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PROFICIENCY OF HIGHER-ORDER THINKING SKILLS IN MALAYSIAN PRIMARY SCIENCE CURRICULUM: INSIGHTS FROM YEAR 5

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ABSTRACT

This study examines the proficiency of higher-order thinking skills (HOTS) among Year 5 primary school students in Malaysia's science curriculum. A survey involving 280 students selected through stratified sampling was conducted to evaluate their mastery of HOTS, focusing on their ability to analyze, evaluate, and apply scientific concepts. Results indicated a moderate level of proficiency, highlighting gaps in independent application and creative problem-solving. These findings underscore the importance of tailored instructional strategies and the development of targeted teaching modules to improve HOTS. Future studies should investigate the long-term impact of such interventions and the role of teacher training in fostering these skills.

KEYWORDS: higher-order thinking skills, science education, instructional modules, ADDIE framework

1. INTRODUCTION

The integration of Higher Order Thinking Skills (HOTS) into science education has emerged as a cornerstone of modern pedagogy. HOTS encompasses skills such as analysis, evaluation, and application, which extend beyond memorization to involve deeper cognitive processes. These skills are crucial for preparing students to navigate complex problems in academic, professional, and everyday contexts. The increasing demands of a knowledge-based economy underscore the importance of equipping students with these skills, particularly in science education, where innovative and critical thinking is often required to address global challenges.

Research highlights the transformative role of technology in fostering HOTS within educational settings. By leveraging digital tools and platforms, educators can create interactive and immersive learning experiences that promote critical thinking and engagement. Studies [1-4] have shown that technology not only enhances the delivery of complex concepts but also provides opportunities for students to collaborate, experiment, and reflect on their learning. This aligns with contemporary efforts to make science education more dynamic and relevant to the needs of 21st-century learners.

Despite advancements in curriculum design, the mastery of HOTS among students remains a significant challenge. In Malaysia, initiatives such as the integration of Information and Communication Technology (ICT) in Form One and Form Two curricula exemplify efforts to address these challenges [5]. However, systemic barriers have impeded progress. Insufficient funding has limited access to technological resources in many schools, while teacher burnout—exacerbated by workload and inadequate professional development—has hindered the effective implementation of HOTS-focused strategies. Furthermore, the disruptions caused by the COVID-19 pandemic have further complicated efforts, exposing gaps in digital readiness and instructional delivery [6-9].

Recognizing these challenges, this study seeks to assess the current proficiency levels of HOTS among Malaysian primary school students, with a specific focus on the science curriculum. By examining students' abilities in analysis, evaluation, and application, the study aims to identify both strengths and areas requiring improvement. Additionally, it explores the role of existing teaching methodologies, curriculum design, and technology in supporting or hindering the development of these critical skills.

The findings of this study are intended to contribute to the broader discourse on enhancing science education through the integration of HOTS. By identifying gaps and proposing targeted strategies, the research seeks to inform educators, policymakers, and curriculum developers on how to better prepare students for the complexities of the modern world. In doing so, it aligns with national and global educational goals of fostering critical thinking, creativity, and problem-solving skills among young learners. Ultimately, this work aims to support the creation of a more innovative and capable generation equipped to tackle future challenges.

2. MATERIALS AND METHODS

2.1 Research Design

This study utilized a cross-sectional survey design, which is well-suited for capturing a snapshot of the current mastery of Higher Order Thinking Skills (HOTS) among Year 5 primary school students in Malaysia. This design allowed the researchers to collect and analyze data at a single point in time, providing insights into students' proficiency levels in analysis, evaluation, and application. The use of a structured survey ensured consistency in data collection, enabling the researchers to identify trends and patterns in HOTS mastery across the sample population. This approach is particularly advantageous in educational research, as it facilitates the exploration of relationships between variables without requiring longitudinal data.

