Ingénierie des Systèmes d'Information
Vol. 29, No. 1, February, 2024, pp. 219-233
Journal homepage: http://iieta.org/journals/isi

Evaluating the Impact of Smart Learning-Based Inquiry on Enhancing Digital Literacy and Critical Thinking Skills

Arnelia Dwi Yasa[1,2], Sri Rahayu[3*], Supriyono Koes Handayanto[4], Ratna Ekawati[1]

[1] Primary Education Department, Universitas Negeri Malang, Malang 65145, Indonesia
[2] Elementary School Teacher Education Department, Universitas PGRI Kanjuruhan, Malang 65148, Indonesia
[3] Chemistry Department, Universitas Negeri Malang, Malang 65145, Indonesia
[4] Physics Department, Universitas Negeri Malang, Malang 65145, Indonesia

Corresponding Author Email: sri.rahayu.fmipa@um.ac.id

https://doi.org/10.18280/isi.290122

Received: 8 December 2023
Revised: 9 January 2024
Accepted: 23 January 2024
Available online: 27 February 2024

Keywords:
21st-century skills, critical thinking, digital literacy, educational technology, inquiry-based learning, smart learning-based inquiry (SLBI)

ABSTRACT

The erosion of essential competencies required for the development of digital literacy and critical thinking skills in the 21st century-attributable to factors such as underutilization of the internet for educational purposes, students' limited abilities in digital operations, information gathering, communication, collaboration, and a deficiency in critical analysis or selection of information-necessitates innovative educational strategies. The smart learning-based inquiry (SLBI) strategy, an advancement from traditional inquiry methods, aims to deepen understanding of learning concepts and problem-solving through digital technology application. This research evaluated the efficacy of the SLBI strategy in augmenting students' digital literacy and critical thinking abilities. Employing a quasi-experimental design with pretest-posttest control groups, the study utilized critical thinking tests and digital literacy questionnaires for data collection. Instrument validity was assessed using the Karl Pearson moment product test formula, yielding r values ranging from 0.465 to 0.724 for the test instrument and 0.556 to 0.945 for the questionnaire. Reliability was verified through Cronbach's alpha, with r values of 0.945 for the test instrument and 0.805 for the questionnaire. Descriptive and inferential statistical analyses were conducted to ascertain the strategy's effectiveness post-implementation. Results indicated that the SLBI strategy, encompassing six stages (orientation, conceptualization, investigation, designing digital reports, reflection, and publishing), significantly improved digital literacy (effect size 2.548, categorized as large) and critical thinking skills (effect size 1.504, also categorized as large) relative to traditional inquiry learning methods. These findings suggest that educators should consider incorporating SLBI strategies to enhance learning outcomes. Furthermore, the research opens avenues for future studies to explore the applicability of SLBI in fostering other competencies such as creative thinking, communicative skills, and learning motivation.

1. INTRODUCTION

The 21st century has seen advances in educational technology. One of the advances felt is the implementation of digital-based learning strategies. Smart learning strategies have penetrated the world of elementary school-level children's education. A smart learning strategy is learning that utilizes information and communication technology during learning so that students have a more interactive learning experience [1]. This strategy is modified according to the demands of children's development, namely an interactive learning process through discovery activities. Modifying the strategy brings something new in the form of the SLBI strategy. The SLBI strategy is a learning strategy that is in congruence with constructivism, connectivism, and reflective learning theories, which provides holistic learning so that students understand concepts and overcome problems through the use of digital technology. This strategy has a broad direction, namely understanding concepts, ways of thinking, problem solving, and digitalization capabilities. So, it is very relevant to the needs for developing 21st century skills, such as critical thinking skills and digital literacy [2, 3].

Critical thinking skills are students' skills in thinking, analyzing, evaluating, and making decisions based on the information they obtain. By thinking critically, students can select and evaluate digital information sources. Through digital literacy, students can assess the credibility of the information sources they use. These two skills are interrelated in helping individuals make intelligent decisions and manage information effectively. Thus, critical thinking skills and digital literacy are two aspects that are related to each other.

Good digital literacy skills enable students to implement their critical thinking in solving problems and making decisions based on digital information [4, 5]. Although many efforts have been made to improve students' digital literacy skills, most previous research tends to ignore the improvement

of critical thinking skills in the context of digital literacy. Previous research confirms that digital literacy is related to students' critical thinking skills [6–8]. Therefore, it is essential for students not only to understand digital technology but also to be able to think critically when evaluating information in the ever-growing digital era [9, 10]. This is caused by the abundance of digital information that can be accessed freely by students, so they must be able to select and analyze information critically [11]. Thus, developing students' digital literacy and critical thinking skills is a must to support students' skills in the 21st century.

The maximum development of critical thinking skills and digital literacy will support students' future careers. The theory put forward by expert states that a person's career is determined by their way of thinking and ability to read phenomena that occur in the environment [12]. A person's career depends on the efforts they make, such as understanding, knowledge, and skills, because these things will have an impact on a person's personal value. The inherent positive value becomes personal branding for students.

