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# DIGITAL INQUIRY-BASED SCIENCE LEARNING IN RURAL PRIMARY SCHOOL

MUHAMMAD ZULFADHLI BIN KAMARUDIN

SULTAN IDRIS EDUCATION UNIVERSITY

2024

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DISSERTATION PRESENTED TO QUALIFY FOR
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# ABSTRACT

This study aimed to explore the management, implementation, teaching materials, and evaluation process of digital inquiry-based science learning in rural primary school. An action research approach using qualitative methods was employed, based on the circle of action and reflection framework. The participants for this study were 8 Year 4 pupils (10-11 years old) from a rural primary school in Melaka selected using purposive sampling. The study comprised three phases: (a) clarifying the initial understanding of primary pupils regarding plant growth and photosynthesis, (b) conducting two action research cycles of digital inquiry-based science learning using the BSCS 5E Instructional model, and (c) analysing the data to address the research questions. Data were collected through interviews, reflection logs, teaching verbatim, pupils' work and document analysis. The findings of the study revealed several key points. Firstly, in managing digital inquiry-based science learning in rural primary school, the activities must be suitable for the cognitive abilities and skills of the target pupils. Secondly, implementing digital inquiry-based science learning in rural primary school necessitates classroom activities that foster active learning and the practice of science process skills. Thirdly, it is crucial for teachers to utilise both digital and non-digital resources when selecting teaching materials for digital inquiry-based science learning in rural primary schools. Lastly, evaluating pupils' progress in digital inquiry-based science learning requires them to apply new concepts and skills. The implications of the study were digital inquiry-based science learning was suitable to be used in the teaching and learning process for the topic of photosynthesis according in the Standards-Based Curriculum for Malaysian Primary Schools Science Year 4. Thus, it is beneficial for primary science teachers to implement digital inquiry-based learning, thus improving their pedagogical practice and pupils' conceptual understanding.

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# PEMBELAJARAN INKUIRI SAINS DIGITAL DI SEKOLAH RENDAH LUAR BANDAR

## ABSTRAK

Kajian ini bertujuan untuk meneroka pengurusan, pelaksanaan, bahan pengajaran, dan proses penilaian dalam pembelajaran inkuiri sains digital di sekolah rendah luar bandar. Pendekatan kajian tindakan menggunakan kaedah kualitatif telah digunakan, berdasarkan kepada rangka kerja '*Circle of action and reflection*'. Peserta kajian ini terdiri daripada 8 orang murid Tahun 4 (10-11 tahun) dari sebuah sekolah rendah luar bandar di Melaka yang dipilih menggunakan persampelan bertujuan. Kajian ini terdiri daripada tiga fasa: (a) mengesahkan pemahaman awal murid-murid sekolah rendah mengenai pertumbuhan tumbuhan dan fotosintesis, (b) menjalankan dua kitaran kajian tindakan dalam pembelajaran inkuiri sains digital menggunakan model pengajaran BSCS 5E dan (c) menganalisis data untuk menjawab soalan-soalan kajian. Data dikumpulkan melalui temu bual, log refleksi, verbatim pengajaran, hasil kerja murid dan analisis dokumen. Hasil analisis data menunjukkan beberapa dapatan kajian. Pertama, dalam pengurusan pembelajaran inkuiri sains digital di sekolah rendah luar bandar, aktiviti-aktiviti tersebut perlu sesuai dengan kebolehan kognitif dan kemahiran murid. Kedua, pelaksanaan pembelajaran inkuiri sains digital di sekolah rendah luar bandar memerlukan aktiviti-aktiviti dalam bilik darjah yang mendorong pembelajaran aktif dan pengamalan kemahiran proses sains. Ketiga, adalah penting bagi guru-guru untuk menggunakan sumber-sumber digital dan bukan digital apabila memilih bahan pengajaran dalam pembelajaran inkuiri sains digital di sekolah rendah luar bandar. Terakhir, penilaian kemajuan murid dalam pembelajaran sains berasaskan penyiasatan digital memerlukan mereka mengaplikasikan konsep dan kemahiran baharu. Implikasi kajian ini adalah pembelajaran inkuiri sains digital sesuai digunakan dalam proses pengajaran dan pembelajaran untuk topik fotosintesis mengikut Kurikulum Standard Sekolah Rendah Sains Tahun 4 di Malaysia. Oleh itu, adalah bermanfaat bagi guru-guru sains sekolah rendah untuk melaksanakan pembelajaran berasaskan penyiasatan digital untuk meningkatkan amalan pedagogi mereka dan pemahaman konstektual murid.

