Journal of Turkish Science Education
http://www.tused.org
© ISSN: 1304-6020

The application of on-line science-based inquiry learning in primary schools

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ABSTRACT

The teacher has an important role in making pupils skilled in inquiry, viz guiding them to carry out inquiry steps in science learning. However, there are obstacles to applying online learning at primary school level, especially inquiry-based science. The purpose of this research is to analyse the application of inquiry in science learning, analyse the effectiveness of e-learning based on the 2020 at the Indonesian Ministry of Education and Culture guidelines, and identify obstacles to implementing e-inquiry science learning at the primary level. This study employed a descriptive qualitative approach. Sources of data were resource persons from 6 educational institutions including trainers, school supervisors, principals, teachers, Grade VI pupils, and their parents. The result showed the only a small number of teachers implemented on-line science-based inquiry learning and the effect of the learning was the utmost significance on student's achievement. However, most of primary school teachers have not applied inquiry-based methods in science learning. Several obstacles to implementing e-inquiry learning at the primary level were identified. These obstacles include the teachers did not understand how to develop an online inquiry model learning scenario, had low skills in using ICT, lack of support for ICT facilities and of e-learning inquiry learning guide, and had limited time.

Introduction

The quality of education largely determines a nation's competitiveness. The quality of Indonesian education so far has not been encouraging. The students' higher-order thinking skills were low and the skills have not increased in International Assessment periods. This is seen based on the PISA (Programme for International Student Assessment) scores from 2000 to 2018. As a result of the 2018 PISA test in science competence, Indonesian school students are ranked 73 out of 78 countries (Rosito, 2020), and 60% of Indonesian school students are below the minimum competency score

(Bunawan, Rangkuti, & Yanti, 2019). The low quality of education is caused by various factors, such as the competence of educators, the quality of teaching and assessment materials, infrastructure, students' socio-economic conditions, and geographical factors (Stahl, Schober, & Spiess, 2018; Utomo & Sudarsyah, 2021; Yakhshieva & Sidiqova, 2020). Hence, much needs to be done to improve the quality of Indonesian education, one of which is improving the quality of the learning process (Widiyanti, Indriyanti, & Ngabekti, 2015) because the quality of education is determined by the quality of the learning process in school (Churiyah et al., 2020).

The Free Learning Policy in 2020, initiated by the Minister of Education and Culture of the Republic of Indonesia (RI), aims to improve the quality of Indonesian school students by improving learning methods that develop higher-order thinking skills (Hadiansah et al., 2022; Ilkorucu, Tapan Broutin, & Boyaci, 2022). Science teaching methods can be improved by implementing the inquiry model (Nasution et al., 2023). Teachers play an important role in making pupils skilled in conducting an inquiry, by guiding them (Wen et al., 2020).

At the primary school level, science ideally develops a knowledge base, critical thinking, and a scientific attitude (Alanazi et al., 2023; Misbah et al., 2018). This is in accordance with the contents of the Regulation of the Minister of Education number 58 of 2014, which asserts that science learning must be carried out by inquiry (discovery) to foster thinking skills, and scientific attitude. Inquiry learning is to develop students' critical thinking (Corlu & Corlu, 2012; Hosler & Arend, 2012; Parmin et al., 2017). In addition. It is underpinned by the idea that collaboration between teacher and learner constitutes a strong pedagogy, but in reality, many science teachers do not apply inquiry-based strategies (Capps & Crawford, 2013).

Research conducted by Rusdiyana et al (2021), revealed several obstacles for teachers in applying an inquiry-based scientific approach to science at primary school. They asserted that teachers' lack of mastery of effective questioning skills, of science content knowledge, and of inquiry steps, and lack of experience in the application of inquiry learning in the online context hinders them from applying an inquiry-based scientific approach. The purpose of this study is to analyse the implementation of and the effectiveness of on-line science-based inquiry learning and identify the obstacles.