They will be known for their skills according to the times. This branding leads to a view of students' professionalism as an influence on their skills. Students who are known to have critical thinking skills and digital literacy have wider opportunities to extend their education to the next level [13]. With these achievements, students have special seats as scholarship recipients or occupy superior classes in their class. Several elementary schools have special programs so that students who have critical thinking skills and digital literacy have the opportunity to take part in competitions, both at local and international levels. In other words, developing critical thinking skills and digital literacy opens a new window for students to achieve brilliant careers at the next level of education and be known as professional students with opportunities to participate in wider local and international competitions.

Furthermore, curriculum demands for learning at the elementary school level have developed to include digital literacy and critical thinking as important skills that students need to master [2, 14, 15]. The curriculum at the elementary school level emphasizes developing digital literacy by teaching students how to use software and hardware, understanding online etiquette, and training them to identify and manage information effectively.

Inquiry-based learning strategies have been widely proposed by researchers to be implemented in natural sciences learning, which allows students to understand a topic through a process of investigation [16–18]. The concept of inquiry-based learning emerged from the views of Dewey [19], who argued that learning should be a constructive and active process where students learn through real actions. However, these strategies are often implemented separately to improve digital literacy and critical thinking skills. Otherwise, the inquiry strategy requires a long time to understand the concept, which is one of its weaknesses. This can reduce student motivation for learning. Apart from that, students experience difficulty gathering information to solve problems [20–23].

SLBI is considered suitable for inquiry-based learning and the need to improve critical thinking skills and digital literacy. SLBI is a strategy developed from an inquiry strategy that utilizes information and communication technology (ICT) and aims to enrich the understanding of learning concepts and improve the learning process. By utilizing technology, smart learning helps students experience a learning experience that is more interactive, adaptive, and can be accessed flexibly [1]. The implementation of the SLBI strategy uses smartphones to access electronic learning platforms (e-learning). Through smartphones, students can develop critical thinking skills to determine the accuracy of information they encounter on the internet.

The SLBI strategy has six stages, namely orientation, conceptualization, investigation, design of a digital report, reflection, and publishing. With the implementation of the strategy, it is hoped that students can integrate learning concepts with real life and think critically when solving problems with the help of digital technology. Apart from that, the strategy also focuses on improving student digital literacy and critical thinking skills. In this research, the SLBI strategy was applied to natural science (IPA) learning in the sixth grade of elementary school. The choice of science as a research subject was due to the demand for students to understand scientific concepts, methods, and ways of thinking.

The sixth grade in elementary school was chosen because they have characteristics that are not found in other classes. In practice in the field, sixth grade is a high class and experiences a transition period from the low class to the high class group. Students at high grade levels are included in the concrete operational stage [24]. This stage is characterized by high curiosity, boredom when faced with abstract learning conditions, understanding the rules, sincere sympathy, having principles, and being independent. The characteristics of six-grade children are in accordance with the content and purpose of using SLBI, which leads to increased understanding and ways of thinking through technology. Sixth grade students have a better level of introspection when operating technology in learning. They already know the function of technology for various things, including learning media. This is different from the lower class because they only know technology as a tool for playing. Therefore, the SLBI strategy is relevant and very suitable to be implemented in science learning.

At the elementary school level, science learning is taught in an integrated thematic manner, providing a holistic understanding for students. In the context of the globalization theme, there are science concepts related to the role of electricity, energy saving, alternative energy, and renewable energy. It is essential to understand these concepts because they can provide elaboration about energy savings and the use of alternative energy sources to meet future electricity needs. As a result, we need an SLBI strategy that includes learning requirements for constructivism, connectivism, and reflection, along with digital literacy and critical thinking.

Several previous studies have highlighted things that are almost the same as this research. For example, research highlights smart learning as a new approach to increasing students' information literacy [25]. Also, research that investigates the digital literacy skills of elementary school students [26].

Then, research was conducted on students' digital literacy skills that can be improved by applying various approaches, such as digital storytelling with mobile devices [27], the method proposed by Andresen, deterministic input, the noisy and gate (G-DINA) model [28], and inquiry-based approaches [29]. Previous research has noted many efforts made by researchers to improve student digital literacy. However, researchers generally have not paid sufficient attention to the development of critical thinking skills in the context of digital literacy. Yampap and Bay's research explored information about elementary school students' critical thinking skills. The

results of their study indicate the low critical thinking skills of students in Indonesia. Previous researchers proposed increasing students' digital literacy through various approaches, such as the inquiry approach and the problem-based quantum learning model [21, 22, 24]. Unfortunately, these studies have not considered digital literacy skills that contribute to improving elementary school students' critical thinking skills.

Previous research used research that was different from this research (quantitative research), such as the use of bibliometric analysis, development research with teachers and students as subjects, qualitative research, and library research. In this study, the use of a quasi-experimental design with a pretest-posttest control group has not been carried out by previous researchers with the same research topic. The use of this design was chosen so that changes in results between the experimental and control groups could be known so that the impact, causes, and consequences of the intervention could be estimated. The use of a control group also helps avoid threats of bias to internal validity by ensuring the two groups are comparable on baseline data and follow the same procedures. After that, including a pretest improves the design's ability to find effects, helps to look at differences between groups at the start, and allows studying the intervention's effects at different pretest sublevels.