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B Interview protocol

C Expert validity form

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# CHAPTER 1

# INTRODUCTION

This chapter discussed the background of the research, from the reformation of the field of science education to the significance of inquiry-based science learning and integrating technology in the learning process in the Malaysian primary science curriculum. Next, this chapter focussed on how the researcher highlighted the purpose and objectives of conducting this research to build the conceptual framework for this study. By the end of this chapter, the discussions on the importance and limitations of this research and the operational definition were reported in this study.

## 1.1 Research Background

Science education has been the subject of numerous reform attempts since its establishment. It aims to expand pupils' scientific knowledge, promote a fun learning experience, and deepen their interest in science by presenting real-world experiences that connect directly to learning objectives (Feille, 2021; Gilbert, 2016). Pupils' cognition has traditionally dominated science education research, and instructional and conceptual approaches to science education might influence pupils' attitudes, motivation and views of science (Gomez-Arizaga et al., 2016; Mupira & Ramnarain, 2018). Thus, when reviewing previous studies in the field of science education, the

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themes mentioned above were abundant, showing the effects of the transformation of science education on pupils as learners. When learning science through inquiry, pupils practice working as scientists to discover and explore the world around them to gain meaningful learning. Over the last several decades, the inquiry has been the foundation of reform efforts in science education and continues to be a critical factor in advancing the status of science teaching and learning as it was proven to be more effective than direct instruction (Akuma & Callaghan, 2019; McLaughlin & MacFadden, 2014).

Contant et al. (2018) highlighted the five criteria that must be achieved to consider whether the activities planned are a full inquiry activity: (1) pupils participate in scientific questions, (2) analyse evidence, (3) create explanations from evidence, (4) assess and explain their proposed findings, and (5) communicate and justify their suggested explanations. Ministry of Education Malaysia (2016b) expanded on this and highlighted three additional factors that contribute to inquiry activities: pupils-centred, eliciting pupils' curiosity and involving the process of cognitive, affective and psychomotor. When questions are raised, evidence is obtained and various explanations are evaluated in the process of interpreting the data. Hence, scientific inquiry is distinguished because it leads to knowledge and comprehension of the natural and artificial worlds through procedures that link explanations to scientific knowledge by communicating, discussing, and justifying discoveries with others (Nawanidbumrung et al., 2022).

Various reasons emerged why it is crucial to implement inquiry in the teaching and learning of science. Tsivitanidou et al. (2018) highlighted three importance of inquiry: providing pupils with opportunities to get a better awareness of science concepts, principles, and phenomena, providing opportunities to build scientific reasoning and a better understanding of science's nature and creating positive attitudes toward science. Gillies (2020) expressed that inquiry-based science engages pupils in examining scientifically oriented issues, where they acquire to prioritise information, evaluate answers in light of plausible hypotheses, and explain and justify their choices using science-specific language. Meanwhile, Sikas (2017) highlighted that pupils must develop scientific knowledge rather than merely memorising science ideas in inquiry-based science instruction.

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In the era of information and communication technology (ICT), education transformed to cope with the changing landscape of the teaching and learning process. Harlen and Qualter (2018) highlighted a few crucial advantages of digital technologies in addition to inquiry-based learning in science: collecting data, using models and simulations, and encouraging collaboration. Meanwhile, according to research in the field of technology-supported inquiry learning, numerous studies show that digital technology tools can be beneficial in boosting pupil learning (Rocha Fernandes et al., 2019; Zydney & Warner, 2016). Thus, teachers must integrate ICT into their instructional activities due to the fast growth of ICT and its comprehensive and in-depth application in Education, especially in the field of science education. With Technological Pedagogical Content Knowledge (TPACK), teachers gain a firm knowledge of choosing the suitable tools in the classroom and how they affect the contents to be delivered to the pupils.