The revolution in the use of computers and the internet in education has given rise to the concept of online teaching (Mansoor & Paul, 2022). Online teaching greatly contributes to changes in the learning process (Maatuk et al., 2021). Online teaching uses different learning sources, varying from information and communication technology to social and digital media (Prahmana et al., 2021). Online teaching by utilising ICT is generally known as e-learning (Gumantan et al., 2021). Educational institutions are rapidly shifting from conventional teaching to the online learning process from primary to tertiary levels (Dahleez et al., 2021). The global crisis caused by the Covid-19 pandemic has challenged educational institutions worldwide to shift from conventional teaching to online teaching (Mansoor, 2021; Amka & Dalle, 2021; Putri, Samsudin, & Suhandi, 2022). This has also happened to the education system in Indonesia, where e-learning has begun to flourish.

In Indonesian Ministry of Education and Culture Law Number 20 of 2023 gave educational institutions the right to choose face-to-face or online learning processes so that it is possible to have many choices towards hybrid learning. The implementation of distance learning allows the academic unit to choose online or offline or a combination of both according to availability, infrastructure, and readiness of facilities (Amka & Dalle, 2021; Noor at al., 2022; Prahmana et al., 2021). According to Allen and Seaman (2010), e-learning can be blended or hybrid learning. E-learning can be designed in an interactive model and a Learning Management System (LMS), such as using Zoom meetings, Google Meet, Skype Classrooms, etc." (Ganesha et al., 2021). In the preparation of an e-learning-based learning implementation plan, there are learning media with several characteristics, including the application of ICT, viz network-based learning, computer-based virtual classes, and digital collaboration to stimulate learners' thoughts, and interest in engaging with these media (Chekour et al., 2022; Wati, 2020).

During the Covid-19 pandemic, the following standards were required to be met in distance learning; a) providing a meaningful and joyful learning experience, b) focusing on life skill education, including understanding the Covid-19 pandemic, d) providing a variety of learning activities and tasks for learning from home, according to their respective interest and condition, including considering the gap in access/facilities for learning from home, and e) providing feedback on evidence or product of learning activity from home (Aliyyah et al., 2020; Syawaludin et al., 2022).

Akcay and Yager (2010) suggested that with inquiry-based learning, pupils' understanding of science concepts increased significantly in process skills, creativity skills, the ability to apply scientific concepts, and a more positive attitude. E-inquiry can improve cognitive learning outcomes for high school students (Raihanati et al., 2021), and the use of mobile devices in mobile scientific investigations enhance the scientific process (Ekici & Erdem, 2020). Widikasih et al (2021) reported that pupils' low understanding of science content and lack of learning motivation were common problems during the online learning process. Such issues further suggested that online learning requires special attention to improve the quality of learning. The availability of facilities, use of networks and the internet, planning, implementation, evaluation of learning, and collaboration with parents were the biggest problems in online learning based on the research findings of Fauzi & Khusuma (2020). To assess the various obstacles in applying online learning in primary schools in Indonesia, it is necessary to do more in-depth research on applying inquiry-based science online (Aslan, 2021). The questions of the current study are multifold and includes;

- How is inquiry-based learning in science applied at the primary school?
- What are the effects of inquiry science learning on students' achievements?
- What are the obstacles in implementing e-inquiry learning at the primary school?

Methods

This study uses a descriptive qualitative research approach. According to Creswell and Creswell (2017), descriptive qualitative research is a research strategy in which the researcher investigates the lives of individuals and asks a person or group of individuals to tell their stories. Sources of data were resource persons from 6 educational institutions including trainers of the South Kalimantan Education Quality Assurance Institution (LPMP) and school supervisors, principals, teachers, Grade VI pupils, and their parents in Banjarbaru (Table 1). The persons were selected by purposive sampling. Banjarbaru is the capital city of South Kalimantan Province that is inhabited by a diverse population of Indonesians.

Table 1

Shows research resource of person

No	Resource Person	Number of Speakers
1	Widyaiswara LPMP South Kalimantan.	1 person
2	Banjarbaru School Supervisor	2 persons
3	Headmaster	2 persons
4	Banjarbaru Elementary School Teacher	6 people
5	Grade VI pupils of SDN Banjarbaru	8 people
6	Parents	8 people

Interview data were collected from November 1, 2021, to November 30, 2021, at Banjarbaru Elementary School, South Kalimantan, Indonesia. The interviews conducted by the researcher were

in-depth interviews. Kaae and Traulsen (2020) and Hennink, Hutter and Bailey (2020) stated that the in-depth interview technique is a typical data collection technique for qualitative research. In conducting interviews, the researcher used the form of grids for interview guidelines and did not use standardised instruments (Table 2). The question prompts for interview guidelines are as follows:

- How did teachers conduct inquiry in science learning at school?
- How did teachers conduct the implementation of e-learning based on distant learning guidelines from the Ministry of Education and Culture in 2020?
- What were obstacles in implementing e-inquiry learning?

