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Primary Science Teachers' Perspectives about Metacognition in Science Teaching

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Abstract: Metacognition in science teaching involves processes that include self-awareness and self-regulation. Metacognition enables the teachers to facilitate student learning and to reflect on their teaching in order to enable themselves to improve or to make any changes to their teaching. In particular, teaching activities, especially in the 21st century, do not merely involve the transfer of knowledge and then applying that knowledge into daily life, but teachers need to reflect, plan and evaluate learning outcomes to enhance further in teaching. This study attempts to gain the perspective and implementation of metacognition skills in teaching science in the primary school classroom. The data was collected through a qualitative research method based on interviews with six science teachers in primary school using semi-structured interview protocol. The interview data were analysed for emerging themes, guided by the research questions. Teachers have a similar perspective of the understanding of metacognition in science teaching. Further discussion focuses on the implementation of metacognition in science teaching. This discussion is divided into three aspects, which are constraints faced, overcoming the constraints, and efforts made to implement metacognition in science teaching. Hence, the understanding of science teachers in regards to metacognition in science teaching is important and gives a positive impact towards teaching and learning in primary science teaching.

Keywords: *Metacognition, primary science, reflection, primary teachers.*

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Introduction

In the teaching of science in school, science teachers are responsible for teaching the facts, principles, theories, and laws that comprise the facts of scientific knowledge, as well as to assist students in establishing problem solving skills through scientific knowledge (Sumintono, 2015). Science education aims to build logical reasoning abilities of the students to enhance their problem solving skills, skills in evaluating information, and to develop higher cognitive skills through evidence-based decision making, regardless of students' level (Glaze, 2018). Teaching logical reasoning in science is difficult because students need to constantly understand new scientific laws and acquire higher cognitive skills.

Cognitive development, which is important in the mastering of new scientific concepts, refers to changes and transformations that occur in the brain to help people understand the world around them (U.S. Department of Health & Human Services, 2020). The human brain is a complex organ, synonymous with the mind, which is very complex to understand and conceptualize. Changes in the brain will reinforce the changes in the mind throughout the growth process, from infancy to adolescence to adulthood. The development of cognitive capabilities in terms of memorizing, reasoning, thinking, spatial processing, problem solving skills and perception will be different in the different stages of growth, especially when it comes to learning (Miller, 2016).

Classroom interaction between teacher and student involves both cognitive development and cognitive skills. The research reported in this article is focused on metacognition which is a cognitive skill. According to Flavell (1976), metacognition refers to an individual's awareness in their thinking process. Nazarieh (2016) mentioned that metacognition is an active process involved in learning. Even though the students are from different cultures or

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different backgrounds, there exists similarities between them, which is that their thinking is developed through the learning process.

Metacognition consists of metacognitive knowledge, metacognitive regulation, and metacognitive experiences (Zohar & Barzilai, 2015). In fact, students' learning outcomes and academic performance are significantly related to metacognitive knowledge (awareness on one self's thinking), and metacognitive regulation (facilitation of learning through reflection, planning and evaluation) (Stanton et al., 2015). Therefore, metacognitive knowledge and metacognitive regulation is the focus in this research.

An effective learning and development process is an important aspect of metacognitive knowledge and metacognitive regulation. These metacognitive skills are related to awareness and recognition in learning, reflection, planning, and evaluating. Given the awareness of educating individuals through metacognitive regulation, teachers need to ensure the flow of the teaching process, including the planning, monitoring, evaluation and reflection. The planning stage is to encourage pupils to identify learning goals. Secondly, the monitoring stage involves monitoring the pupil's progress towards the goals, so as to evaluate the method that will enable the achievement of the learning goal and finally, self-reflect the entire learning process. Since metacognition is not an innate skill, pupils need support and encouragement, especially for primary school pupils (Bromley, 2019).

Malaysia's current education system has been implementing Higher Order Thinking Skills (HOTS) in Malaysia since 2013 (Malaysian Education Blueprint 2013-2025). HOTS is based on the concept of Bloom's Taxonomy, which is from simple cognitive domain to complex cognitive domain namely, from remember, understand, application, analysing and evaluating of the entire learning outcomes (Mahajan & Sarjit Singh, 2017). At the same time, metacognition is a person's awareness of thinking about his or her thought process (Meggit, 2012) and the ability to reflect one's thoughts (Weil et al., 2013). The HOTS curriculum embraces metacognitive skills. However, the implementation of HOTS and metacognition was still under a lot of constraints from student attitudes as well as facilitation, teacher still unfamiliar with the implications of HOTS, thus, to study the teachers understanding and implement metacognitive skills in teaching science is vital.