The use of test instruments was chosen as a suitable tool for measuring critical thinking skills, while questionnaire instruments were suitable for measuring digital literacy. As per Ennis' theory, test instruments are developed according to indicators of critical thinking skills because students need instruments that not only measure cognitive abilities of memorization and understanding but can also train their thinking abilities [30]. Next, digital literacy is measured using a questionnaire. The measurement tool was determined because digital literacy is a construct variable that cannot be measured. Digital literacy measurement uses a hierarchical model with two levels of latent variables and a repetition approach to measure both constructs. Digital literacy measurements are divided into three categories, namely high, medium, and low. Therefore, the use of questionnaires is considered the most appropriate for collecting digital literacy data.

Therefore, this research aims to exercise the effectiveness of the smart learning-based inquiry strategy to improve students' digital literacy and critical thinking skills. From this aim, the formulation of this study problem could be justified, namely, is the smart learning-based inquiry strategy effective in improving students' digital literacy and critical thinking skills? The aim and formulation of the problem clearly lead to the hypothesis or provisional conjecture in this research, namely: students who study with the smart learning-based inquiry strategy have better digital literacy and critical thinking skills than students who study with conventional strategies.

This research contributes to the development of elementary school-level learning. Teachers can consider appropriate methods for students to improve digital literacy and critical thinking skills. Next, for future researchers, the theory written in this research can be used as a reference if they want to conduct research on a similar topic. Future researchers can modify newer strategies for digital literacy and critical thinking skills or test existing strategies against other skills such as creative thinking, communication, learning motivation, and so on.

2. THEORETICAL STUDIES

The literature review in this research is divided into several parts. The initial section discusses SLBI strategies in general. Then, discussion of literature about critical thinking skills, digital literacy skills, and the relationship between SLBI strategies, critical thinking skills, and digital literacy skills.

2.1 Smart learning-based inquiry strategies

The term "smart" in the SLBI strategy is taken from the words "smart pedagogy." Smart learning is learning that utilizes ICT during the learning process with a learning experience that is more interactive, adaptive, and can be accessed flexibly [1]. The implementation of learning with the SLBI strategy uses smartphones to access electronic learning platforms (e-learning). The SLBI strategy learning design is considered a potential solution in this case. This strategy is expected to provide holistic learning that allows students to understand concepts and overcome problems by utilizing digital technology. Furthermore, the SLBI strategy has six stages, which include: orientation, conceptualization, investigation, design of a digital report, reflection, and publishing.

The SLBI strategy learning process emphasizes learning patterns that direct students to think more critically and digest abstract things into concrete ones based on their experience of knowledge. The SLBI strategy has advantages that other strategies do not have. For example, the SLBI strategy facilitates students mastering an activity by repeating it so that it becomes enjoyable for them. Apart from that, the SLBI strategy also provides meaning to students, so that students' motivation to learn grows. This concept is the impact of integrating inquiry strategies into smart learning.

In theory, the inquiry strategy has the advantage of allowing students to gain learning experience so that they can construct new knowledge learned during the learning process [31]. Apart from that, the inquiry learning strategy is a collection of learning activities that involve systematically investigating, criticizing, and analyzing concepts or findings so that students can compile their findings independently and confidently. The benefits of inquiry learning for students are easier understanding of concepts and ideas, maximum use of memory and transfer of knowledge, and more developed critical thinking skills.

According to this theory, inquiry integrated with smart learning strategies is the right alternative for maximizing students' critical thinking skills and digital literacy. Smart learning strategies can maximize digital literacy, and inquiry strategies can maximize students' critical thinking skills. The advantages or strengths of the SLBI strategy are not found in other strategies. The SLBI strategy has complete and comprehensive strength in the form of linking information technology-based learning, which is linked to discovery-based learning. In the end, a more modern learning stage will be obtained without leaving behind constructive learning for students. The combination of these two strategies becomes a new concept on how to improve students' critical thinking skills and digital literacy through one effective strategy, namely SLBI.

2.2 Critical thinking

Critical thinking is an intelligence that every human being

possesses to carry out reasonable reflective thinking in making decisions [32]. The critical thinking theory used is the theory developed by Ennis [33]. This theory provides a strong basis for measuring and understanding critical thinking skills. This theory emphasizes the essential role of logical and rational thinking in the decision-making process. Decision-making is based on what is believed. By referring to Ennis' theory, measuring critical thinking skills is used to identify and measure the extent to which someone has good critical thinking skills. Critical thinking skills are grouped into five categories: elementary clarification, basic support, inference, advanced clarification, strategy, and tactics [34-36].

The level of students' critical thinking skills is determined based on their stage of development. Elementary school students aged 6–12 years are at the concrete operational stage of development [24]. At this stage, children can think logically with concrete objects, not just memorized concepts. Elementary students can be trained to think critically when formulating questions, answering questions, reporting observation results, drawing conclusions, and thinking about alternative answers [3].

Based on the results of studies from several previous studies, there are five critical thinking indicators used to examine elementary school students' critical thinking skills. There are five indicators of critical thinking, including elementary clarification, basic decision-making, inference, explaining conclusions, and reviewing. The five indicators of elementary students' critical thinking skills are depicted in Table 1. Elementary students can only think critically with five indicators because the development of their critical thinking skills is in line with the stage of children's cognitive development. At this stage, they are limited in their abstract thinking and are more likely to focus on concrete things. Their experience and knowledge are also still limited because they are still in the process of learning and exploring. However, it is important to remember that the development of critical thinking is an ongoing process that can be enhanced through appropriate guidance and learning as students gain age and experience.