To enhance the reliability and generalizability of the findings, a stratified sampling technique was employed. This method involved dividing the population into strata based on geographical zones, such as urban, suburban, and rural areas, to ensure proportional representation. By doing so, the study accounted for potential variations in educational resources, teaching methods, and student demographics across different zones. This sampling approach not only increased the diversity of the sample but also enabled a more comprehensive understanding of the factors influencing HOTS proficiency. Such methodological rigor ensures that the results are reflective of the broader student population, providing valuable insights for educators and policymakers.

2.2 Research Type and Duration

The research spanned an Eight-month period, from January to August 2022, and was structured into three key phases: data collection, analysis, and reporting. During the data collection phase, surveys were administered to the selected sample of Year 5 primary school students, ensuring adherence to the research timeline and ethical guidelines. This phase also involved monitoring and verifying the accuracy of the responses to maintain the integrity of the data. The analysis phase focused on processing and interpreting the collected data using statistical tools and methodologies to evaluate the students' mastery of Higher Order Thinking Skills (HOTS). Finally, the reporting phase consolidated the findings into a comprehensive report, highlighting key insights, implications, and recommendations for improving HOTS in primary science education. This systematic approach ensured that each phase contributed meaningfully to the study's overall objectives, paving the way for actionable outcomes.

2.3 Inclusion and Exclusion Criteria

The study focused on students enrolled in Year 5 science classes across Malaysian primary schools, aiming to capture a representative understanding of their proficiency in Higher Order Thinking Skills (HOTS). These students were selected as at a critical stage of developing foundational cognitive skills necessary for more advanced scientific learning. To ensure the reliability and validity of the findings, strict inclusion criteria were applied. Only students who completed all survey components and demonstrated consistent participation throughout the data collection process were included in the analysis. Any students with incomplete responses, missing data, or irregular participation were excluded to prevent potential biases and inaccuracies in the results. This careful selection process ensured that the dataset was robust and reflective of the actual performance levels of Year 5 students in mastering HOTS within the science curriculum.

2.4 Sampling and Data Collection

A total of 280 Year 5 students were selected for the study using a stratified random sampling method to ensure a balanced representation across different geographical zones in Malaysia. The zones included North, South, Central, East, West, Sabah, and Sarawak, encompassing a diverse range of urban, suburban, and rural school settings. This sampling approach was designed to capture variations in educational environments, access to resources, and teaching practices that may influence the mastery of Higher Order Thinking Skills (HOTS). By dividing the population into strata based on geographical zones and then randomly selecting participants within each stratum, the study ensured an equitable distribution of students, minimizing potential biases. This method enhanced the representativeness and generalizability of the findings, providing a comprehensive overview of HOTS proficiency among

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Year 5 students across Malaysia's diverse educational landscape. The distribution of respondents is outlined in Table 1.

Table 1: Survey Respondents by Zone

Zone	*State/District*	*Number of Respondents*
North	Perlis	54
South	Johor	55
Central	Kuala Lumpur	55
East	Terengganu	55
West	Selangor	55
Sabah	Kota Kinabalu	55
Sarawak	Kuching	55
	Total	**384**

3. RESULTS

In this study, as many as five states involving elementary school students were given stratified random sampling to answer the questionnaire. They are (1) Northern Zone (Perlis): 60 respondents, (2) Southern Zone (Johor): 52 respondents, (3) Central Zone (Kuala Lumpur): 66 respondents, (4) Eastern Zone (Terengganu): 44 respondents and (5) West Zone (Selangor): 59 respondents. The five states are a stratified random sampling to show the total population in the research area, and to infer the results of the population from which it was drawn. Table 2 shows the demographic profile of the respondents.