On the other hand, researchers suggested that compared to adolescences, young children are limited in exploring their metacognitive skills because metacognitive skills are related to a person's thinking process and awareness in regards to their thought process, thinking about thinking, as well as self-regulation learning, which involves reflecting, planning, and evaluating. In contrast, children lack the experience in monitoring their cognitive domain (Flavell, 1979). This research aims to explore primary school science teachers' perspectives on metacognition in science teaching.

Globally, teachers are a noble profession as they pass on knowledge while teaching wisdom to generations around the world. As a 21st century educator, a teacher is responsible to help students develop 21st century knowledge and skills, such as metacognitive knowledge and metacognitive regulation. For this reason, this study is significant to all the education stakeholders, such as principals, teachers, education researchers, and parents, to understand the current education system as well as the perspectives of teachers teaching in the current education system of HOTS through metacognition (Tsapali et al., 2020). In addition, metacognitive knowledge and metacognitive regulation may be helpful and beneficial to educators because it could provide them with what students learn, as well as the ways they learn (Stephanou & Mpiontini, 2017).

Literature Review

Science education could empower 21st century skills and could achieve better results through the implementation of metacognition skills (Fauzi & Sa'diyah, 2019). The process of practicing metacognitive skills involves cultivating students' active thinking skills in order to understand and to be aware his/her own learning method and ultimately bring better learning outcomes (Mevarech & Fan, 2018). Generally, society would be emphasizing on university students to become independent, autonomous and self-regulated learners. In fact, these skills could be practiced in primary school, which helps them to learn through metacognitive skills (Hinojosa et al., 2020). However, the teacher plays a crucial role in determining the metacognitive ability of students. According to Seman et al., (2017) the results achieved in the "Malaysia Education Blueprint" (2013-2025), seem to be frustrating, especially in Malaysia, teachers' factor literature is needed to explain this phenomenon. Thus this research aims to investigate primary science teachers' perspectives about metacognition in science teaching.

Science is the education of things happening around us. Scientific knowledge provides meaning to the world, people, students, and eventually makes human lives more advanced (Sulaiman et al., 2011). Science education in Malaysia is full of challenges. This is evident in the fact that, until 2012, the medium of instruction for science curriculum constantly changed from English to Malay. When HOTS was introduced in 2013, science teachers demanded the implementation of metacognition in science teaching (Mahmud et al., 2018). Therefore, the current research hopes to find out the perspective of science teachers in regards to the latest education system, especially on metacognitive skills.

Science teachers play a role in producing a lifelong learner, and metacognition provides knowledge about what is happening around students, so it is essential for science teachers to teach students about what happens in daily life, but

implementing metacognition is crucial as well (Avargil et al., 2018). The implementation of metacognition in science learning requires teachers to support students learning development, which indirectly improves student abilities and enables students to evaluate further learning abilities (Rahman et al., 2011).

There are some strategies for teacher's instruction to improve pupils' metacognitive skills, for instance, concept maps, self-assessment rubrics, and think aloud method (Pedone, 2014). Science lessons involve a lot of classroom activities which enable science teachers to encourage students to be aware of their learning strategy, as well as to promote metacognitive cycles in planning, monitoring, evaluation, and reflections (Bromley, 2019). In addition, an impressive science lesson is the ability of science teachers to perform various activities (such as group work) to make the lessons in the classroom interesting and help students learn and understand better (Sulaiman & Abdul Rahim, 2009).

Science education requires evolving cognitive activities, so science classrooms would always require students to conduct scientific inquiry, decision making, and argumentation (Zohar & Barzilai, 2015). However, the classroom is a place that provides a high flow of cognitive skills such as critical thinking and problem solving (Ong et al., 2016), at the same time, the classroom provides space to reinforce metacognitive acquisition via the interaction between teachers and students. The metacognitive strategies encourage and enhance student in understanding, planning, applying a skill, recognizing mistakes and making evaluations towards those mistakes, these practices indirectly guide students to become self-regulated learners (Abdullah et al., 2017).

Metacognition is not only applicable to students, but to teachers as well. Teachers play a significant role in assisting students in developing their intellectual and metacognitive skills, and train pupils to become a self-regulated learner in order to achieve an effective academic learning (Bromley, 2019). Thus, a science teacher needs to practice their metacognitive skills by planning the curriculum, monitoring their instructional goal and self-reflect on their teaching methods to ensure effective and improved teaching methods, as well as provide students with meaningful understanding of science. Moreover, metacognitive teaching can help teachers realize and enable better adjustment to their teaching methods and pedagogy strategies in order to fulfil the needs of students (Hara et al., 2019).

