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Exploring The Need of Teaching Module for Enhancing Higher-Order Thinking Skills

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Abstract

The purpose of this research is to analyze the necessity for the development of a scientific teaching module based on students' HOTS. Empowerment of HOTS in primary school Science Education is a special requirement to ensure students achieve the 6 student aspirations outlined in the Malaysian Education Development Plan. Specifically, this study explores the problems and needs to develop a teaching module in science subjects that apply Higher Order Thinking Skills (HOTS). The development of this module is based on the ADDIE model which consists of analysis, design, development, evaluation, and implementation phases. This study uses a semi-structured interview method on six Science teachers of the Ministry of Education (MOE) from different schools. The objective of the analysis phase was to identify the need to develop teaching modules for electrical topics under the Science syllabus. To find out the need for the development of the module, an interview was conducted with six science teachers who are experts in the field in the Seremban area. Four themes emerged from the need analysis namely; (1) The importance of learning electrical topics, (2) Problems in the teaching and learning of Science, (3) Teaching strategies, and (4) Desired improvements. The development of this module contributes to teaching and facilitation to improve students' HOTS in primary school science subjects.

Keywords: Teaching Module, Higher-Order Thinking Skills, Primary School Student, Teacher, Science

Introduction

In recent years, there has been much attention on effective science teaching strategies for student achievement (Fauth et al., 2019; Sahin & Yilmaz, 2020). Science education research has long focused on scientific higher-order thinking skills (HOTS). It has been recognized that students' HOTS plays a significant part in the science learning process (Sun et al., 2022b). HOTS refers to the ability to think on a higher level than remembering information or repeating something back to someone (Zohar, 2005). Science learning is characterized by conceptual understanding, involvement, and collaboration between students while conducting practical activities. HOTS not only allows students to learn scientific concepts but also enables them to develop scientific literacy by involving them in scientific research (Caiman & Jakobson, 2019).

Besides helping students pass exams, science also assists them in understanding and applying what they have studied. Several initiatives over the past 20 years have been made to overhaul scientific instruction in schools (Sahin & Yilmaz, 2020). Teachers, as “change agents”, can better comprehend, practice, and implement HOTS, such as critical thinking and argumentation skills, for science education reform to be successful. Teachers may be smart and creative in choosing and developing effective teaching and learning techniques, and they can entice students to follow them. As a result, the teaching approach adopted can develop students’ thinking skills by developing their preferences, abilities, and competencies. According to Yeung (2015), teaching for developing HOTS is critical for preparing students to participate in and contribute to modern societies. Previous research has suggested that most students are uninterested in science courses, even though these disciplines have a significant association with their daily life (Sulaiman et al., 2021). One of the most challenging tasks for educational systems, including Malaysia’s, has been to encourage students to continue their science education (Bal-Taştan et al., 2018). The problem of reduced interest in school science subjects is caused by various factors, including gender and age, primary school teachers’ lack of confidence in teaching science courses, lack of subject expertise, lack of abstract thinking, and traditional teaching methods (Lin et al., 2019).

Study Context

The Trends in International Mathematics and Science Study (TIMSS) is an international comparative study by the International Association for the Evaluation of Educational Achievement (IEA). The TIMSS study is conducted every four years, and the first TIMSS study was undertaken in TIMSS 1995. The studies offered by the IEA include TIMSS Grade Four, TIMSS Grade Eight, and TIMSS Advanced. The Program for International Students Assessment (PISA) measures the literacy rate of 15-year-old students, especially in mathematics, science, and reading ability rate. Based on the report on the status of Malaysia’s achievements in TIMSS and PISA in 2018, Malaysia is in the bottom 20 countries (OECD, 2018). This result shows that Malaysia’s achievements in TIMSS are still not something to be proud of (Ministry of Education, 2019). According to Damaianti et al. (2020), core literacy for student growth should focus on increasing students’ HOTS, where HOTS indicates the greater pursuit of disciplinary education principles. Therefore, the current study aims to explore the problems and requirements related to developing teaching modules to improve students’ HOTS in science subjects for the topic of electricity. The study addressed the following question: what are the problems and requirements related to the development of a module to improve students’ HOTS in science subjects for the topic of electricity based on the teachers’ point of view?

