natural Science Course. According to Bloom's taxonomy, analytical thinking is the fourth cognitive level. Analytical thinking is a critical cognitive skill that involves the ability to break down complex information into smaller and manageable parts, scrutinize these parts, and draw logical conclusions. The analytical thinking process includes differentiating, organizing, and attributing information, which helps in building knowledge by connecting new information with prior knowledge (Wijaya et al., 2023).

Analytical thinking skills are essential for university students, particularly those preparing to become teachers. The ability to analyze and interpret data critically forms the foundation of sound decision-making and effective problem-solving. Analytical



thinking enables future teachers to understand knowledge structures, trace conceptual relationships, and evaluate the validity of information before drawing conclusions (Wang et al., 2025). It also helps students break down complex ideas into smaller and more manageable components, develop hypotheses, and formulate solutions based on logical reasoning and evidence (Hollett & Cassalia, 2022).

From a cognitive perspective, analytical thinking involves a series of mental processes such as differentiating, organizing, and attributing. It also includes skills such as specifying, generalizing, error analyzing, matching, and classifying (Blegur et al., 2023). These processes are crucial in teacher education, as they allow pre-service teachers to assess learning situations systematically and respond pedagogically to students' varying abilities (Qolfathiriyus et al., 2019). Furthermore, analytical thinking helps students recognize patterns of pseudo thinking and refine them toward more rational, evidence-based reasoning (Maqruf et al., 2025).

Integrating analytical thinking into teacher education programs requires instructional strategies that actively engage students in exploration and reflection. The 5E Inquiry-Based Approach combined with the 5W1H technique has been shown to significantly enhance analytical thinking by guiding students through exploration, explanation, and evaluation of scientific phenomena (Udonsathian & Worapun, 2024). Similarly, Problem-Based Learning (PBL) has proven to be an effective approach in higher education for developing analytical skills, as it challenges students to identify authentic problems, gather relevant information, and construct well-reasoned solutions through critical reflection (Suyatman et al., 2021).

The benefits of analytical thinking for future teachers extend beyond cognitive development to pedagogical competence. Analytical thinking represents a dimension of critical thinking that aligns with the demands of 21st-century education (Suyatman et al., 2021). It enables future teachers to understand concepts, principles, and their real-life applications skills that are indispensable for effective teaching and learning (Prawita et al., 2019). Moreover, students who develop strong analytical thinking skills tend to become more self-directed and efficient learners, leading to improved academic outcomes and professional readiness (Anthonysamy et al., 2024).

Analytical thinking skills are fundamental in science education, particularly for pre-service teachers preparing to teach at the elementary level. In the twenty-first century, where knowledge evolves rapidly and information is abundant, analytical



thinking equips future teachers with the ability to think scientifically, systematically, and logically when addressing questions and problems in the classroom (Demir, 2022; Hollett & Cassalia, 2022; Suyatman et al., 2021). These skills enable them to break down complex scientific ideas into smaller and more understandable components, develop hypotheses, and construct reasoned explanations based on evidence (Hollett & Cassalia, 2022). Such competencies are essential in the teaching of science because understanding the relationships among variables and processes forms the foundation of inquiry-based learning.

Beyond cognitive comprehension, analytical thinking also fosters higher-order reasoning and critical thinking, both of which are crucial for solving complex and unstructured problems in science learning (Irwanto et al., 2017; Kartika Sari et al., 2021). Teachers who possess strong analytical thinking skills are better prepared to guide students in developing their own reasoning processes, evaluating evidence, and cultivating curiosity-driven exploration of natural phenomena. Therefore, analytical thinking functions not only as an individual cognitive ability but also as a pedagogical competency that helps teachers promote scientific literacy and encourage inquiry-based habits of mind among their students.

Building upon the general concepts of analytical thinking skills in Natural Science education, the Madrasah Ibtidaiyah Professional Teacher Education Program (PPG MI) has developed several indicators aimed at nurturing these competencies among its students. It leads to the ability to break information down into its components, understand the structure of relationships between parts, and identify underlying principles. The indicators of the questions are as follows by (1) When presented with a story problem, students can analyze the concepts of material, and mixture changes and their relation to daily life; (2) When presented with a story problem, students can analyze energy changes in daily life; (3) When presented with a story problem, students can identify types of levers and pulleys in daily life; (4) When presented with a story problem, students are able to analyze waves and sound in their daily lives; (5) When presented with a story problem, students are able to analyze light in their daily lives; (6) When presented with a story about magnets, students are able to analyze the characteristics of magnets in their daily lives; (7) When presented with a breeding phenomenon, students can analyze animal breeding systems; (8) When presented with a breeding phenomenon, students can analyze plant breeding systems; (9) When presented with a digestive or respiratory phenomenon or problem, students can analyze the human respiratory and/or digestive systems; (10) When presented with



an environmental phenomenon or problem, students can study ecology (Kementerian Agama Republik Indonesia, 2021). Based on these indicators, students' analytical thinking skills are demonstrated by the data presented in Table 1.