This study aims to explore primary science teachers' perspective on metacognition in science teaching. It also aims to understand the implementation of metacognition in teaching science from teachers' perspectives.

Methodology

Research Design

This research was conducted in a qualitative research design with the purpose to explore the perspectives of primary science teachers about metacognitive in science teaching. This study also explored the implementation of metacognition in science teaching. The participants of this research consisted of six primary science teachers who participated voluntarily. Informed consent is important for conducting research. This is to ensure that the personal information of participants is protected. The data was obtained through semi-structured interviews where each interview took approximately 30 minutes. The interviews were later transcribed and analysed to identify relevant themes (Cresswell, 2008).

Participant Selection

Purposive sampling was employed to identify six primary science teachers willing to participate in the research. This type of sampling method is a non-probability sampling. The justification of applying purposive sampling rather than convenience sampling is because the research was conducted qualitatively and required participants with specific characteristics (Etikan et al. 2016). Purposive sampling allows the selection of participants and situations that are rich in terms of knowledge to achieve the purpose of the study, which is to obtain primary school science teachers' perspectives towards metacognition and implementation of metacognition in science teaching (Kaya, 2018). Participation is based on voluntary-basis. Participants who were willing to participate in this research comprised of in-service primary science teachers. Data is collected through interviews, and to complete.

Six primary science teachers volunteered to participate in this research (called as R1-R6). All teachers have more than six years' experiences in teaching science in the level 2 of primary school (Year 4 – Year 6). In addition, the participants graduated from public universities or teachers' Institutes, majoring in primary science education. Moreover, they also attended various workshops organized by the Ministry of Education (MOE), such as "Standard Based Curriculum for Primary Schools Science New Curriculum". This course provides exposure to the new science syllabus, which has been updated from The Integrated Curriculum for Primary School. In addition, three teachers participated in the "Science and Mathematics Teacher Training for Implementation of the Dual Language Program Extension". The six teachers also participated in the "Teaching and Learning Aids Innovation Course" organized by the District Education Office, showing them new innovations in teaching science. All teachers in this study are willing to participate in this research, which examines primary science teachers' perspectives on metacognitive in science teaching.

Data Collection and Analysis

As mentioned previously, the data was collected through interviews. Bernard (2012) mentioned that in qualitative research that adopts interviews as a means of data collection, data saturation is important to fulfil the research needs. Researchers in qualitative research need to obtain as much information as possible, therefore the interview questions should be well prepared to allow rich information to be gathered from the research participants (Ness, 2015). Another important aspect of qualitative research is data triangulation. This research used data triangulation, as the interview questions were uniformly conducted to obtain data from primary school science teachers who teach different classes and standards in primary school (Honorene, 2017). In addition, methodology in terms of the timings to interview the teachers is conducted differently based on the teacher's availability, as well as when analysing the interview data, all researchers are gathered for discussion to form a theme that ensures that the investigator's triangulation is implied (Rugg, 2010), therefore, data validity is verified. Furthermore, research reliability was tested through the inter-rater reliability (IRR) test, IRR is a coding technique that involves multiple researchers in the coding process (McAlister et al.,2017). Research questions are provided to two independent lectures as they were invited to go through the data to complete the IRR process. With the completion of the analysis process, the interviews were converted into written form, grouped, and concluded with a theme to answer the research question of the research, and the themes were narrowed down into two main themes: (1) the perspectives of metacognitive in science teaching and (2) the implementation of metacognitive in science teaching.

Findings / Results

This section discusses the finding themes and is summarized into five themes; (a) Perspectives toward Metacognitive in Science Teaching, (b) Purpose of Metacognition in Science Teaching (c) Constraint in Implementation Metacognitive in Science Teaching, (d) Evaluation and Solution in implement Metacognitive in Science Teaching, and (e) Efforts in Implementation Metacognitive in Science Teaching. The finding is related to the purpose of the study, that is, teachers' perspectives and implementation of metacognition in primary school science teaching. This research adopts a qualitative research method and aims to collect respondents' perspectives and implementation of metacognitive teaching through interviews. Based on interviews with six primary school science teachers, their valuable feedback is documented.

(1) The perspectives of metacognitive in science teaching

The collection of this information involved six primary science teachers who were willing to participate in this research and share their science teaching experiences in using metacognition with primary school pupils. The first theme was to invite teachers to provide their professional perspectives on metacognition in primary school science teaching.