Literature Review

The Importance of Science Education

The development of science and technology has always been a feature of developed countries. Part of this achievement can be attributed to their ongoing evaluation and understanding of the science curriculum development. They aim to raise all age groups’ proficiency levels in math and science (Razali et al., 2020). Past researchers have placed a great deal of emphasis on the importance of science for employment, especially its global significance in improving the socioeconomic status of the nation, ensuring the stability of technology, and improving the standard of science curriculum development (Mat & Mustakim, 2021; Paige et al., 2016). Nevertheless, several factors must be recognized to produce scientifically literate students interested in science to create a workforce of qualified professionals. Factors that affect students' interest in science must also be analyzed in terms of their learning criteria.

Issues in Science Education in Primary Schools

The most recent technology developments have the potential to transform the educational landscape. The development of multimedia and the Internet has given teachers and students additional opportunities to study and facilities to rapidly and easily access information and educational resources online (Suwono & Dewi, 2019). Yet, many students are unable to understand HOTS due to the traditional teacher-centered approach and the fact-memorizing phenomena (Mat & Yusoff, 2019; Zainudin et al., 2018). Consequently, mastery of HOTS among students is still low (Darling-Hammond & Oakes, 2021). Teachers must develop teaching resources that are not just focused on one source to provide students with relevant HOTS experiences. This situation demonstrates the critical necessity for one of these guides to serve as a teaching module that focuses on implementing HOTS starting in primary school. Many primary school students are still struggling to grasp HOTS. To apply HOTS to students, useful lessons and methods should be used by teachers.

Teaching and Learning in Science Education

Numerous factors influence success and interest in science among students. They include the topics studied, workload, student assignments, personal orientation and skills, teaching design, materials for successful teaching, teacher effectiveness, teaching skills, motivation, student personality, and the number of students in a class. They also comprise contextual, emotional, and motivational factors (Say & Bağ, 2017). Learning was viewed as linear and sequential in learning theories that were widely accepted until about 25 years ago. This perspective led to a hierarchical description of learning. Learning goals were organized in a progression from simple, lower-order cognitive tasks to more difficult ones. It was often believed that only the collection of fundamental, pre-requisite learning could lead to complicated comprehension (Bloom, 1956). According to Shepard (1991), the most problematic ramification of the mastery learning model of teaching is that when it is in the later stage in the hierarchy, HOTS is not taught until pre-requisite skills have been mastered. Frequently, students never reach the stage where they may participate in HOTS. On the other hand, by enhancing the students' HOTS and learning abilities, science teaching and learning in primary schools has to be improved (Ichsan et al., 2019). Without a demand, efforts to raise the standard of education in this demanding 21st century become non-competitive (Scott, 2017). Because of the many ways that students learn, teachers must adopt various teaching approaches. The goal of learning is to combine new and old information. The growing complexity of today's technologically advanced students has made them disinterested in traditional teaching and learning techniques. According to Attard and Holmes (2020), teaching programs and instructional techniques require innovative methods for keeping students engaged. Although we are largely unaware of the distinctive characteristics of HOTS in science education, there is little doubt that science teachers need such a module to enhance their instruction and foster students' critical-thinking skills. Technological innovation is increasingly incorporated into the classroom nowadays (Gulley & Jackson, 2016). For instance, Jackman and Roberts' (2014) research showed that social media use positively affected students' idea understanding. Likewise, Moghavvemi et al (2018) explored how the usage of YouTube assisted Malaysian students in successfully and independently completing their homework.

HOTS and Bloom's Taxonomy

According to Bloom's (1956) taxonomy, the term HOTS may be used to describe cognitive activities above the level of recall and comprehension. It alludes to cognitive exercises like analyzing, synthesizing, and evaluating (Bloom, 1956). Recently, several studies have suggested that Bloom's taxonomy should be used to guide the creation of HOTS in science education (Istiyono et al., 2020; Subia et al., 2020). HOTS enables students to work on problems involving operational analysis, evaluation, and creativity. Bloom's taxonomy consisted of six majors: knowledge, comprehension, application, analysis, synthesis, and evaluation. Moreover, Brookhart (2010) claimed that Bloom's cognitive taxonomy's highest level, HOTS, is intended. Any cognitive taxonomy's educational objective is to provide students with transferable skills and thinking capacity. Based on Bloom's taxonomy, Anderson and Krathwohl (2001) created a new classification system for knowledge and cognitive processes. However, they criticized the leveling system. Yet, the science education research community has fallen short of the requirement to create trustworthy and effective models to help students build their passion in science education (Sun et al., 2022b). The challenges of creating a HOTS model in practice are ascribed to a number of factors, such as teachers' lack of knowledge of how to communicate HOTS in science education, the ambiguity of the HOTS idea, and the challenges of looking into particular strategies to improve students' HOTS.