Observing primary science education in Malaysia, the Ministry of Education supports the practice of digital learning as technology can significantly boost interest in science education. Technology and digital tools such as television, radio, video, computer, and the internet enhance teaching and studying science appeal and effectiveness. Abstract or complex scientific subjects are easier to teach and understand via technology (Ministry of Education Malaysia, 2018a). This also supports the Malaysia Education Blueprint 2013 – 2025 in Shift 7: leverage information and communication technology (ICT) to scale quality learning across Malaysia. ICT was ingrained in all aspects of school life, with no urban-rural divide, and all teachers and pupils possessed the skills necessary to use this technology effectively and meaningfully (Ministry of Education Malaysia, 2013). Thus, it is essential to integrate technology into inquiry teaching and learning to provide a meaningful learning experience for primary school pupils in 21st-century learning.

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## 1.2 Problem Statement

The Science Standards-Based Curriculum for Primary Schools (KSSR) is intended to pique pupils' interest in science and foster their creativity through experiences and investigations, thus acquiring scientific knowledge, skills, attitudes and noble values (Ministry of Education Malaysia, 2018a). The inquiry approach was selected as primary science education's teaching and learning pedagogy to fulfil the aim. From a global perspective, although the importance of inquiry is heavily weighted in science education, it is rarely applied in the classroom context (Gillies, 2020). Choi et al. (2021) expressed that primary science teachers acknowledge the importance of the inquiry approach and generally understand how to implement it in their teaching and learning process. However, most science teachers prefer the traditional teacher-centred method as the predecessor is a convoluted process that requires the preparation of specific classroom circumstances and instructional materials (Baroudi & Rodjan Helder, 2021). As a result, the convenience of planning the science lesson trumps the assurance of the benefits of the inquiry approach to the pupils.

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The same situation persists in the Malaysian science education system. Halim et al. (2018) expressed that even though Malaysian science teachers acknowledge inquiry in a science lesson, they tend to be challenging and complex in the absence of clear guidelines for implementing inquiry. Consequently, most science teachers conduct learning activities that they believe accord with the philosophy of inquiry even if they contravene it. Ong et al. (2021) supported this by expressing that the science teachers' confusion about what, why, and how of inquiry indicates a pedagogical flaw in implementing inquiry learning in the classrooms. Hence, it is necessary to establish the success of an inquiry-based scientific lesson within the context of the Malaysian science curriculum, which might serve as a reference for primary science teachers implementing inquiry-based science instruction in their classrooms (Ong et al., 2018).

Realising the difficulties in practising an inquiry-based approach, Malaysian primary science teachers opted to leave it behind. They chose to give a lecture in front of the classroom without involving the pupils' participation, hence minimising interactions with their pupils (Tay & Saleh, 2019). Pupils are solely exposed to instructor explanations and not scientific skills, not fully developing their scientific

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thinking through inquiry activities (Baharom et al., 2020). Furthermore, Baroudi and Rodjan Helder's (2021) study highlighted a few factors contributing to why science teachers hesitate to practice the inquiry-based approach in their lessons. Three main factors highlighted were limited ICT and teaching resources, the lack of skills in integrating ICT into the inquiry classroom settings, and teachers not being trained in the professional development of enforcing an inquiry-based approach. This was supported by Mahmud et al. (2018), highlighting directions for the future of science teacher education, including enhancing science teachers' ICT expertise as Malaysian science teachers continue to lack the ability to incorporate ICT into their lessons due to poor training given to them.

The capacity of educators to incorporate technology into various teaching approaches has become critical in the 21st century due to the fast growth of technology. This breakthrough has altered the way individuals teach and learn in the classroom. Nicol (2021) expressed that it is self-evident that most new inquiry-based instruction methods are connected to both hard and soft technology. With the rollout of 5G technology combined with the rise of artificial intelligence and the momentum of research on the use of technology in education, it comes down to the fact that new methods of inquiry instruction continue to evolve as technology advances (Nicol, 2021). Moreover, recent research indicated that science instructors must have a firm grasp of how technology may be integrated successfully with pedagogy and content knowledge to maximise the teaching and learning of science (Kapici & Akcay, 2020; Tanak, 2020).