Table 1. Critical thinking skills of elementary school students [37]

Critical Thinking Skills	Indicators
Performing basic classification	a. Formulating questions b. Identifying facts and data provided c. Identifying the relevance and irrelevance of information
Looking for the basis for decisions	a. Using science concepts b. Using logical reasoning (procedure) c. Conducting research
Drawing a conclusion	a. Concluding for solutions b. Providing alternative answers
Elaborating conclusions	a. Explaining the meaning of the conclusion b. Explain terms used in conclusions
Reviewing	a. Reviewing/checking completion b. Adjusting solutions to questions

Based on Table 1, this research adopts indicators according to the theory developed by Ennis. The indicators determined are performing basic classification, looking for the basis for decisions, drawing a conclusion, elaborating conclusions, and reviewing. These indicators are criteria for measuring critical thinking skills. The measuring instrument used is a test instrument. Test instruments are suitable for measuring critical thinking skills because test instruments are a form of training in solving problems by prioritizing critical thinking.

2.3 Digital literacy

In 21st-century learning, students need to develop digital literacy skills because digital literacy has a key role in strengthening collaboration skills, social interaction, and information access [5, 38]. Digital literacy is considered one of the eight skills necessary for lifelong learning [39]. Digital literacy skills are grouped into six aspects, namely information and data literacy; communication and collaboration; digital content creation; safety; problem solving; and career-related competencies [40-42].

The literacy skills of elementary school students in Indonesia are currently limited to collecting information on the Internet [38]. Data about the low level of digital literacy skills in Indonesia was also obtained from the results of the 2018 Program for International Student Assessment (PISA) survey. From these results, children's literacy skills in Indonesia are the lowest compared to abilities in other fields (mathematics and science) [43]. The literacy ability score obtained only reached 371 points, which means it is 116 points behind the average score of other countries, namely a score of 487. This shows that, along with developments in science and technology, reading ability continues to lag behind other countries, resulting in low ability. reading results in low interest in reading for students.

Table 2. Framework of digital literacy dimensions

Dimensions	Descriptions	Indicators
Technical dimension	Skills in using digital devices (smartboard, earphones/smartphone headsets, laptops).	Accessing
	Storing, sending, and downloading information.	Managing
	Solving technical problems.	Creating
Cognitive dimension	Thinking critically in searching and evaluating information	Evaluating
	Selecting the software used to complete task.	Integrating
Social-emotional dimension	Collaborating by utilizing digital media.	Collaborating
	Communicating in written and spoken language using digital media.	Communicating

Elementary students have the highest digital literacy skills in terms of accessing information on the Internet, while skills for creating digital information products experience slower development [17]. Students' digital literacy skills are grouped into three dimensions of digital literacy, which include technical, cognitive, and social-emotional [44]. The technical dimension includes students' procedural skills in operating and using basic digital devices. The cognitive dimension relates to students' skills in searching for information, evaluating information, and selecting appropriate software for the task at hand. In this dimension, students are also expected to have an understanding of ethics and morals in the use of information [45]. The social-emotional dimension relates to students' skills

in using the internet to communicate, learn, and interact socially. Based on the three dimensions of digital literacy, there are seven indicators used to measure students' digital literacy, which include accessing, managing, creating, evaluating, integrating, collaborating, and communicating [46]. A framework for digital literacy dimensions can be found in Table 2.

2.4 Development of SLBI strategies for critical thinking skills and digital literacy

The development of SLBI strategies is based on constructivism, connectivism, and reflective learning theories [19]. Based on constructivist theory, students can construct or build their knowledge [47]. In the SLBI strategy, students can think critically to select the information used in constructing knowledge. The knowledge construction stage can be accomplished by giving problems through problem statements or questions and answers between the teacher and students. When students are given a problem, they become motivated and curious about the problem. The SLBI strategy facilitates students accessing information technology through available tools.

Apart from that, according to constructivism theory, SLBI also facilitates the development of students' procedural knowledge by accessing, managing, and evaluating information digitally. SLBI facilitates students to carry out experiments by collecting data or experimental evidence in order to obtain correct interpretation results. This activity is packaged in a new stage in the form of an investigation into the SLBI strategy.

Constructivism theory is also related to building new things by designing the results of research activities. In the SLBI strategy, there is a stage in the form of designing a digital report that represents the theory. The draft research results will be created in digital form. Thus, constructivism theory produces orientation steps as a development of constructivism theory, which is similar to the stages of critical thinking skills and digital literacy.