Science Education and HOTS

Helping students develop HOTS, which will enable them to think critically, ask meaningful questions, reason, and solve problems, is the main objective of science education (Sun et al., 2022a). The definition of HOTS includes the ability to produce complex, non-algorithmic, multiple solutions and make nuanced judgements and interpretations (Sun et al., 2022b). Metacognition is increasingly acknowledged as an essential component of HOTSs, according to (Hamzah et al., 2022). Furthermore, other studies have accepted the common perspective of 'HOTS about cognition' (Nelson et al., 1999). When HOTS is needed to address difficult challenges, people use various abilities to accomplish their objectives (Pratama & Retnawati, 2018). In science education, science self-efficacy influences students' science-related activities as they experience success in science (Zeldin & Pajares, 2000). Metacognitive abilities have traditionally been seen as critical to the development of scientific reasoning because they provide the epistemological foundation, conceptual motivation, and cognitive control for individuals to employ underlying talents in science learning tasks (Lehmann, 2022).

Methodology

This study aimed to investigate the need to develop a module to enhance HOTS among primary school students. Throughout this study, the authors adhered to the Standards for Reporting Qualitative Research (Tong et al., 2007).

Design

This study utilized the qualitative approach to gather data. More detailed information was gathered via semi-structured interviews (Brown & Danaher, 2019). Creswell and Poth (2016) suggested that the appropriate minimum informants for a qualitative study were between three to seven people depending on the saturation of the data occurring during future studies. Yin's (2018) opinion presented that two to ten samples were sufficient to reach saturation. As a result, the sixth interviewee showed signs of saturation when the same themes were repeated with subsequent interviewees.

The Research Team and Reflexivity

The researchers had been working as research assistants (PhD students) and a faculty member (lecturer) on an education faculty. The researchers comprised two females, all trained in qualitative research. The researchers were also acquainted with six of the interviewees.

Setting and Time

The data were collected between May 20, and June 12, 2022, in Negeri Sembilan, Malaysia.

Sample

This qualitative study's sample consisted of six specialist teachers from six different schools. Six primary school science teachers in Negeri Sembilan, Malaysia, participated in focus groups. Six people were interviewed as part of the study, all of whom were chosen by purposive sampling. The criteria for selecting these teachers to be study participants were based on the importance of their personal and professional experiences and abilities to articulate and reflect on issues and challenges of teaching using various methods, such as virtual learning methods in teaching primary school science subjects. The participants of this study consisted of three male teachers and three female teachers. All participants must have an average of 5 to 25 years of full-time teaching experience in primary schools in Malaysia.

Table 1
Demographic Information of Informants.

Informant	Sex	Age	Post	Teaching Experience (years)	Education
T1	Male	45	Science teacher	25	Degree
T2	Male	45	Science teacher	25	Degree
T3	Male	43	Science teacher	22	Degree
T4	Female	40	Science teacher	18	Degree
T5	Female	42	Science teacher	19	Degree
T6	Female	41	Science teacher	17	Degree

Data Collection Tools

According to the existing literature, the data were gathered using a semi-structured interview form, which included the following open-ended questions

1. How can students improve their HOTS in science classes?
2. How can technology help develop HOTS among primary students?
3. What are the challenges and opportunities of using virtual technologies in developing HOTS?
4. What has your experience been with a HOTS-related module in the classroom and among students?
5. How can you, as a teacher, develop HOTS among your students?

Data Collection Process

Individual in-depth interviews were used to acquire the data. Pilot interviews with two participants other than the main participants were conducted before the start of the study interviews. Based on the results of these pilot interviews, the interview procedure and questions were modified. Initially, phone calls were made to those selected using the snowball sampling technique, those who satisfied the inclusion criteria (i.e., science teachers, five years of experience in teaching) were informed of the study's goal and methodology, and times for online interviews were scheduled. Each interview only involved the interviewer and participant. The interviews lasted 45 to 90 minutes on average. Both verbal and nonverbal clues were noted using written notes and a voice recorder. Participants received interview transcripts for their approval, additional feedback, and/or revisions.