Table 2

Grid for interview guidelines

Variable	Sub variable	Indicator
1. Application of inquiry in science learning	1. Steps of inquiry	1. Make a simple map based on observation 2. Designing an investigation/experiment 3. Pupils conduct experiment/experiment 4. Pupils discover concepts through experiment
2. Implementation of e-learning based on distant learning guidelines from the Ministry of Education and Culture in 2020	1. Provide a meaningful and joyful learning experience 2. Focus on life skills education 3. Provide a variety of e-learning learning activities	1. Learning that is applied by e-learning creates a spirit of learning for pupils 2. Learning that is applied by e-learning provides assignments that can be done easier than traditional one. 3. Learning with a scientific approach (inquiry) 4. Pupils doing experiments at home supervised by online 5. Class discussions are conducted via WA, Google Classroom, Zoom, or google meet.
3. Obstacles to implementing e-inquiry learning		1. Identify the causes of teacher difficulties in facilitating pupils to engage in e-learning lessons. 2. Identify the causes of teacher difficulties in facilitating pupils to ask questions during e-learning. 3. Identify the causes of difficulty pupils experience with e-learning 4. Identification of difficulties conducting class discussion through e-learning

Data analysis was carried out using the Miles and Huberman (2014) model, which included the stages of data reduction, data display, and data verification. Figure 1 presents the data analysis design that was carried out.

According to Miles, Huberman and Saldaña (2018), activities in qualitative data analysis must be carried out interactively and continuously until complete. Miles et al.'s interactive model has four

stages followed in the current study. Researchers make reflection notes, which contain interpretations of the phenomena found, Data reduction is a form of analysis that sharpens, categorises, directs, discards what is not needed, and organises the data needed according to the focus of the research problem. The presentation of qualitative data is generally in the form of narrative text. Drawing conclusions and verification is carried out from the beginning of data collection. Qualitative researchers begin to look for the meaning of regular problem, patterns, causal paths, possible configurations, and proportions. The researcher has provided conclusions by looking at the existing patterns, but they are not yet stable and then increase to become more stable, detailed, and firmly rooted. Verification is carried out on the conclusions during the research, reviewing notes from the field.

An inductive and thematic analytical approach was utilised to analyse the data by identifying, evaluating, and making themes based on participants' interviews (Gao, 2021). The interview responses of all the study participants were extracted utilising keywords and categorized based on specific theme.

Findings

The results of the interviews can be seen in table 3.

Table 3

Summary of interview results

Research variable	Findings on the application of online inquiry in Banjarbaru Elementary Schools, South Kalimantan, Indonesia
Application of inquiry in IPA learning in elementary school	The application of inquiry in science learning has not been carried out by most primary school teachers in Banjarbaru because some reasons. They do not understand how to develop online inquiry learning scenarios and the mindset of teachers, principals, and supervisors that the learning objectives are based on more content than competency achievement.
Implementation of e-learning based on circular letter No. 4 of the Ministry of Education and Culture of 2020	Most teachers do not apply inquiry learning while online teaching science. The most frequently used platform is WhatsApp, there are less variety of learning activities, and most pupils feel bored learning science. The only a small number of teachers online teaching science using online and applying inquiry learning. The learning activities are accompanied by experiments; the platforms used are WhatsApp, Google Classroom, and Zoom meetings, so that pupils feel happy learning science.
Obstacles in implementing e-inquiry learning	Most respondents stated that obstacles to implementing e-inquiry learning at the primary level in Banjarbaru were the mindset of teachers who are not yet competency-oriented, teachers' low skills in using ICT, lack of support for ICT facilities, no e-learning inquiry learning guide, time constraints, and low innovation online learning.