(a) Perspectives toward Metacognitive in Science Teaching

The word "cognition" itself is about thinking. Therefore, teachers expressed a few views towards metacognition in primary school science teaching science:

i. Thinking skills (in-depth thinking, problem solving)
ii. Reflect, planning, evaluate
iii. Guide students to think

The first perspective toward metacognition in science teaching in primary school refers to students' thinking skills:

"……*This metacognitive refers to students thinking in a higher level*……." R1.

"…… *metacognitive is a high-level thinking ability that can solve problems in stages planning, predicting, solving, and improving cognitive skills*" R2.

"……*metacognitive requires students to think a few steps ahead to solve the problem*" R3.

At the same time, despite receiving similar responses, other participants that taught science metacognitively had different perspectives throughout the interview, which involved reflecting, planning, and evaluating the classroom teaching and learning in the curriculum. *"..... teacher reflect on past lesson and self-reflection about the fitness of the syllabus. Teacher need to plan appropriate teaching and learning activities…evaluation is about student themselves in assess their understanding from the teaching……"* R4.

"……self-reflect can helps pupils realize the way of thinking… the focus of planning is on teacher designing programs for teaching and facilitating pupils' classroom activities... through questioning or presentation to evaluate students' understanding, so that pupils get more sophisticated ideas, as well as students who are left behind can express their talents……" R6.

Along with R1, R2, R3, R4 and R6, there is a respondent who supported metacognition in both perspectives. Among those two perspectives, the respondent supported that metacognition in primary school science teaching involves not only the students' thinking skills but also self-reflection regarding the learning process. *"…… metacognitive is a higher level thinking that needs to be done together with reflection, pupils need to know how to learn... this can guide students to think about how to solve problems and make decisions ……"* R5.

(b) Reason for Implementing Metacognition in Science Teaching

After obtaining the science teachers' perspectives on metacognition in science teaching, the researchers explored the reasons for implementing metacognition in science teaching. The data from the interviews indicated that the teachers have different reasons for implementing metacognition, respectively. The reasons are as follow:

i. Understand the concepts
ii. Effectiveness of the teaching and learning process
iii. Deeper thinking
iv. Guide student to think more
v. Makes it easier for students to understand
vi. Effective and impactful teaching

Since metacognition is important and crucial in science teaching, it is a skill to assist pupils to comprehend science better and access students' deep knowledge in learning.

"…… Metacognitive is necessary in science teaching in order to better understand the concepts of abstract science ……" R1, along with *"…… metacognitive is necessary to understand the science concepts……"* R3.

It is understandable that metacognition is necessary in science teaching because it could help students to recognize their learning pattern and learn science more easily. This is not only applicable to the science subject, but for other subjects as well. *"…… to make it easier for pupils to understand during the lesson, and knowing what they have learn through metacognitive process, plan, monitor and evaluate……"* R5.

Subsequently, teachers perceive metacognition in the science subject as a useful tool because not only does it help students to be aware of their learning strategies, but it also helps to provide information to teachers to achieve effective learning outcomes, *"…… help science teachers to implement and enhance the effectiveness of the teaching and learning process……"* R2.

Metacognitive teaching can ensure effective and impactful teaching, *"…… metacognitive is a vital element that needs to be emphasized through reflection, planning and evaluating of teachers to create a very effective teaching method that positively impact for benefits of teachers as well as for students……"* R6.

(2) The implementation of metacognition in science teaching

Malaysia introduced higher order thinking skills (HOTS) in the latest "Malaysia Education Blueprint" (2013-2025), but the result seems discouraging due to teacher factors (Seman et al., 2017). Therefore, in the following sections, teachers' responses to constraints, overcoming such constraints, and their effort in the implementation of metacognitive in science teaching are cumulative.

(a) Constraints when Implementing Metacognition in Science Teaching

This research also investigated the constraints faced by the teachers when implementing metacognition in science teaching. This section discusses the obstacles encountered by the teachers in the process of implementing metacognition in teaching science.

The findings of the study indicate that the constraints faced by science teachers in implementing metacognition include:

i. Content overload
ii. Low cognitive thinking among students
iii. Student unable to think outside the box, resources are limited
iv. Students are unwilling to try
v. Lack of exposure
vi. Show no interest.

One of the teachers explained that the content of metacognitive teaching in science teaching is overloaded, and the syllabus covers a lot of aspects. According to the respondent:

"……the metacognitive of teaching has too much content to complete, and the content of the syllabus is very large, it is difficult for students to understand……" R1. Moreover, metacognition is a process involving cognition, so the constraint faced by the next teacher is about the cognitive thinking of students who are still at a low level:

"……metacognitive, student lack of exposure and cognitive thinking is low……" R2.