Ethical Issues

Prior to performing this research, the study's protocol was authorized by the UPM Ethics Council for Research Involving Human Subjects (No. JKEUPM-2021-844). The provisions of the 1995 Declaration of Helsinki (as amended in Brazil, 2013) were explained to the interviewees before the start of the sessions, and their verbal and written agreements were acquired. The researchers closely observed the privacy principle when gathering and storing the interviewees' information. In achieving this, all identifiable information was completely anonymized during transcription by using a pseudonym. All interviewees were given access to the transcriptions for their review. Voice recordings, transcripts, and interview notes were stored on a password-protected computer. All obtained data will be destroyed five years after the research and publication procedures are completed.

For the results to be trustworthy, bias issues are required to be appropriately addressed and acknowledged (Flick, 2008). The researchers evaluated potential bias against the aim to impartially examine the subjective experiences of the subjects (Patton, 2005). This study adhered to a strict protocol with much pre-planning to ensure the data were succinct and to lessen researcher bias in the semi-structured interview. The transcripts and findings were shared with team members for feedback. To engage in this study, the interviewees provided written informed permission.

Data Analysis

Thematic analysis was manually applied to the data. The study team used an inductive technique Gratton & Jones (2014) to read the transcripts line-by-line after the interviews to comprehend the interviewees' experiences and create themes. In addition, the MAXQDA 20.0

statistics software was employed to prevent any human errors. A constant comparison technique was adopted to compare and improve the developing themes about the participants' varied experiences (Ritchie et al., 2014).

Trustworthiness

The following four criteria—credibility, transferability, dependability, and confirmability—were used to determine the study's trustworthiness (Carcary, 2020). Obtaining participants' approval, describing the studied phenomenon in detail, using the MAXQDA 20.0 software package to analyze the data, comparing the results with previous research findings, holding researcher meetings at regular intervals to discuss the research process, and advantageously implementing the researchers' intertextual qualifications and experiences all contributed to credibility. The research sample, setting, and procedure were all properly reported to guarantee transferability. Intertextual participant utterances were explicitly cited, and comprehensive definitions between the researched environment and the study were established. Dependability was achieved by inter-coder consistency and by transmitting all data collecting tools, raw data, analytical encodings, and derived conclusions to a professional who was not involved in the research. Confirmability was ensured by using multiple data collection methods, considering each researcher's reflective comments, and having each researcher code the data individually.

Results

Analysis of the data revealed four major themes capturing the experiences of the study participants. An interview was conducted with six science teachers to examine the need to develop the teaching module. Four themes emerged from the need analysis, namely (1) the importance of HOTS knowledge, (2) challenges in teaching and learning, (3) teaching strategies, and (4) teaching skills.

Theme 1: Importance of HOTS Knowledge

The topic of electricity is one of the topics in the primary school science curriculum. In this topic, six objectives need to be mastered by students, namely explain with examples of the sources that produce electricity, identify the arrangement of bulbs in series and parallel in a complete electrical circuit, draw diagrams of series circuits using symbols, compare the brightness of bulbs in a series or parallel circuit, explain the effects of negligence in the handling of electrical equipment, describe safety measures, and explain observations on the safety of handling equipment and saving electricity.

From the interview sessions, two sub-themes emerged under the importance of the HOTS knowledge theme: basic issues and applications. All six teachers agreed that HOTS knowledge was fundamental to be mastered by students. Unfortunately, the data suggested that teachers had certain misunderstandings regarding some essential components of HOTS, and what is more, these critical components were difficult to grasp.

Since science is the study of technology, the concept of electricity is essential to understand getting a clearer picture of technological progress. Quoting the words of Teacher 5, "It is important that students can apply the concept of electricity in the Physics chapter while studying in secondary school later, and the knowledge of the teacher plays an important role". According to Teacher 1, it is vital to understand how electrical topics may be used and transferred to students so that they can utilize them in their future lives, such as when using electrical circuits. However, Teacher 2 stated that, “Even I as a teacher read a lot of topics related to the importance of HOTS when I was a preservice teacher, I am not sure about the significance of HOTS for my students in school and how having these skills will affect their lives in the future”.