The Science Standards-Based Curriculum for Primary Schools (KSSR) highlighted the assimilation of technology into the lesson. It is a highly successful instrument for increasing interest in science education and making science teaching and learning more engaging and effective (Ministry of Education Malaysia, 2018a). Thus, the question remains of how the teachers choose the suitable technological tools to be applied in the lesson. Teachers must understand the basic principle of Technological Pedagogical Content Knowledge (TPACK) to plan lessons that fully maximise the outcomes of integrating technology into education. As teachers grasp the concept of TPACK and scientific inquiry, they understand planning a technology-integrated scientific inquiry lesson. As mentioned in the previous part, although teachers realised

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the importance of scientific inquiry in science education, the lack of knowledge on how to implement the inquiry approach affects teachers' decisions in conducting lessons in the class. Thus, teachers must adapt to these changes to gain the benefits of both inquiry-based learning and the implementation of technological tools.

The integration of digital technologies into inquiry-based learning is beneficial in the field of science education. This is due to the nature of science education which covers an organised body of knowledge that is frequently opaque to pupils, and the employment of digital tools in classrooms is regarded as a potential strategy for promoting science education, especially in inquiry-based classrooms (Rocha Fernandes et al., 2019). Meanwhile, using digital tools like mobile tablets during scientific inquiry activities makes children passionate about utilising them, and they quickly go beyond the novelty phase to take advantage of the learning assistance they provide (Harlen & Qualter, 2018). Pupils' inquiry skills like communication, collaboration, creating explanations and drawing conclusions were enhanced with the aid of digital technology tools (Contant et al., 2018; Harlen & Qualter, 2018).

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A study was conducted by Abd Samad et al. (2019) to explore the acceptance and readiness of primary school science teachers to implement mobile learning in primary school. The study indicates high acceptance and preparedness among primary school science teachers to utilise digital learning. Meanwhile, the study by Abd Samad et al. (2022) shows that primary school pupils in rural areas chose mobile devices as the leading technological tools for digital learning and mobile applications as the central technological software for digital learning. Both these studies fit the need to conduct this study as it shows that even though primary science teachers lack skills in using technology in inquiry-based learning, they are ready to adapt and use technology in their teaching process. In addition, primary school pupils in rural areas chose to use mobile devices and mobile applications in their learning, thus fitting the target participants in this study to apply digital inquiry learning in primary school.

However, there is still a lack of study on digital inquiry-based learning in rural primary schools in Malaysia. As the study was a practitioner's research, the first-hand review of the process of managing, implementing, using teaching materials and conducting evaluation processes in digital inquiry-based science learning was recorded

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in this action research study. This study explored the best practice of digital inquiry learning for science in rural primary school in local Malaysian settings. Hence, an action research study promoted primary science teachers implementing digital inquiry-based science learning in primary school.

### 1.3 Research Purpose

The 60:40 Policy is the foundation of the Ministry of Education's (MOE) Educational Policy, which is based on the Higher Education Planning Committee Report. It aims to ensure that 60% of students should be enrolled in science/ technical streams at the secondary and higher education levels, and 40% should be enrolled in arts streams (Academy of Sciences Malaysia, 2021; Ministry of Education Malaysia, 2013). However, school students' involvement in the science stream has not yet reached the required proportion, despite the increasing trend of qualified students who opted for the arts stream instead (Zainudin et al., 2015). The study of Phang et al. (2014) highlighted a few factors that contributed to the failure of the 60:40 policy: pupils' interest in science, science teachers' teaching strategies and pedagogical content knowledge, and the use of information technology (ICT) in the teaching and learning of science. Thus, transformation must be made in the teaching and learning of science by integrating it with digital learning, starting at primary school to initiate and nurture the pupils' interest in science, thus continuing to further their studies in the science stream in the forthcoming years.

This study aimed to support the Malaysia Education Blueprint 2013 – 2025. In the document, the Ministry of Education highlighted both inquiry-based learning and digital learning as the proposed intervention to be practised by Malaysian teachers to revamp their teaching process. The document described increasing pupils' achievement and engagement through novel learning methodologies that promote project-based and inquiry-based learning achieved by student-directed inquiry (Ministry of Education Malaysia, 2013). Meanwhile, digital learning was highlighted with ICT literacy for teachers to plan, develop, and evaluate authentic learning experiences and assessments, combining modern technologies and resources to maximise subject learning (Ministry of Education Malaysia, 2013). In addition, pupils' digital skills were promoted. They

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learn how to use ICT to boost their learning properly, thus equipping them with the skills and information to learn well in an increasingly digital environment (Ministry of Education Malaysia, 2013).