Table 3. Formulation of SLBI learning strategy constructs

Stages of Critical Thinking Skills	Literasi Digital Stages of Digital Literacy Skills	Construct of Mapping Skill Result for Developing SLBI Strategy	Step Development of SLBI Strategy Learning	Underlying Theories
Asking for an explanation or answering challenges	• Accessing	• Fostering motivation, curiosity, and attracting interest. • Providing problems through problem statements.	*Orientation*	Piaget's Constructivism Theory
Asking for an explanation or answering challenges	• Managing • Collaborating	• Training students to manage digital information. • Asking students to conduct critical discussions. • Formulating research questions and predictions.	*Conceptualization*	Piaget's Constructivism Theory Vygotsky's Constructivism theory
Observing and considering the results of observations	• Accessing • managing • integrating • evaluating • Integrating • Collaborating	• Building procedural knowledge by accessing, managing, integrating, and evaluating digital information. • Conducting experiments. • Collecting data/evidence of experimental results. • Interpreting data. • Practicing critical thinking to find the basis for decisions in determining conclusions.	*Investigation*	Connectivism Theory Vygotsky's Constructivism Theory
Looking for the basis for decisions	• Evaluating • Collaborating • Creating	• Selecting software for creating digital reports of research results. • Practicing critical thinking skills to determine the content included in the digital report. • Designing research results in a digital form.	*Design a digital report*	Vygotsky's Constructivism Theory
Making deductions	• Evaluating • Collaborating • Creating	• Critically evaluating the digital report that has been created. • Improving digital reports based on evaluation results.	*Reflection*	Dewey's Theory of Reflective Thinking
Making deductions	• Communicating • Collaborating	• Uploading digital reports on social media (Instagram)	*Publishing*	Vygotsky's Theory of Constructivism Cognitivism Theory Connectivism Theory

In line with connectivism theory, learning in schools also requires interaction with various online resources, collaboration with other people, and exploration through extensive information networks. Therefore, during learning

activities, students can explore information in detail and widely by utilizing digital technology. Collaboration and interaction through digital technology are also needed by students to improve their digital literacy skills and critical thinking in receiving the information obtained. This is because students must be able to respond to technological developments and adjust to changes in the complexity of information in the digital era.

In accordance with connectivism theory, the SLBI strategy includes a collaboration process carried out by uploading the results of digital reports on social media. This process also includes delivery to the public. The stage in question is publishing as a derivative of connectivism theory.

The development of SLBI strategies is also based on reflective theory, in which students can interpret, reflect, and form meanings based on various perspectives [19]. This can help students and teachers reflect on learning activities. From this theory, the SLBI strategy raises a reflection stage as part of interpreting the results obtained. The interpretation process is packaged at the stage of critically evaluating the results of the digital report that has been created and improving the evaluation results.

Based on these three theories, the syntax of the SLBI learning strategy is obtained. The SLBI strategy includes: orientation, conceptualization, investigation, design of a digital report, reflection, and publication. The formulation of the SLBI strategy construct, along with the syntax, is delineated in Table 3.

3. RESEARCH METHODS

This research used a quasi-experimental design with a pretest-posttest control group. Quasi-experimental research is research that tries to show the relationship between dependent and independent variables randomly [48]. Meanwhile, the pretest-posttest control group design is defined as a research design consisting of two groups, a control group and an experimental group, that are selected randomly. The two groups were then given a pretest to determine the initial condition and whether there were any differences between the experimental group and the control group. Good pretest results occur if the scores of the experimental group and the control group are not significantly different.

This research has two groups, namely the experimental class and the control class. The experimental class was given treatment, namely the application of the SLBI strategy to the learning process, while the learning process in the control class was not given special treatment. This means that the learning process in the control class is carried out as usual. Before the learning process, in the control class and experimental class, the dependent variable was measured by the students' initial abilities by means of a pre-test. After that, the learning process in the control class continued as usual. Meanwhile, the experimental class was given treatment, namely the implementation of the SLBI strategy. After completing the treatment, the dependent variables (critical thinking skills and digital literacy) in the control and experimental classes were measured again (post-test).

3.1 Participants

This research was conducted at an elementary school located in Malang, Indonesia. The number of participants selected was 110 students with diverse socio-economic backgrounds. Participants in this research were also spread across several areas, including the Sukun sub-district and the Lowokwaru sub-district. In detail, there were 54 female students and 56 male students who participated in the research.

Participants in this quasi-experimental study were sixth-grade elementary school students. Two classes were randomly selected as the experimental group (N = 53), while the other two classes became the control group (N = 57).

3.2 Data collection and instruments research

Research instruments for developing SLBI learning strategies were divided into two types: test instruments and non-test instruments. The test instrument, consisting of 20 multiple-choice questions, was developed to measure students' critical thinking skills. The multiple-choice questions contain material about energy savings and the use of alternative energy sources. The second instrument was a digital literacy instrument in the form of a questionnaire with 10 statements.

The test instrument developed was aimed at measuring students' critical thinking skills. The number of questions was 20 multiple-choice questions. By referring to Ennis' theory, measuring critical thinking skills was used to identify and measure the extent to which someone had good critical thinking skills. Critical thinking skills were grouped into five skills, namely performing basic classification, looking for the basis for decisions, drawing a conclusion, elaborating conclusions, and reviewing [49, 50]. However, the level of students' critical thinking skills was determined based on their stage of development. Elementary school students aged 6–12 years were at the concrete operational stage of development [51]. At this stage, children can think logically with concrete objects, not just memorized concepts. Elementary students can be trained to think critically when formulating questions, answering questions, reporting observation results, drawing conclusions, and thinking about alternative answers [3].