Theme 2: Challenges in Teaching HOTS

Students face many problems in learning science. Different perspectives were expressed by the six teachers on the problems faced by students during teaching. Under this theme, six sub-themes appeared: difficult terms, lack of thinking skills, misconceptions, techniques, nature of the topic, and students’ attitudes. The analysis found that many related passages shared between the theme of the importance of HOTS and the theme of problems in the teaching and learning HOTS of electrical topics. As Teacher 3 said, “Students cannot imagine a complete electrical circuit process”. According to Teacher 5, “Students have difficulty understanding various terms related to electrical topics”. Four other teachers supported this statement as they mentioned that terms, such as serial circuit, parallel circuit, complete circuit, and green technology, are among the terms that were difficult for students to understand. According to Teacher 3, students struggled to understand the term because it was presented as something new.

The lack of HOTS was also a barrier for students to master this topic. According to the six teachers, most students could not apply the knowledge learned to complete the HOTS assignments. Often, students memorized sentences in textbooks and notes provided by the teacher,and they failed to provide further explanations in their own words and understanding. Students seemed to have difficulty analyzing the information provided to produce something satisfactory. For example, Teacher 6 described the student’s answer, “Students are always confused to identify circuitdifferences”. He added that students also faced difficulties explaining the difference between series and parallel circuits. Due to these difficulties, there was a high level of misconceptions among students, especially between the concepts of series circuits and parallel circuits.

Student attitudes also contributed to problems in teaching and understanding science subjects. For example, students refused to ask questions during teaching and learning activities. Teacher 5 said, “Teachers assume students understand the lessons taught because not many ask”. However, Teacher 2 added that students did not ask questions because they did not understand the information presented by the teacher and were not trained to ask questions. Teacher 2 also added that the absence of questions among the students might be due to the lack of existing knowledge. All six teachers agreed that this attitude would affect the learning culture among students and, in turn, their understanding of electrical topics.

All teachers agreed that classroom activities and experiments had a high potential to strengthen students’ understanding. However, teachers have time constraints that prevent them from delivering different activities and experiments in the classroom. Teachers also need to rush on specific topics to ensure all topics in the curriculum specification are covered on time. Teacher 3 said, “I always have to attend teacher meetings outside, and sometimes it takes two or three days or even a week in a row. My students cannot continue learning Science because the substitute teachers are not Science teachers". Upon returning from the meeting, he had to rush to teach to finish the syllabus.

Teachers 4 and 5 also corresponded that using media, such as videos, would help students to visualize the complete circuit process. As for Teacher 6, he preferred to conduct experiments in his class because he believed that students would get better understanding through experiments. Teacher 6 said, "I prefer to conduct experiments with my students because they can observe phenomena and experience real-life situations". However, due to time constraints, experimental activities were limited.

Theme 3: Teaching Strategies

Teaching strategies consist of three main sub-themes, namely static illustrations, multimedia, and experiments. All teachers agreed they used many static illustrations to teach this topic to their students. As Teacher 1 said, he preferred to draw a circuit arrangement on a whiteboard traditionally and asks students to draw it along with it. For Teacher 3, he used a PowerPoint presentation to show static diagrams. He acknowledged that utilizing such graphics to depict the operation of an electrical circuit was rather difficult. He claimed that employing multimedia encouraged students to think abstractly, which was crucial for understanding science. On the other hand, Teacher 2 preferred to refer to diagrams in textbooks due to time constraints that prevented her from providing other teaching materials for her students.

Teacher 1 always used the workbook to familiarize his students with the HOTS questions and improve students' understanding, and he would typically ask questions to his students during his induction set. His justification for this strategy was to make sure students understood and remembered previous topics he had taught. Teacher 1 also emphasized that repetition of informationwas important to encourage students to retain information in their long-term memory. Teacher 1 then added, "The difficult terms in science need to be memorized; there is no other way for them to get used to the terms. We as a teacher need to play a role in helping them memorize those terms".

All six teachers had similar perspectives on video presentations. They argued that the video presentation would help students visualize the differentiation between series circuits and parallel circuits. Teachers sometimes use videos in the classroom to enhance students' understanding. All teachers agreed that these experiments were beneficial in helping students experience real-lifesituations. Through these learning activities, students would be able to apply the concepts taught toreal phenomena that occur in everyday life.