Specifically, this study observed four leading purposes: the process of management of digital inquiry-based science learning in rural primary school, the process of implementation of digital inquiry-based science learning in rural primary school, the teaching materials used in digital inquiry-based science learning in rural primary school and the evaluation process of digital inquiry-based science learning in rural primary school. A further and detailed explanation of the purpose of this research can be seen in the research objectives and research questions.

## 1.4 Research Objectives

Specifically, three objectives emerged in the action research study on digital inquiry-based science learning in rural primary school. Below are the research objectives of this study:

i. To explore the management of digital inquiry-based science learning in rural primary school.

ii. To explore the implementation of digital inquiry-based science learning in rural primary school.

iii. To explore the teaching materials in digital inquiry-based science learning in rural primary school.

iv. To explore the evaluation process in digital inquiry-based science learning in rural primary school.

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## 1.5 Research Questions

The research questions for this study were:

i. How to manage digital inquiry-based science learning in rural primary school?

ii. How to implement digital inquiry-based science learning in rural primary school?

iii. What are the teaching materials in digital inquiry-based science learning in rural primary school?

iv. How to do evaluation process in digital inquiry-based science learning in rural primary school?

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## 1.6 Conceptual Framework

The conceptual framework formed in this study was based on three theories: Dewey's Theory of Inquiry (specific to the pedagogy of scientific inquiry), Technological Pedagogical Content Knowledge (specific to the integration of technology elements on pedagogical content knowledge for the teachers) and Piaget's Stages of Cognitive Development (specific to the concrete operational stage for primary school pupils). The three theories were expanded to fit the research objectives and research design, which can be seen in Figure 1.1 below:

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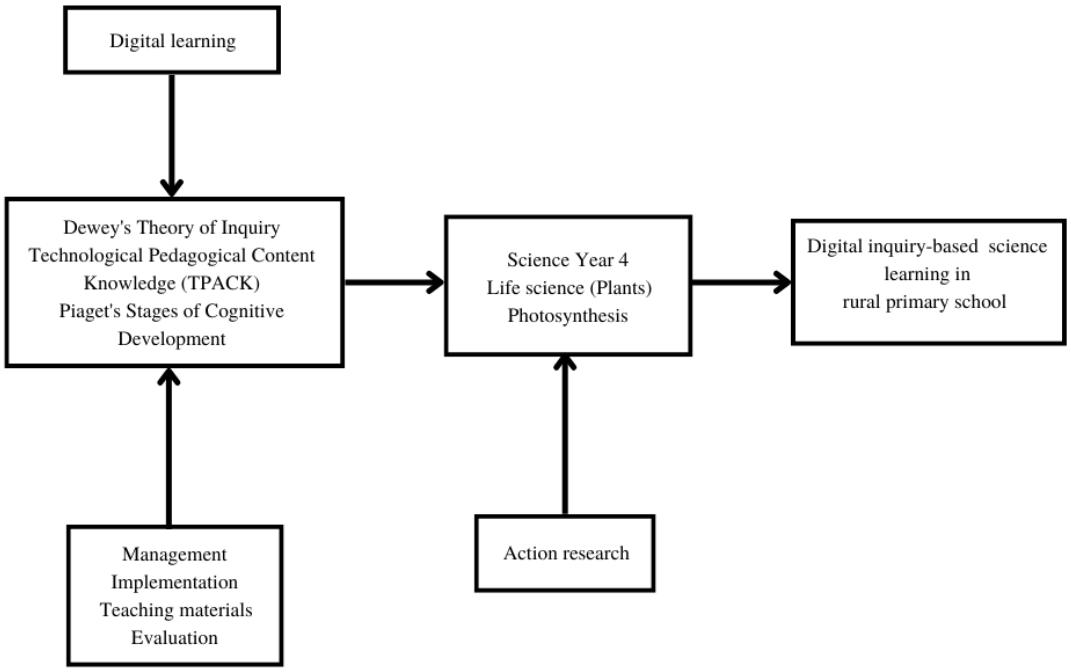


*Figure 1.1.* Framework for digital inquiry-based science learning in rural primary school

Dewey's Theory of Inquiry highlighted the incorporation of inquiry as an organising approach in school science. In science class, too much focus was laid on facts and not enough on science for thinking and the nature of inquiry (Barrow, 2006). Meanwhile, Technological Pedagogical Content Knowledge by Herring et al. (2016) highlighted the need to maximise the benefits of technology integration in education. Piaget's Stages of Cognitive Development discussed how primary school pupils were in the concrete operational stage, in which they comprehend better by handling concrete objects (Babakr et al., 2019). Thus, using digital inquiry-based science learning for primary school, it is essential to highlight the beginning point of pupils' grasp of a scientific concept to cultivate their interest in science.