Teaching in the 21st century requires teachers to lead a class discussion to promote student learning, but when students do not respond or students are not interested in the course, students' attitudes are a common constraint and cause teachers to feel frustrated:

"…… students did not respond to the question……" R3.

"…… students can't think outside of the box and limited resources to refer as we are in rural school……" R4.

"…… Students are not exposed to the knowledge of metacognition, and they are unwilling to try ……" R5.

"…… when students get into a field they do not want; student behave not interest ……." R6.

(b) Overcoming the Constraints when Implementing Metacognition in Science Teaching

After encountering constraints that frustrate science teachers, this section aims to identify how teachers can overcome those constraints. Science teachers use multiple ways to solve those constraint, such as:

i. Course Mapping
ii. Note to memorize
iii. Cooperative method
iv. Demonstration of work
v. Planning time, additional reference material
vi. Diversified teaching method

The first attempt is for the teacher to utilize the time before class to prepare lessons beforehand. The teacher breaks up the topics according to the syllabus in order to apply the mapping technique to help students learn metacognition.

"…… my way in solving this problem is use tables, such as curriculum mapping. I first break down the science topics in science according to the syllabus provided……" R1.

In addition, another teacher also provided similar attempts to support the implementation of metacognitive; the teacher utilizes the time to provide notes for students to study in advance.

"……provided note before hands to pupils to memorize before teaching, then, further explanation and helps student to expose and enhance their thinking……" R2.

However, both teachers' solutions were supported by another teacher; the teacher not only utilizes extra time to prepare extra notes for students, but the teacher also teaches metacognitive by encouraging students to plan the lesson.

"…… additional notes will be given beside textbook. Students need to plan accordingly to what they want to learn in sequence, then they can expend their ideas to understand and solve problem ……" R5.

As stated before, the 21st century classroom teaching method requires the teacher to conduct class discussions, and the teacher will assign students to a group or in a pair in order to promote student learning from each other.

"…… solve with cooperative methods, in pairs. So weak students could get help from their classmate…." R3.

In addition to evaluation and solution in implementing metacognition in science teaching, creative teaching methods and diversity in instruction from the teachers are carried out in order to ease the constraints they faced while teaching.

"…… by demonstrating during the activity and giving specific instructions on the work card, students' understanding can be automatically enhanced ……" R4.

"……experiments, ask question, give quizzes online, to discover new ideas and talents from students……" R6.

(c) Efforts in Implementing Metacognition in Science Teaching

The final is to discuss the findings related to the efforts of science teachers to implement metacognition in science teaching. These efforts are:

i. Planning the lesson
ii. Preparation for class (for example: apparatus)

iii. Student capabilities, resources and tools

iv. Easy-to-learn materials

v. Students' understanding and quality of experience

The interview question at this stage is inclined to be self-reflection questions compared to other questions. The previous questions were straight forward about teachers' understanding and observable circumstances, but the purpose of this session is to ask teachers about factors that should be considered in the metacognition of the science subject in primary school. These are the extra efforts the teachers have put in to help students learn science. These extra efforts will be fully described below:

In addition to teaching metacognition, teachers can also practice their metacognitive skills in the teaching, such as planning, *"…… planning is important because it could make easier for student to understand a scientific concept……"* R1. *"…… planning. I planned and picked the most important topics, and then prepared specific questions……"* R3.

Apart from planning, teachers also pay more attention to preparing tools or equipment for students to ensure that they are facilitated and learn in the classroom. *"…… tools in conducting science experiment class……"* R2.

Moreover, another teacher supports preparation, but the teacher considers the student's background and student's ability when implementing metacognition teaching science lesson. *"……the ability of the student, there are also enough facilities in conduct a class, such as experiment lesson……"* R4.

Additionally, other than planning, preparation, and student background, teacher R5 would also strive to provide material and space for students' growth, *"…… providing learning material that students can easily learn, providing student with space and preparation for student to master the metacognitive skills"* R5.

Last but not least, teacher R6 would consider students' qualities in the process of implementing metacognition in teaching science, *"…… teacher asked questions at their level, but the student did not reach the level expected by the teacher, therefore, so this is not the quality of the student we want to achieve……"* R6.

Discussion.

Firstly, different data were obtained from teachers. However, some positive perspectives were seen from science teachers, indicating that they passed on metacognitive skills in science subject. Teachers' perspectives are similar to each other as metacognition is a thinking skill, and teachers also recognize metacognitive skills such as reflect, plan and evaluate (Stanton et al., 2015), and in addition to that, teachers not only provide, but also instruct students to apply metacognitive skills in science learning. Additionally, teachers also shared their view on metacognition. Metacognition essential for primary school science teaching, because metacognition not only establishes a good foundation for students' cognitive thinking, such as understanding concepts and gaining a deeper understanding, but it can also assist students in realizing their learning strategies. Certainly, an effective and positive impactful teaching and learning process could be implemented (Broomley, 2019).