Discussion

The Application of Inquiry in Science Learning

The finding showed that the only a small teachers implemented online inquiry learning. The online inquiry learning has developed students' higher order thinking skills. According Ulia & Kusmaryono (2021), inquiry learning challenges children (10-12 years old) to argue and ask scientific

questions and develops their scientific attitudes. Inquiry-based science learning provides hands-on experience. Through direct experience, learners can find facts, learn to find knowledge, practise science processes and develop curiosity (Dewi et al., 2021). At the same time, the results of this interview in Banjarbaru indicated that most teachers have not implemented online inquiry. As one of the pupils stated:

Our science teachers usually deliver the lecture but do not conduct experiments and ask many questions based on our observation, especially during the online learning. We often lose interest and sometimes get involved in other activities rather than paying attention to the lectures.

Online inquiry can help students achieve Higher Order Thinking Skills (HOTS), the ability to conduct an inquiry is a part of HOTS (Handayani et al., 2019). However, in science learning in Banjarbaru, South Kalimantan, Indonesia, most primary school teachers stated that they cannot help their students to achieve HOTS, one reason for which is their low experience in conducting a series of experiments and analysis of result data patterns during the experiment when teaching science in class. As one of the principals stated;

Although we are supplied with competent teachers, they are less trained in conducting a series of experiments and utilising modern learning technologies in the classroom based on the constraints of resources.

This applies to prospective primary school teacher students generally. They have difficulty in guiding children to design appropriate experiments to test pupils' hypotheses. One of the causes of the teachers' inability to apply online inquiry is their low level of higher-order thinking skills. A trainer of the Education Quality Assurance Institute in South Kalimantan, Indonesia, stated that;

Inquiry learning at the elementary school level is needed, but most teachers did not implement it because they did not have the opportunities to attend well inquiry training. The only a small number of primary schools have the experiment tools and materials. Very few principals and supervisors give attention and facilitate their teachers to implement inquiry learning.

Inquiry learning encourages pupils to use "hands-on" and "mind-on" in the exploration and elaboration process. In the exploration process, they develop their observation and manipulation skills, manipulate one variable, and observe its effect on other variables to gain factual knowledge. It can be done directly (offline) and/or electronically (online). At the same time, in the elaboration process, pupils can collaborate, communicate, and discuss to find concepts (mind on), find solutions to research problems, or find project designs. They can record exploration activities with video and observe them together in class, both in conventional (offline) and virtual (online) classes.

Teachers' decision on whether the proportion of inquiry activities is greater offline or online depends on the school's readiness, including the teachers' basic competence. It is necessary to provide a guide or manual for e-inquiry learning that can be applied both online and offline.

E-Learning Achievement Based on the Ministry of Education and Culture in 2020 Guidelines

Interview results revealed that most of the teachers, while teaching science subjects do not use inquiry approach. As a result, pupils are less enthusiastic about online learning. This lack of enthusiasm for learning is also caused by a lack of variety in learning activities. One pupil stated that;

Teachers mostly use WhatsApp (WA), which begins with the teacher sending a video via WA to observe students, then they continue to answer written tests.

Banjarbaru Elementary School mostly uses WhatsApp as a means of the online teaching and learning process. Even though WhatsApp was created only as a communication medium and is not set up for distance learning classes or online learning, there are still many shortcomings in implementing online learning, making learning less meaningful (Fauzi & Khusuma, 2020). Primary school teachers in Banjarbaru who only use WhatsApp as an online learning tool find it difficult to apply inquiry approach when teaching science because they use it only for chat without utilizing video call and record as well as other facilitation. Anugrahana (2020) found that as many as 100% of

teachers at a school in Yogyakarta used WA facilities where teachers created WhatsApp groups so that all pupils could be involved in groups.

The finding showed when teaching science online, pupils feel happy learning science even though they are not face-to-face with the teacher. A supervisor for the Banjarbaru Elementary School in South Kalimantan stated that;

The target schools have conducted online science learning while still applying inquiry approach and 25% of teachers are able to apply online inquiry so that pupils find their own concepts. Learning is carried out using WA, Google classroom, and zoom meetings and gives the effect that pupils are happy to learn science. This success is due to the support of parents, as most of the parents have accompanied their children to learn online.