Theme 4: Teaching HOTS

All six teachers voiced their desired improvements in teaching HOTS in electrical topics from the interview sessions. The desired improvements can be summarized into two categories, i.e., active learning and technology assignments. Under the active learning task sub-theme, all six teachers agreed that students should be encouraged to ask questions in the classroom because questions are rarely asked during teaching and learning, except during experimental activities. Asking questions can help teachers measure two factors: students' level of interest and level of understanding. Meanwhile, group experiments and activities will encourage students to communicate and collaborate with their peers. As

Teacher 5 said, "Teachers also need to play an important role in engaging in student learning during active learning tasks. From my personal experience, without a plan, I cannot improve HOTS among my students. Students do not want to engage in various topics, and I need to encourage them by some methods, such as asking questions and [giving] rewards. I also allow my students to have a presentation in the classroom, and other students can have a debate about other students' presentation to develop their sense of critical thinking".

Under the technology sub-theme, all six teachers agreed that videos, animations, and diagrams thatresembled real structures could make it easier for students to describe the structure and processes of series circuits and parallel circuits. Teacher 2 said, "I believe using technology such as animationor video can help students to visualize the process". This was supported by Teachers 4 and 6,who agreed that most students could understand the process of electrical circuits more easilythrough visualization.

From the perspective of the six teachers, having a clear strategy to teach HOTS is very important for students to understand the basic concepts of science and apply that knowledge across the subject. The main problem students encounter is their failure to describe abstract processes in science, especially those that occur in electrical circuits. Teachers mustuse different strategies to teach their students to understand this concept. However, time constraints usually prevent them from preparing teaching materials. Even worse, technical problems such as poor internet connections prevent them from regularly using technology in theirclassrooms.

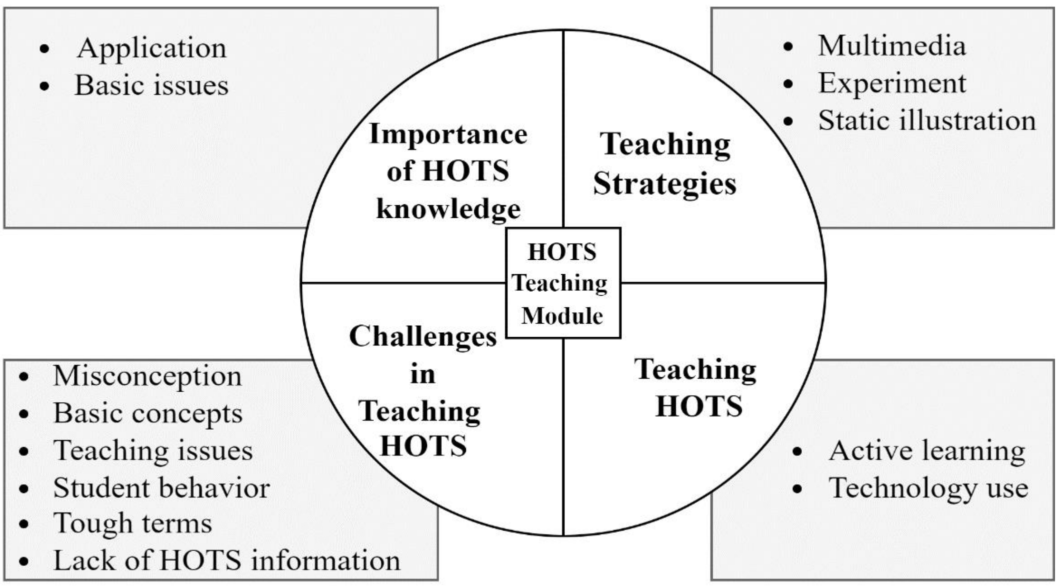

Figure 1. Themes and sub-themes of the study.

Discussion

The current study investigated Malaysian teachers' experiences in building a teaching module to improve HOTS among students in the setting of primary schools. The data were collected through in-depth interviews to answer the research questions. The findings supported the previous studies that students' HOTS depended on how teachers delivered the teaching (Seman et al., 2017). The data analysis resulted in four major themes describing the different ways of teaching science experienced by the study participants. The present findings showed that these four elements were also necessary for creating a module in the classroom to enhance HOTS among students. The researchers used interviews to investigate science teachers' perceptions of developing a module to enhance HOTS and overcome the obstacles they have experienced in their classrooms. According to the interview, all interviewees agreed that teaching HOTS was crucial in their class since it helped students be more active and critical thinkers when learning science.