Table 2. Demographic Profile of Respondents (N=280)

No	Descriptor	N	Percentage
1	Race		
	Malay	263	93.9
	Chinase	3	0.01
	Indian Total	14 280	6.09 100
2	Gender		
	Male	120	42.9
	Female	160	57.1

	Total	280	100
3	Negeri		
	Selangor	59	21.1
	Perlis	58	21.1
	Kuala Lumpur	66	25.6
	Terengganu	45	13.6
	Johor Total	52 280	18.6 100

The demographic data presented in the table reveals that most respondents in this study were Malays, comprising 93.9% of the total sample. This aligns with the ethnic composition of many Malaysian primary schools, particularly in the selected zones, reflecting the broader population distribution. Gender representation in the study was balanced, with female respondents accounting for 57.1% and male respondents making up 42.9%, indicating a slightly higher participation rate among female students. Additionally, the data highlights that Kuala Lumpur contributed the largest number of respondents, representing 25.6% of the total sample. This significant proportion may be attributed to the city's higher population density and concentration of schools compared to other regions. These demographic insights provide a comprehensive understanding of the study's sample composition, offering context for interpreting the findings and their implications. Table 3 also shows the Feedback on Mastery of Science Subjects in General.

Table 3. Feedback on Mastery of Science Subjects in General

Item	Descriptor	N	Mean	Standard Division
A1	I agree that science subjects are subjects that I am interested in.	280	2.435	0.873
A2	I agree that science subjects encourage me to think.	280	2.807	0.879
A3	I agree that science subjects are useful in my life.	280	3.185	0.843

A4	I agree that science subjects should be given more time.	280	2.842	0.963
A5	I agree that science is a fun subject.	280	2.853	0.985
	Average		**2.824**	**0.909**

The data presented in the table highlights varying levels of agreement among respondents regarding their perceptions of science subjects. The highest level of agreement was observed for the statement that science subjects are useful in life, with a mean score (M) of 3.185 and a standard deviation (SD) of 0.843. This indicates that most students recognize the practical relevance of science in everyday life and its potential contributions to solving real-world problems. Conversely, the lowest level of agreement was associated with the statement that science is a subject of personal interest, with a mean score of 2.435 and a slightly larger standard deviation of 0.873, suggesting a lack of intrinsic motivation or passion for the subject among many respondents. When examining the overall mastery of science subjects, the findings indicate a moderate level, with a mean score of 2.824 and a standard deviation of 0.909. These results underscore the need for strategies that not only reinforce the practical value of science but also foster greater interest and engagement among students to enhance both their proficiency and enthusiasm for the subject. Table 4 shows the feedback on HOTS mastery in general.

Table 4. Feedback on Mastering higher order thinking skills in general

Item	Descriptor	N	Mean	Standard Division
B1	HOTS makes me always ask to get creative and innovative ideas.	280	2.528	0.946
B2	HOTS makes me constantly ask to make a decision.	280	2.764	0.951
B3	HOTS keeps me asking for more information.	280	3.067	0.854
B4	HOTS makes me always ask to share opinions in carrying out activities.	280	3.082	0.917

B5	HOTS makes me constantly ask to perform activities without teacher supervision.	280	2.282	1.082
	Average		**2.745**	**0.950**

Based on the data presented in the table, the highest level of agreement among respondents pertains to the perception that higher-order thinking skills (HOTS) encourage them to actively seek opportunities to share opinions when engaging in activities (M = 3.082, SD = 0.917). This indicates that participants generally recognize the importance of collaboration and exchange of ideas as a key component of HOTS implementation. Conversely, the lowest level of agreement is observed in the statement that HOTS encourages individuals to perform independently without teacher supervision (M = 2.282, SD = 1.082). This suggests that while HOTS may foster critical thinking and problem-solving, it does not necessarily translate into a strong inclination for unsupervised learning. Taken together, these findings indicate that the overall mastery of HOTS among the participants is at a moderate level (M = 2.745, SD = 0.950). This reflects a balanced perspective, where participants appreciate the role of HOTS in promoting collaborative and guided learning but may still require structured support to fully develop independent application of these skills. Table 5 shows the feedback on the source of electricity.