The implementation of metacognitive thinking in science subject is vital and important. The constraints faced by science teachers are pertaining to students' attitude and to encourage students to think. According (Flavell, 1979), young children lack self-awareness and self-regulating metacognitive ability. Therefore, in the current research, the constraints faced by science teachers in implementing metacognition in science teaching are low cognitive thinking among students, student lack if creativity, students' reluctance to try, lack of exposure and the students showing no interest. However, metacognitive skills are very important to students, especially primary school students, because early recognition of his/her own learning is better and early practice to actively control the thinking process is essential to promote student success. In other words, metacognition can help students seek the best way to enhance and apply the knowledge they have learned to diagnose and solve problems (Mevarech & Fan, 2018; Chatzipanteli et al., 2013). Therefore, teachers need to decide on further strategies to be used to improve students' interest in learning science through metacognitive skills.

Teachers are essential to firmly establish students' cognitions. Through teaching, teacher assist students to diagnose and solve problems efficiently, especially for primary school students. Metacognition is a key skill for their survival and success in the 21st century (Thienngam et al., 2020). Thus, it seems that this is an emerging issue but some of the solutions were obtained from the teachers in the current research. Even though the teachers' opinions are varied, some effective strategies are adopted, for instance, to help them attract the interest of the students through mapping and cooperative methods (Pedone, 2014; Sulaiman & Abdul Rahim, 2009), and at the same time, the responsibility of science teaching could still be carried out. In addition, the factors for science teachers to implement metacognition in primary school science teaching are various, as obtained from interviews. These factors enable science teachers to maintain mindfulness, as well as increase the awareness of teachers in other subjects, and take preventive measures before implementing metacognition in the classroom so that teachers can make better adjustments and to ensure effective teaching (Hara at al., 2019).

Besides, despite the opinions obtained from the teachers in overcoming the constraints in implementing metacognition in science teaching, the interviews with science teachers also discussed other aspects of work, which is an effort to implement metacognition in science teaching. This aspect is ought to be used as a reference for other education stakeholder. The efforts discussed are, planning the lesson in advance by picking the most important topics, as well as preparing specific questions to make it easier for student to understand. On the other hand, teachers would also utilise some scientific tools or equipment to promote students to learn science. Additionally, efforts provided by the teachers is to take into account the students' background and the ability in learning science and then to implement suitable metacognition teaching science lessons. Additional learning materials are another option for students to master metacognitive skills. These efforts have brought light to the field of science education, as mentioned by Seman et al., (2017), the achievement of the Malaysia Education Blueprint 2013-2025 is discouraging, yet, through this study, researchers could be informed of the additional efforts contributed by these teachers in science teaching.

Conclusion

The current research seeks to obtain the perspectives and implementation of metacognition in teaching science among primary school science teachers. Cognitive skills have been recognized as a 21st century skill. Therefore, it is essential and important to practice cognitive skills, such as higher order thinking along with metacognition in teaching. A qualitative research method was conducted and the results were deliberated based on the interview sessions. Finding from this study show that the science teachers understood metacognition in science teaching as the teachers apply reflecting, planning, and evaluating in their teaching instructions which eventually gives a positive impact towards teaching and learning. However, several constraints and solutions were shared by the teachers. In short, current research attempts to determine the perspectives of science teachers in implementing metacognition in science teaching among primary school science teachers. Metacognition is an important skill in the 21st century because students must establish a good foundation of metacognitive skills as early as possible starting from early childhood and primary school.

Recommendations

Nonetheless, this study suggests that science teachers can share their perspectives in metacognition and provide different views when implementing it in science teaching. Further research may have an impact on teacher teaching exploration in other science subjects, such as biology, physics and chemistry. Correspondingly, other subjects, such as mathematics, requires highly metacognitive skills, but there is a lack of empirical research to support the importance of metacognitive skills in mathematics subjects (Abdullah et al., 2017; Ahdhianto et al.,2020), so the following further research could explore the metacognitive skills in mathematics.

Furthermore, future research may consider interviewing more participants, perhaps to broaden the scope to secondary schools, private schools, and even tuition teachers, as the expansion of the scope allows for more information to be obtained to help teachers or novice teachers conduct metacognitive teaching. In addition, besides solely using the qualitative method, further research may include surveys in conducting the research in order to obtain better understanding from the teachers.