Before being used, the instrument went through a validity and reliability testing process. The validity test in this research uses the product moment correlation formula from Karl Person, while the reliability test uses the Cronbach's alpha formula. The validity test results displayed that the calculated r-value ranged between 0.465 and 0.724. Meanwhile, the r-table value was 0.444, indicating that the instrument can be categorized as valid. Apart from that, the results of the reliability test displayed that the calculated r-value was in the range of 0.556 to 0.945, so the instrument is said to be reliable. Thus, this instrument can be considered valid and reliable so that it can be used in research.

The digital literacy research instrument was adapted from Ng [52]. The modifications made were in the form of simplifying indicators to suit the abilities and conditions of elementary school students in Indonesia. For example, the use of digital media, the detailed aspects of each indicator, and the habits of elementary school students. The instrument was tested on a small scale to test the attributes used. Students' digital literacy skills were tested using a questionnaire instrument. The questionnaire used is a closed type of questionnaire. A closed questionnaire is referred to as a questionnaire in which there are alternative answers that the respondent can choose from. The questionnaire used is a statement type. Respondents can provide answers in the form of a checklist or check selected points. In this research, researchers carried out several stages in preparing the

questionnaire.

In the first stage, plan the data sources and respondents. Researchers determined elementary school students in Malang as the data source. After that, the researcher wrote down the things that would be asked. The questions asked are in accordance with the indicators of digital literacy skills as displayed in Table 4.

Table 4. The dimensions of digital literacy

	Technical
1	I have skills in using digital devices.
2	I can solve technical problems.
3	I know the differences between some apps.
4	I can learn new apps easily.
5	I keep up with new technology.
6	I have good ICT skills.
	Cognitive
1	I can search for information by utilizing digital devices to complete assignments.
2	I can select information on the internet that is appropriate for the task.
	Social-Emotional
1	I can communicate with friends at school through digital apps to complete assignments.
2	Digital apps help me to collaborate with friends in completing school assignments.

Next, the researcher determines the order according to what will be asked. Preparing the questionnaire begins with creating a grid that matches the indicators so that the direction is clear. From this grid, it is rearranged into a questionnaire sheet. There are 10 questionnaire statements. The number of statements has been adjusted to the specified digital literacy indicators. Researchers also determine the scoring format. The scoring dimension was a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4= agree, and 5=strongly agree). After being sure of the questions and questionnaire format used, the researcher positioned himself as an interviewer, measuring whether the questions were good and appropriate or not. After everything was completely prepared, the researcher tested the questionnaire instrument prepared on respondents outside the sample. The results of the field test were analyzed first by calculating the readability of each statement made. Then, the researcher calculated the validity and reliability of the questionnaire instrument.

Before being used, the questionnaire went through a validity and reliability testing process. The validity test results showed that the calculated r value ranged from 0.556 to 0.945. Meanwhile, the r table value was 0.444, indicating that the questionnaire met the valid criteria. Apart from that, the reliability test results produced a value of 0.805, indicating that the instrument was reliable. Thus, the questionnaires can be used as research instruments in this research.

3.3 Data analysis

Digital literacy and critical thinking skills were used as indicators to assess the effectiveness of SLBI learning strategies. The correlation between the experiences students have and the accomplishments they make demonstrates the strategy's effectiveness. The impact of the SLBI strategy can be seen in changes in students' digital literacy and critical thinking skills after the strategy's implementation.

Quantitative data was analyzed by calculating the t test. This test is carried out after the prerequisite tests (linearity test, normality test, and homogeneity test) have been fulfilled. The normality test is an assessment to determine the distribution of research data (normal or not). Kolmogorov-Smirnov, with the help of the SPSS application, was used to test normality. The Kolmogorov-Smirnov test functions as a goodness-of-fit test. In the special case of normality testing, the research sample is standardized and compared with a standard normal distribution.

Homogeneity testing is used to decide whether several population variants are the same or not. This test is a prerequisite for independent sample t test analysis. The formula used to test homogeneity in this research is the Levene test. Levene's test is used to test whether k samples come from a population with the same variance.

The normality test results from the digital literacy skills questionnaire instrument have a significance value of more than 0.05, or normal distribution. Then, the linearity test value of the digital literacy skills questionnaire instrument reached $0.772 > 0.05$. This means that there is a linear relationship between the pretest and posttest scores. The homogeneity test results reached a significance value (Sig.) of $0.068 > 0.05$ and (posttest) $0.122 > 0.05$. This means that the variance of experimental class data and control class data is homogeneous.

Furthermore, the normality test results of the critical thinking skills test instrument reached a significance value (Sig.) < 0.05, or the data was normally distributed. Furthermore, the linearity test results reached the Sig value. The deviation from linearity is $0.443>0.05$, or there is a linear relationship between pretest and posttest scores. Then, the homogeneity test results reached a significance value (Sig.) based on a mean (pretest) of 0.866 and a mean (posttest) of 0.356. This means that the data variance meets the homogeneous criteria.