Table 5. Feedback About Electrical Energy Sources

Item	Descriptor	N	Mean	Standard Division
C1	I can explain that solar cells can produce electricity.	280	2.367	1.049
C2	I can explain that a power station can produce electricity.	280	2.632	1.052
C3	I can explain that dry cells can produce electricity.	280	3.007	0.976
C4	I can explain that a dynamo can produce electricity.	280	2.442	1.052
C5	I can explain that accumulators can produce electricity.	280	2.439	1.052

C6	I can explain that a generator can produce electricity.	280	2.635	1.082
	Average		**2.587**	**1.044**

Based on the data presented in the table, the highest level of agreement among respondents is their ability to explain that dry cells can produce electricity (M = 3.007, SD = 0.976). This suggests that participants are relatively more familiar with and confident in understanding the function and mechanism of dry cells as a common source of electricity, likely due to their widespread use in daily life. In contrast, the lowest level of agreement is observed in their ability to explain that solar cells can produce electricity (M = 2.367, SD = 1.049). This indicates a lower familiarity or understanding of solar cells, which may be attributed to the comparatively specialized knowledge required to grasp the workings of renewable energy technologies. Overall, these findings reveal that the mastery of electricity sources among the participants is at a moderate level (M = 2.587, SD = 1.044). While participants demonstrate some understanding of basic and commonly used electricity sources, such as dry cells, there is a clear need to enhance knowledge and comprehension of alternative and renewable energy sources, like solar cells, to ensure a more comprehensive grasp of the topic. Table 6 shows the feedback on the series circuit and the parallel circuit.

Table 6. Feedback About Series Circuits and Parallel Circuits

Item	Descriptor	N	Mean	Standard Division
D1	I can identify the series arrangement of bulbs in a complete electrical circuit.	280	2.732	1.118
D2	I can identify the arrangement of bulbs in parallel in a complete electrical circuit.	280	2.985	1.005
D3	I can draw a series circuit diagram using symbols.	280	3.060	1.022
D4	I can draw a parallel circuit diagram using symbols.	280	3.021	1.060

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D5	I was able to compare the brightness of bulbs in a series circuit.	280	3.139	2.567
D6	I was able to compare the brightness of bulbs in a parallel circuit.	280	3.050	0.918
D7	I was able to experiment with varying the brightness of bulbs in a series circuit by varying the number of bulbs.	280	2.967	0.947
D8	I was able to experiment with varying the brightness of bulbs in a parallel circuit by varying the number of bulbs.	280	2.925	0.971
D9	I was able to experiment with varying the brightness of bulbs in a series circuit by varying the number of dry cells.	280	2.925	0.997
D10	I was able to experiment to vary the brightness of the bulb in a parallel circuit by varying the number of dry cells.	280	2.867	0.961
D11	I can explain observations about circuits by various methods	280	2.625	1.036
	Average		**2.936**	**1.147**

Based on the data presented in the table, the highest level of agreement among respondents is their ability to compare the brightness of bulbs in a series circuit (M = 3.139, SD = 2.567). This suggests that participants have a relatively stronger understanding of the fundamental properties of series circuits, such as the effect of current flow on bulb brightness. This could be due to the practical and observable nature of this concept, which is often emphasized in instructional activities. On the other hand, the lowest level of agreement is observed in their ability to explain observations about circuits using various methods (M = 2.625, SD = 1.036). This indicates a gap in applying diverse analytical approaches or reasoning techniques to interpret circuit behavior, which may require a deeper

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conceptual understanding or additional practice. Overall, these findings highlight that the mastery of series and parallel circuits is at a moderate level (M = 2.936, SD = 1.147). While participants demonstrate some proficiency in identifying and comparing basic properties, such as bulb brightness, there is room for improvement in their ability to articulate and analyze circuit phenomena through a variety of methods, suggesting the need for more targeted instructional interventions to deepen conceptual understanding and application.