Ganesha et al (2021) reported that online learning at Mekar Elementary School was successfully implemented so that third-grade elementary school pupils became enthusiastic about participating in learning and the implementation of learning through zoom meetings. It can be inferred that teachers and educational institutions are striving to follow the Ministry of Education and Culture Guidelines while keeping in mind the resources and teachers' competency constraints.

The Obstacle in Implementing E-Inquiry Learning at the Primary Level

Investigation skills are very important in science learning (Bahar & Aksut, 2020; Yıldız-Feyzioğlu & Demirci, 2021) because it is part of the skills of 21st-century learners. They can access information from one corner of the world in a short time and interpret information from their own perspective by finding out through digital learning resources (Kaçar & Balım, 2021). Through online inquiry learning, students can explore information needed in various form on the internet to answer the question about natural phenomena.

Interview results indicated that the main challenges facing online science teaching were the limited time for implementation, lack of an inquiry learning guide for e-learning, limited ICT Facilities, and the poor digital literacy of teachers. This is in line with the results of Saglam and Şahin (2017) who moreover noted that teachers had a negative opinion about the application of inquiry in science learning. This occurs as a result of a lack of inquiry experience in the past, crowded classrooms, and pupils' non-awareness of science process skills. Inquiry-based science learning requires more time, preparation and expertise from the teacher than traditional teaching. It is accordingly necessary to support school principals and supervisors in creating a culture of inquiry in science learning in primary schools.

In response to a question regarding obstacles to learning e-inquiry learning, a trainer asserted that;

First of all, most schools do not have complete experimental tools and materials and do not have electronic learning tools. Secondly, network constraints and signal strength. Schools in cities have no problem with signal strength, but this is a problem for schools in remote villages. The third is the problem of teacher skills in using technology. Not all teachers are skilled at using technology in learning. Most of them teach only conventionally, so it really hinders the implementation of e-learning.

One of the solutions offered is a policy that encourages digital schools. Digital schools are the fulfilment of ICT facilities and the skills of teachers and principals in using ICT to help pupils more easily achieve competencies, especially critical thinking competencies. Besides that, the principal needs to develop policies to support teachers and students in implementing a culture of using ICT in the inquiry learning process to develop reasoning power in elementary-level learning. To translate the policy into action, it is needed monitoring the implementation and evaluation to see the effect of the policy implementation on students' achievement.

Another obstacle raised by the respondents is linked with homework. A parent stated that,

In the teaching process, homework that assignments to students is not in accordance with e-inquiry learning. The homework contains more questions to test knowledge than questions to develop investigation skills. During online learning sessions, assignments to students are not varied and only through WhatsApp.
Moreover, another parent reported that,

During online learning sessions, we faced many issues regarding connectivity based on poor Internet connections and the high cost associated with them.

Indonesia has many regions that do not yet have a stable internet network, and internet speed is still slow. Access to online learning requires fast internet and high RAM. If the internet is low, it results in sound loss, delayed images, and difficulty entering online classes (Cahyadi & Widyastuti, 2022). However, only a few pupils experienced internet problems in the current study as Banjarbaru is a city with easy internet network access.

Conclusion and Implications

Most primary school teachers in Banjarbaru have not applied inquiry-based methods in science learning because teachers do not yet understand how to develop an online inquiry model learning scenario. Another cause is the mindset of the teachers, principals, and supervisors that the learning objective is based on content of curriculum and not competency-based achievement. Most teachers use e-learning for science but do not apply inquiry approach. The most frequently used platform is WA, which has less variety of learning activities, and most pupils feel bored studying science. Learning activities vary, some involving experiments, platforms also varying, including WhatsApp, Google Classroom, and Zoom Meeting, so that pupils feel happy to study science. Obstacles in implementing e-inquiry learning included teachers who focused on more contents of curriculum than competencies achievement, lack of skills in using ICT, lack of support for ICT facilities, lack of an e-learning inquiry learning guide, and limited time.

This study suggests a need for a guide or manual for the application of e-inquiry learning in science subjects for primary school teachers, local government policies that encourage digital schools are needed, and there is a need for school policies to support teachers and students in implementing the culture of using ICT in inquiry learning. Constraints in applying inquiry-based science can be overcome if principals, supervisor and trainer assist teachers with coaching approach in designing e-inquiry science learning to achieve students' competencies.

Acknowledgments

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