Statistical data analysis was accomplished with the help of IBM SPSS Statistics 21 software. In this research, to determine the differences between two groups of data, a T test was carried out. The T test is an inferential statistical test method used to determine whether there is a significant difference between the averages of two groups of data. The T test also displays the amount of influence an independent variable has on other dependent variables, assuming the variables are constant. The choice of the T test was due to several reasons: (1) the samples taken in this study were random from the same population; (2) the data being compared only consists of two groups (control and experimental groups); (3) the data is independent; (4) the data has a normal distribution; and (5) the amount of variance in the t-test is homogeneous. After completing the t-test in this research, the next step was to carry out additional analysis with the effect size test. The effect size test was used to measure how big the effect or difference was between two groups or treatments in a study.

Table 5. Classification of effect size

Value d	Effect Size
$0,8 \leq d \leq 2,0$	High
$0,5 \leq d \leq 0,8$	Medium
$0,2 \leq d \leq 0,5$	Low

Grouping the effect size calculation results into large, medium, and small effect groups refers to the Gravetter and Wallnau criteria. The classification of effect size calculation results using Cohen's formula is interpreted in Table 5.

4. RESULTS

This research produced several findings, which are explained in several subsections.

4.1 Implementation of SLBI learning strategies

The implementation of the SLBI learning strategy was carried out by following the pretest-posttest control group design research design with a treatment duration of 6 meetings (each meeting lasted 4 JP @ 35 minutes) concerning the SLBI learning strategy lesson plan. The learning was carried out using a model-based LMS. The initial appearance of the LMS in Indonesian is depicted in Figure 1.

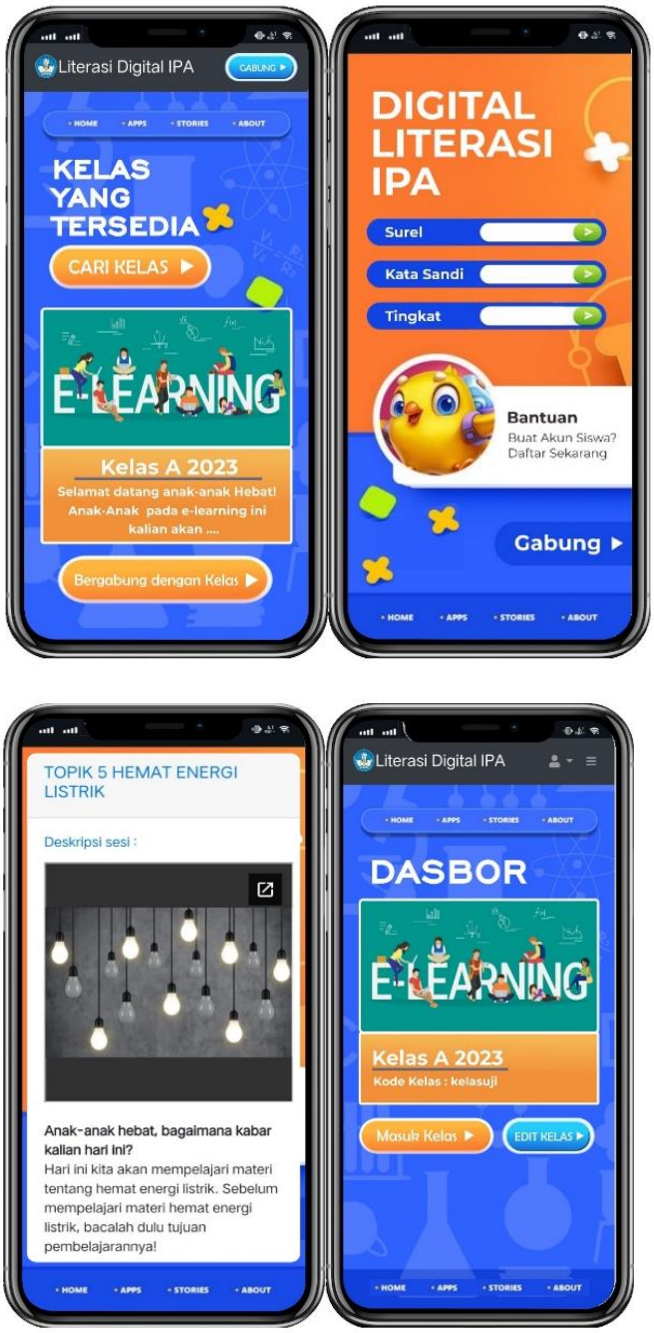

Figure 1. The initial appearance of the LMS in Indonesian

The implementation of learning using the SLBI strategy began with the orientation phase. In the orientation phase, students' prior knowledge was connected with new information. Students needed to build their own knowledge by understanding concepts. At this stage, the teacher motivated students by providing problem statements related to the topic of globalization. This problem statement was presented on the online learning platform (LMS), according to the image in Figure 2.

Figure 2. The orientation phase

During the implementation of SLI learning strategies, students had difficulty solving problem statements given by the teacher. Then, the teacher instructed students to understand and analyze the problem statements given. Next, the teacher asked students to gather information to solve the problem statement in the conceptualization phase.

In the conceptualization phase, students could think critically to select the information used in constructing knowledge. Students could practice developing new knowledge. The new knowledge obtained by students was related to the various problem statements given. Critical discussions could form the basis for decisions in formulating hypotheses. At this stage, students were able to access information in the form of videos contained in the LMS. The LMS display is in Figure 3.