Past research has shown that teachers must have a combination of subject-matter, general pedagogical, and pedagogical content knowledge when teaching specific topics (Lederman & Gess-Newsome, 1999). HOTS is crucial for effective learning and is the core purpose of scientific education (Saido et al., 2018). The ever-changing and challenging world requires students to go beyond the building of their knowledge capacity. They need to develop their HOTS, such as critical system thinking, decision-making, and problem-solving (Roets & Maritz, 2017). There is no doubt that the development of HOTS among students is prominent; however, for that to occur, the teachers must acquire and practice these skills.

Conclusion

This study provided useful insight into science teachers' experiences regarding the promotion of HOTS. This study indicated that the participants highly perceived implementing HOTS in 21st-century learning. However, the participants faced some challenges in implementing HOTS in science teaching. Malaysian schools have been using the HOTS module for more than five years. We are now uncertain about how the module was implemented in classrooms and whether it met its stated goals. The present study has given some insight into Malaysian schools' application of science modules and the use of HOTS by teachers. It has shown some discrepancy between what is occurring in classrooms and the real situation. The results of this study showed that students require a suitable module to improve their HOTS.

Implications

Based on the four themes raised through the interviews, it seems that there is a need for alternative teaching modules to facilitate HOTS for both students and science teachers. The information obtained can also lead to different teaching approaches, which challenge students' cognitive skills because these skills require students to process the knowledge they receive. Moreover, the study findings will be helpful to instructors and curriculum designers. First, science teachers might benefit from analyzing students' cognitive skill levels to detect and correct shortcomings by implementing learning activities that promote HOTS. Second, curriculum designers might utilize the data to analyze how far the new science curriculum has met its goals and propose methods to improve HOTS among science students. HOTS acquisition may also be aided by in-service professional development programs for science teachers on using the curriculum to transmit the understanding of scientific principles and their applications in daily life.

Like many advanced proficiencies, technical training cannot realize HOTS alone. It is essential that connections be made between theory and practice, so that students, particularly teachers, will be able to apply HOTS while learning. Teachers today should focus on promising educational activities and settings to foster thinking and the thinking skills that they seek to induce in these settings. The present findings suggest that professional development programs would be structured so that teachers will better understand what HOTS is and will be able to conceptualize it more coherently. The study also suggests encouraging teachers to apply various instructional strategies, as presented in this study and others, to help their students accomplish tasks requiring HOTS. The findings can help to elaborate on the pedagogical aspects of HOTS, such as metacognition, critical thinking, and problem-solving. Specifically, this can be done by first eliciting teachers' intuitive knowledge on these issues and then bringing into the discussion some of the literature about HOTS, transferring in a way that will connect to teachers' pre-instructional knowledge. The teaching module should consider the students' inclinations, abilities, and skills based on their thinking capacity. Suitable teaching methods will help students follow the lesson and acquire knowledge and skills, cultivating a deep interest in students.

Other than that, this module will encourage students to think critically and analyze information in a deeper and more complex manner. By incorporating activities that require problem-solving, reasoning, and evaluation, HOTS modules help develop students' critical thinking skills. This emphasis on critical thinking aligns with educational theories that advocate for a shift from rote memorization to higher-level cognitive processes.

Moreover, HOTS teaching modules often involve open-ended questions and scenarios that require students to think creatively and come up with innovative solutions. By encouraging divergent thinking and imagination, HOTS modules will support theories that recognize the importance of fostering creativity in education. These modules will help students develop their creative thinking skills, which are essential in various fields and real-life situations.

HOTS teaching modules align with educational theories that emphasize critical thinking, creativity, metacognition, collaboration, and real-world applicability. By incorporating these modules into educational practices, educators can enhance their instructional strategies and provide students with a more holistic and engaging learning experience.

Limitations

The current study had some limitations that should be addressed in future research. The impacts on students' learning were not tested, which is one of the study's limitations. Further research is needed to evaluate such impacts. Another issue in this study is that the interpretations are restricted. Observations and opinions are influenced by personal experience and expertise. Further research, such as empirical and longitudinal studies, will be required to assess the efficacy of teaching the HOTS module. The limitations that science teachers confront may reflect the setting at the study location. Additional research in a different culture may validate the findings and provide a better understanding of the barriers to developing HOTS. Lastly, the researchers chose the participants based on their interests and willingness to be interviewed. As a result, the volunteers may have had strong feelings on the subject.

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