Table 2. Students' Analytical Thinking Skills

Indicator Number	Percentage	Category
1	43,48%	Medium
2	95,65%	Very High
3	43,48%	Medium
4	78,26%	High
5	69,57%	High
6	73,91%	High
7	73,91%	High
8	82,61%	Very High
9	100%	Very High
10	100%	Very High
Average	76,09%	High

(Kamala, 2024)

The Urgency of Improving Learning Approaches to Strengthen Analytical Thinking Skills

This section discusses the analytical thinking skills of PPG students enrolled in science courses. Based on Table 2, indicators 2, 8, 9, and 10 demonstrate that students have strong analytical skills regarding energy changes, plant and animal reproduction, respiratory and digestive systems, and ecological/environmental issues. Table 2 shows that the Indicator 2: Energy Changes (95.65%); Indicator 8: Analysis of Plant Breeding Systems (82.61%); Indicator 9: Analysis of the human respiratory and digestive systems (100%); and indicator 10: Analysis of environmental and ecological issues (100%). These indicators are more often connected to real life or taught in a more contextualized way in the field. Contextualized learning encourages critical and analytical thinking by connecting subject matter with real-life contexts (Thamrin et al., 2024). Additionally, connecting learning with real-life situations improves students' ability to analyze, evaluate, and create solutions to problems (Haryanto & Arty, 2019; Raub et al., 2015; Reddy & Revathy, 2024). These achievements demonstrate that students can competently analyze familiar phenomena and materials often discussed in basic education.

Assessment questions on indicators 2, 8, 9, and 10 have strong visual



representations or story narratives (Table 2), making them easier to analyze. Strong visual representations and story narratives in science assessment questions have been shown to facilitate analysis of thought processes and conceptual understanding. Using narratives and visuals, such as sequential images or digital story maps, helps students build mental models, connect information, and improve their ability to make inferences and think critically, especially when the narratives stimulate imagination and creativity (Cohn, 2020; Reyes & Villanueva, 2024; Rooha et al., 2023). Research shows that visual narratives make science concepts more accessible and encourage logical and creative thinking, strengthening science literacy (Reyes & Villanueva, 2024; Tee, 2025). Visual narratives can also help students reflect on their thought processes and understand the "complexity" of the scientific method (Dickinson & Telford, 2020). Additionally, dynamic visual narratives have been shown to improve children's ability to make inferences, which is an important foundation for analytical thinking (Rooha et al., 2023). Thus, integrating visual representations and narratives into science assessments clarifies the material and enriches students' cognitive processes when analyzing and solving problems.

In indicators 4, 5, 6, and 7, researchers analyze waves and sound, light, magnetism, and animal breeding quite well. The analysis of indicator 4: waves and sound is (78.26%), indicator 5: light is (69.57%); indicator 6: Analysis of magnetic characteristics is (73.91%); and indicator 7: Analysis of Animal Breeding Systems is (73.91%). The data suggest that analytical thinking skills could be improved. Students may understand the concept in general but have difficulty relating it to more complex or applicable story problems. Students often have misconceptions about waves and light due to theoretical learning and minimal visualization, so they have difficulty in understanding an abstract concepts in depth. Studies show that common misconceptions include the relationship between period and frequency, wave properties, and the difference between transverse and longitudinal waves (Aodina et al., 2024; Tika & Mufit, 2024). The main contributing factors are abstract material, daily experiences that do not align with scientific concepts, and learning methods that are less interactive and do not utilize visual media (Aodina et al., 2024; Tika & Mufit, 2024). Visualizations, such as diagrams, models, and dynamic animations, help represent abstract and difficult-to-observe phenomena, making it easier for students to develop a deeper, more structured understanding (Evagorou et al., 2015; McElhaney et al., 2015; Ryoo & Bedell, 2017). Therefore, incorporating visualization into the assessment process is crucial for overcoming limitations in conceptual understanding and



enhancing students' analytical skills in science learning.

The two indicators with the lowest achievement are indicator 1. Analyze the concepts of material change and mixtures (43.48%) and 3. Identify the type of lever and pulley (43.48%). These results suggest that students are having difficulty analyzing basic mechanical and chemical concepts. The concept of simple machines is often difficult to understand because learning is usually theoretical and does not involve direct experience or concrete visualization. PPG students indeed carry out the learning process online. This prevents students from exploring the subject in everyday life. Many students have difficulty understanding how simple machines such as levers, pulleys, and inclined planes work in everyday life when they are only explained abstractly (Norbury, 2006; Norliana Yusof et al., 2024). Research shows that using props, physical models, or educational kits can help students better understand the basic principles of simple aircraft through hands-on practice and visualization. Linking the concept of simple aircraft to real-life activities and providing opportunities for direct observation can help students more easily understand the benefits and working principles of simple aircraft in everyday life (Norbury, 2006; Norliana Yusof et al., 2024). Although PPG students learn online to develop comprehensive analytical skills, they need to use visualization through online simulations.

Overall, the average analytical skill level of students is 76.09% (see Table 2), which is in the "high" category. This indicates that PPG Madrasah Ibtidaiyah students generally have strong analytical thinking skills when solving contextual science problems. However, this analysis reveals a significant gap between the highest and lowest indicators (100% vs. 43.48%). This can be used to evaluate the curriculum or learning methods. Materials that are purely conceptual or mechanical in nature, such as levers and mixtures, require a more concrete, visual learning approach, such as experiments or simulations.

CONCLUSION

Based on the results of this study which examining the analytical thinking skills of PPG Madrasah Ibtidaiyah students enrolled in Natural Science courses, it can be concluded that these students' analytical thinking skills fall within the high category, with an average achievement score of 76.09%. This indicates that students can generally analyze science concepts based on everyday phenomena. However, variations exist among the indicators. Some topics, such as material changes, mixtures, and lever-pulley mechanisms, are in the medium category. This indicates the need to strengthen the



connection between abstract concepts and applicable contexts. Strengthening analytical thinking skills must be an integral part of every learning session, particularly in natural science courses. Context-based learning, hands-on practice, problem-solving-based assessments must be integrated so that students can understand concepts and critically analyze and apply them in the context of their future careers as madrasah teachers.

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