In addition, the teachers' efforts discussed in this research are only a small part of the understanding of the teachers' contributions. Further study might have suggested to obtain more results from other primary school science teachers in different regions or states, so that it can be combined and served as a guide for primary school science teachers on metacognition in science teaching.

Limitations

There are some limitations inherent in this research. Since the researchers attempted to explore the primary science teachers' perspective of metacognition and the implementation of metacognition in science teaching. Thus, researchers were not able to analyse teaching content based on aspects of other subjects.

Another limitation of the research is that it centred on using multiple case studies in a bounded system (six science teachers participated in the research). Although the purpose of qualitative research could not be generalized, the research results might be prompted in the strategies and processes associated to this research. In addition, to adopt a multiple case study approach, time management needs to consider the time required to collect detailed data.

On the other hand, due to the confidentiality of the documents, this research also has limited the disclosure of data collected from the school teachers.

Moreover, this research was conducted on teachers selected from school in *Negeri Sembilan*, Malaysia. Therefore, generalization of the results obtained in this study maybe subject to limitations.

This research included only a relatively small sample of teachers in a specific area of teaching, which are science teachers. Given that the information obtained from the study was gathered from a primary school, the generalizability might be limited.

References

Abdullah, A. H., Abdul Rahman, S. N. S., & Hamzah, M. H. (2017). Metacognitive skills of Malaysian students in non-routine mathematical problem solving. *Bolema, Mathematics Education Bullentin/ Bolema: Boletim de Educação Matemática, 31*(57), 310-322.

U.S. Department of Health & Human Services. (2020, September 30). *Adolescent Health.* https://www.hhs.gov/ash/oah/adolescent-development/explained/cognitive/index.html

Ahdhianto, E., Marsigit, Haryanto, & Santi, N. N. (2020). The effect of metacognitive-based contextual learning model on fifth-grade students' problem-solving and communication skills. *European Journal of Educational Research, 9*(2), 753-764. https://doi.org/10.12973/eu-jer.9.2.753.

Avargil, S., Lavi, R., & Dori, Y. J. (2018). Students' metacognition and metacognitive strategies in science education. In Y. J. Dori, Z. Mevareach, & D. Bake (Eds.), *Cognition, metacognition, and culture in STEM Education* (pp. 33-64). Springer.

Bromley, M. (2019). *Metacognition in the primary school classroom*. Headteacher Update. https://www.headteacher-update.com/best-practice-article/metacognition-in-the-primary-school-classroom/216221/

Chatzipanteli, A., Grammatikopoulos, V., & Gregoriadis, A. (2013). Development and evaluation of metacognition in early childhood education. *Early Child Development and Care, 184*(8), 1223–1232.

Creswell, J. W. (2008). *Education research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Pearson.

Fauzi, A., & Sa'diyah, W. (2019). Students' Metacognitive Skills from the Viewpoint of Answering Biological Questions: Is It Already Good? *Indonesian Journal of Science Education/ Jurnal Pendidikan IPA Indonesia*, *8*(3), 317-327.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist, 34*(10), 906–911. https://doi.org/10.1037/0003-066X.34.10.906

Glaze, A. L. (2018). Teaching and learning science in the 21st century: challenging critical assumptions in post-secondary science. *Education Sciences, 8*(12), 1-8. http://doi.org/10.3390/educsci8010012

Mahajan, M., & Sarjit Singh, M. K. (2017). Importance and benefits of learning outcomes. *IOSR Journal of Humanities and Social Science, 22*(3), 65-67.

McAlister, A. M., Lee, D. M., Ehlert, K. M., Kajfez, R. L., Faber, C. J., & Kennedy, M. S. (2017, June 24-28). *Qualitative coding: An approach to assess inter-rater* [Paper presentation]. American Society for Engineering Education, The Ohio State University, Columbus, Ohio.

Meggitt, C. (2012). *Understand Child Development: Teach Yourself*. Hachette.

Mendez Hinojosa, L. M, Cardenas Rodriguez, M., & Ortiz Paez, C. A. (2020). Measurement of metacognition: adaptation of metacognitive state inventory in Spanish to Mexican university students. *European Journal of Educational Research, 9*(1), 413-421. https://doi.org/10.12973/eu-jer.9.1.413.

Mevarech, Z. R., & Fan, L. (2018). Cognition, metacognition, and mathematics literacy. In Y. J. Dori, Z. R. Mevarech, & D. R. Baker (Eds.), *Cognition, metacognition, culture in STEM education* (pp.261-278). Springer.