Digital learning was incorporated into the science lesson plans based on the aforementioned theories. In this study, digital tools used by the pupils were mobile devices and mobile applications. Thus, the researcher ensured that both tools were

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incorporated when planning the lesson. In addition, the four research objectives in this study laid out as the theories mentioned before the management, implementation, teaching materials and evaluation process of digital inquiry-based science learning for rural primary school. The management includes how the researcher uses various technological tools to administer the inquiry-based science lesson. The implementation refers to the process that happens in the classroom when the study is conducted. Meanwhile, the teaching materials included all the teacher's aids used in this study, both conventional and technological tools. Lastly, the evaluation process includes how the researcher assesses pupils' achievement throughout rural primary schools' digital inquiry-based science learning lessons.

All theories, research objectives and the digital learning process were assimilated into the science year 4 plants topic in the content standard photosynthesis. The main document referenced was The Standards-Based Curriculum for Primary Schools Science Year 4 Curriculum and Assessment Standards Document (Ministry of Education Malaysia, 2018a). The action research was integrated into the research design using the Feldman et al. (2018) framework, the circle of action and reflection. Digital inquiry-based science learning in rural primary school complemented science teachers' teaching and learning process, including lesson plans and the teaching materials incorporated in this study.

## 1.7 Operational Definition

Digital learning

Digital learning refers to any learning facilitated by technology or instructional practices that make efficient use of technology. The use of mobile devices (iPad or mobile tablets) and mobile applications (AhaSlides, Arloon Plants, Seesaw and Blooket) were practised throughout this study.

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Inquiry-based learning

Contant et al. (2018) expressed that in achieving full inquiry, the activities planned must fit all the five criteria: pupils participated in scientific questions, analysed evidence, created explanations from evidence, assessed and explained their proposed findings, and justified their suggested explanations. The researcher ensured that the lesson planned throughout this study fits all the criteria.

Science learning

Science learning refers to a science subject taught in primary schools in Malaysia. The Ministry of Education provided the syllabus for primary school through a specific document of The Standards-Based Curriculum for Primary Schools Science Curriculum and Assessment Standards Document. In this study, the document used for Year 4 is the life science theme with the topic of the plant.

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Digital inquiry-based science learning

The process where primary pupils learned science using the inquiry approach that fulfilled all the five criteria aligned by Contant et al. (2018) with the aid of various technological tools, including mobile devices and mobile applications.

Rural primary school

Rural Primary school refer to Sekolah Kebangsaan Luar Bandar (literally translated as Rural National School) in Malaysia. Rural schools are located in the countryside rather than in an urban area in town. Pupils aged from 7 to 13 years old go to primary school. In this study, participants from year 4 were selected with ages ranging from 10 – 11 years old. This is due to changes in the school calendar due to the Covid-19 pandemic. School years start from late March to early March of the following year instead of January to December.

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Management of digital inquiry-based science learning

Management refers to the process of dealing with or administrating digital inquiry-based science learning. In this study, the researcher strategizes and provides procedures for the action plan of digital inquiry-based science learning before and while implementing it in the classroom.

Implementation of digital inquiry-based science learning

The process of executing the action plan of digital inquiry-based science learning into effect in the classroom. The researcher conducts the lesson following the 5E Instructional Model and ensures the digital technological tools aid pupils in inquiry activities.

Teaching materials of digital inquiry-based science learning

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Teaching materials refer to the resources used by the teacher during the lesson. This study incorporated two types of teaching materials: non-digital teaching materials related to traditional science investigation activities and digital teaching materials related to digital learning activities.

Evaluation process of digital inquiry-based science learning

The process of assessing pupils' changes in conceptual understanding of the topic of photosynthesis. In this study, the researcher practised informal evaluation at the start and throughout the 5E Instructional Model sequence and formal evaluation that occurs at the end of the 5E Instructional Model.