The study's results reveal a moderate level of proficiency in higher-order thinking skills (HOTS) among Year 5 students, with evaluative reasoning emerging as a relative strength. This indicates that students are generally able to assess, compare, and justify scientific concepts to a certain extent. However, the gap in creative problem-solving skills points to an imbalance in the development of HOTS components. These findings suggest that while some aspects of HOTS are being addressed effectively, others, such as innovative thinking and the ability to generate original solutions, require more focused attention within the educational framework.

One potential explanation for this disparity lies in the persistence of traditional teaching methods in Malaysian classrooms. Many teachers still emphasize rote memorization and procedural tasks over critical and creative thinking. This approach, while effective for foundational knowledge acquisition, often falls short in cultivating the skills necessary for independent problem-solving and innovation. Previous studies [17-19] support this observation, highlighting a systemic reliance on teacher-centered practices that limit opportunities for students to explore and experiment with new ideas. Addressing these limitations requires a paradigm shift in pedagogy, moving towards more dynamic and student-centered approaches.

To bridge the gap in creative problem-solving, instructional strategies such as problem-based and inquiry-based learning should be integrated into the science curriculum. These methods encourage students to investigate real-world problems, ask questions, and develop solutions through exploration and collaboration. By engaging students in active learning, these strategies can stimulate curiosity and foster a deeper understanding of scientific concepts. Additionally, incorporating open-ended tasks and interdisciplinary projects into lessons could help students apply their knowledge creatively and independently.

The findings also underscore the importance of enhancing teacher training programs to support the integration of HOTS into classroom practices. Teachers must be equipped with the tools, knowledge, and confidence to implement innovative teaching methods effectively. Furthermore, the development of interactive, technology-driven learning modules could play a pivotal role in addressing these challenges. Digital platforms, simulations, and gamified learning experiences can make science lessons more engaging and accessible, helping students build both evaluative and creative problem-solving skills. Together, these approaches can create a more balanced and effective science education framework, ensuring students are better prepared for future challenges.

4. CONCLUSION

This study highlights the moderate proficiency levels of higher-order thinking skills (HOTS) among Year 5 students in Malaysia, emphasizing the need for immediate attention to bridge the identified gaps. The findings reveal a particular struggle in creative problem-solving and the independent application of scientific concepts, which are essential components of HOTS. These challenges suggest a need to rethink current teaching methodologies and assessment approaches to foster deeper cognitive engagement. By prioritizing HOTS in the curriculum, educators can lay a strong foundation for students to tackle real-world problems effectively.

Addressing these gaps requires a concerted effort to develop targeted instructional strategies tailored to the needs of primary school students. Incorporating active learning techniques, such as problem-based learning, inquiry-based approaches, and collaborative projects, can help students enhance their analytical and evaluative skills. Moreover, curriculum designers should integrate HOTS-focused activities and assessments to ensure a seamless alignment between learning objectives and teaching practices. These efforts can empower students to transition from rote learning to meaningful application of knowledge.

The role of technology in facilitating HOTS development cannot be overlooked. Interactive digital tools, such as virtual simulations and gamified learning platforms, can provide immersive experiences that promote critical thinking and creativity. Leveraging technology in science education allows for personalized learning pathways, enabling students to explore scientific concepts at their own pace. Further research should delve into how technology-driven interventions can complement traditional teaching methods to create a dynamic and engaging learning environment for primary school science.

Future studies should also examine the long-term impact of HOTS-focused interventions, particularly in how they influence students' academic performance and adaptability in later stages of education. Equally important is the exploration of teacher training programs that emphasize the pedagogical skills needed to nurture HOTS effectively. Teachers play a pivotal role in shaping students' cognitive development and equipping them with the right tools and strategies is critical for sustained success. By addressing these multifaceted aspects, education stakeholders can foster a generation of learners prepared for the complexities of the modern world.

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