Miller Jr, H. L. (Ed.). (2016). *The Sage encyclopedia of theory in psychology*. SAGE Publications.

Ministry of Education. (2013). *Preschoool to Post- Secondary Education.* Kementerian Pendidikan Malaysia.

Murray, J. W. (2014). Higher-order thinking and metacognition in the first year core-education classroom: A case study in the use of color-coded drafts. *Open Review of Educational Research*, *1*(1), 56-69. https://doi.org/10.1080/23265507.2014.964297

Nazarieh, M. (2016). A brief history of metacognition and principles of metacognitive instruction in learning. *BEST: Journal of Humanities, Arts, Medicine and Sciences*, *2*(2), 61-64.

Neuman, L. W. (2007). *Social research methods, 6/E*. Pearson Education.

O'Hara, S., Pritchard, R., & Pitta, D. (2019). Teaching with and for metacognition in disciplinary discussions. In N. Feza (Ed.), *Metacognition in learning* (pp.1-20). IntechOpen.

Ong, K. K. A., Hart, C. E., & Chen, P, K. (2016). Promoting higher-order thinking through teacher questioning: A case study of a Singapore science classroom. *New Waves Educational Research & Development, 19*(1), 1-19.

Pedone, F. (2014, March 10 -12). *How to improve metacognitive in primary school* [Paper presentation]. 8th International Technology, Education and Development (INTED2014), Valencia, Spain.

Rahman, S., Yasin, R. M., Abudullah, M. S., & Subahan, T. (2011). Student learning style and preferences for the promotion of metacognitive development activities in science class. *World Applied Sciences Journal, 14,* 11-16.

Rugg, D. (2010). *An introduction to triangulation*. UNAIDS Monitoring and Evaluation Division.

Seman, S. C., Yusoff, W. M. W., & Embong, R. (2017). Teachers' challenges in teaching and learning for higher order thinking skills (HOTS) in Primary School. *International Journal of Asian Social Science, 7*(7), 534-545. http://doi.org/10.18488/journal.1.2017.77.534.545.

Stanton, J. D., Neider, X. N., Gallegos, I. J. & Clark, N. C. (2015). Differences in metacognitive regulation in introductory biology students: when prompts are not enough. *CBE Life Sciences Education, 14*(2)*,* 1-12. https://doi.org/10.1187/cbe.14-08-0135

Stephanou, G. & Mpiontini, M. H. (2017). Metacognitive knowledge and metacognitive regulation in self-regulatory learning style, and in its effects on performance expectation and subsequent performance across diverse school subjects. *Psychology, 8*, 1941-1975. https://doi.org/10.4236/psych.2017.812125

Sulaiman, T., & Abdul Rahim, S. S. (2009). Perspectives of science teaching: comparison between western Australian teachers and Malaysian teachers. *International Journal of Learning, 16*(2), 63-76. http:// doi.org/10.18848/1447-9494/CGP/v16i02/46112

Sulaiman, T., Baki, R., & Abdul Rahim, S. S. (2011). Perspectives of learning science effectively: Comparison between western Australian teachers and Malaysian teachers. *Pertanika Journal of Social Science & Humanities, 19*(1), 1-15.

Sumintono, B. (2015, October 31). *Science education in Malaysia: challenge in the 21st century* [Paper Presentation]. 1st International Seminar on Science Education (ISSE), Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.

Thienngam, S., Promlek, A., & Thongsaard, K. (2020). Influence of teachers' metacognitive skills on development of early-childhood students. *Australian Journal of Teacher Education, 45*(1), 19-30.

Tsapali, M., Paes, T. M., & Ellefson, M. R. (2020). Researching cognitive development in primary schools: methods and practical considerations. *Journal of the Chartered College of Teaching, 18*.

Ucak, E. (2019). "Science teaching and science teachers" from students' point of view. *International Journal of Educational Methodology, 5*(2), 221-233. https://doi.org/10.12973/ijem.5.1.221

Weil, L. G., Fleming, S. M., Dumontheil, I., Kilford, E. J., Weil, R. S., Rees, G., Dolan, R. J., & Blakemore, S. J. (2013). The development of metacognitive ability in adolescence. *Consciousness and Cognition, 22*(1), 264-271. http://doi.org/10.1016/j.concog.2013.01.004

Zohar, A., & Barzilai, S. (2015). Metacognition and teaching higher order thinking (HOT) in science education: students' thinking, teachers' knowledge, and instructional practices. In R. Wegerif, L. Li & J. Kaufman (Eds.), *Routledge international handbook of research on teaching thinking* (pp. 229-242). Routledge.