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## 1.8 Limitations of the research

This action research study explored digital inquiry-based science learning for rural primary school, specifically the management, implementation, teaching materials and evaluation process. However, there were a few constraints in conducting this research. This research was only conducted in one rural primary school in Melaka, with participants selected using purposive sampling in one year 4 classroom for science subjects aged 10 - 11 years. Thus, the results derived from this study cannot be generalised to all pupils' levels in primary school. However, as qualitative data collection and analysis, the researcher went deeper to explore based on the research questions.

The second limitation of this study is that the topics selected were plants' growth and photosynthesis. It represented a small part of the topics and did not cover the entire topic in the year 4 primary science topics or even the life science theme in the year 4 primary science curriculum. Thus, the observed implementation effects were only applied to the selected topics, not other topics covered in the primary science curriculum. The limitations were due to the time constraints in conducting this study and the need to explore more the integration of digital learning with the science topic of photosynthesis.

The last limitation of this study was the research design: action research. As the study was conducted as practitioner's research, where the researcher conducted the study and reflected on his action before moving on to the next cycle, few questions were raised on the validity of the data. However, the researcher explained in detail the positionality of the researcher and how data validation occurs in the validity section in chapter 3 of this study.

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### 1.9 The importance of the research

This study empirically established how digital inquiry-based learning may be taught in primary school science. Scholars in science education have emphasised the need for inquiry teaching in schools. From the global context, the search through the Scopus database and science education journals based on Scimago Journal Rank from the first quartile shows a low number of articles that were affected by the study maturity. Numerous research problems remain unanswered in a less mature field of study, and the number of available articles is limited and distributed (Kraus et al., 2020). Similarly, searching through Google Scholar shows a few articles demonstrating how digital inquiry-based learning should be implemented in a Malaysian primary school. Thus, this study provided an addition to the body of knowledge that shows how digital inquiry-based science learning performed among primary school pupils in Malaysia as it fits into the Ministry of Education Malaysia's curriculum and syllabus.

Furthermore, this research was favourable to the Ministry of Education. The ministry's virtual learning environment for schools across the country has shifted from a single provider - VLE Frog to more broad providers with the launch of Digital Educational Learning Initiative Malaysia (DELIMa) in 2020. Teachers in Malaysia were generally inclined to use Google Classroom and Microsoft Teams as it is known to broad consumers. However, the technological tools provided in this study were more suitable for primary school pupils as it was designed specifically for them. Thus, this study exposed additional technological tools to be applied in the primary science classroom that can be reflected on the DELIMa website for teachers nationwide.

In addition, there has been little research on implementing inquiry-based science learning according to the TPACK framework until now. Most of the studies on technology-integrated scientific inquiry among primary school pupils focused on its effects on the pupils without a complete understanding of how the technology used in the studies was related to the contents to be delivered to the pupils and the pedagogy was applied in the science classroom. Furthermore, some applications were neutral because they can be used in any subject and do not correlate with science content, thus requiring further details on their application in the science classroom. Furthermore, previous studies on TPACK in a science classroom were conducted among pre-service

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and in-service teachers as the main participants in the study. These studies mainly focussed on teachers' perception of the integration of inquiry and the TPACK framework formed and how it affects the teaching and learning process. There were few studies on how the TPACK framework's application affects pupils' learning process.

Thus, this research complemented primary school science teachers in implementing digital inquiry-based science learning for primary school. As teachers had difficulties choosing the technological tools and implementing inquiry-based science learning among primary school pupils, this research provided insight into enforcing technology in an inquiry classroom. Moreover, the practitioner's action research study provided action and reflection from the teacher's point of view on integrating technology in an inquiry classroom. The cyclical action research process expressed the detailed lesson planning process.

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## 1.10 Conclusion

This chapter discusses the research background, problem statement, objectives and research questions, conceptual framework, operational definition, limitations and the importance of the research. This gave an insight into the purpose of why the researcher selected the topic of digital inquiry-based science learning in rural primary school. The advancement of the digital age through Industrial Revolution 4.0 encourages changes in the teaching and learning process to be shifted to digital mobile technology. As a result, primary school science teachers should maximise the usage of different digital technologies in inquiry-based learning to support pupils' learning.

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