If the information available in the LMS was not sufficient, students had the option to search for additional information via websites such as https://www.google.com/ and https://www.yahoo.com/. This was done so that students could obtain more information related to the subject matter being studied. Before using the information found on the internet, students were expected to evaluate the credibility of the information source.

Critical thinking skills are very important for students to assess the credibility of information sources before using them to solve problems. During the implementation, students were still confused and asked a lot of questions regarding how to collect information. At this stage, the teacher provided instructions regarding how to collect information. Apart from that, teachers should also provide technical explanations regarding how to collect information so that they do not spend

a lot of time explaining it. This was done so that the minimum possible explanation was given regarding the technicalities of using the LMS.

Figure 3. The conceptualization phase

At the investigation stage, students discussed with friends (online or offline) how to carry out investigations and exchange information. Collaborative knowledge construction could lead to a more comprehensive understanding of topics, improved problem-solving skills, and increased motivation and engagement. This can provide an opportunity for individuals to learn from others with different experiences. At this stage, students experimented to prove the truth of the information obtained. Students and their groups prepared tools and materials to conduct experiments. While conducting experiments, students thought critically to solve problems. Critical thinking skills have an important role in solving problems because they help students to analyze problems objectively and logically, make the right decisions, avoid mistakes, increase creativity, and improve problem-solving abilities. Teachers facilitated students in carrying out experimental activities by directing students to collect information using digital devices so that they could assist in investigative activities. The final stage in this phase was that students made conclusions based on the results of the experiment. During limited testing, offline discussions went quite well when carrying out investigations. However, online discussions did not take place because students were more focused on their experimental activities. As a corrective step, representatives from each group were directed to hold online discussions to discuss the findings during the investigation. The LMS display in this phase is in Figure 4.

In digital report design, students could create the results of their experiments in a digital report format. Students could use simple software to create digital reports, which also allowed students to do critical thinking in determining the material to be included in the digital report design. During the process of designing a digital report, the teacher accompanied and guided students to complete the digital report. During the field trial, the teacher gave a long technical explanation because students were still confused about the content that should be included in the digital report. One way to overcome this problem was by playing video examples of research results for students. After seeing the examples of learning practice videos, students had a better understanding of the digital report format they should use, so they could reduce long technical explanations during field trials. The LMS displayed in the digital report design phase is in Figure 5.

Figure 4. The investigation phases

Figure 5. The design of digital report

Figure 6. The reflection phases

Figure 7. The publishing phases

Next, in the reflection stage, students received guidance from the teacher to assess the suitability of the digital report. Students evaluated the digital report content critically and made improvements based on the results of the evaluation. Apart from that, at the reflection stage, students presented their digital report to other groups to get input that could help them improve the quality of the digital report. Reflection was not a process that simply sorted ideas, but rather a step that referred to previous ideas to determine the next step. This stage had been successfully implemented in limited trials and extensive trials. The reflection phase is displayed in Figure 6.

During the publishing phase, students had the opportunity to upload their digital reports to social media platforms, such as Instagram. This provided students with the opportunity to publish their digital reports online. Through this approach, social interaction made a significant contribution to the development of students' thinking. Initially, students were given guidance on publishing their digital report, but after that, they were expected to be able to do it independently. In field trials, this stage could be carried out well. The display of this phase is in Figure 7.

4.2 Results of testing the effectiveness of SLB learning strategies on digital literacy skills

The results of the SLBI learning strategy effectiveness test were obtained from the quantitative test of the SLBI strategy on digital literacy skills. Quantitative tests were carried out using IBM SPSS 21. Data analysis for digital literacy and critical thinking skills used the t-test by carrying out prerequisite tests first, namely normality tests, linearity tests, and homogeneity tests.

The normality testing process is carried out in several stages: (1) determining the hypothesis; (2) determining the test statistics used; (3) testing the data with the Kolmogorov-Smirnov formula with the help of SPSS; (4) observing the plot pattern of the results obtained from SPSS; (5) interpreting the results; and (6) summarizing the research results descriptively. Similar tests were also carried out when testing the homogeneity of research data. The process followed is the same. The difference is in the test formula used. In the SPSS application, homogeneity testing is carried out using the Levene test formula.

Based on statistical tests related to digital literacy, the significance value (Sig.) was > 0.05, or the research data was normally distributed. Apart from the data having to be normal, the data was required to be linear. Then, the results of the linearity test reveal the Sig value. The deviation from linearity is 0.772 > 0.05. So, it can be concluded that there was a linear relationship between the pretest and posttest scores.

Next, a homogeneity test was carried out with the help of the IBM SPSS version 21 program. The homogeneity test results showed that the significance value (Sig.) based on the mean (pretest) was 0.068 > 0.05 and (posttest) 0.122 > 0.05. This means that the variance of experimental class data and control class data was homogeneous. The experimental class and control class data did not meet the criteria of normal, linear, and homogeneous, so the analysis could be continued using the t-test. The results of the t-test are presented in Table 6.

Based on the SPSS output, the Sig. (2-tailed) 0.000 < 0.05. From these values, it can be indicated that there was a significant difference between digital literacy skills in the experimental and control classes. To determine how effective the SLBI learning strategy was, further analysis was carried out using Cohen's effect size which is presented in Table 7.

Table 7 shows that the effect size value was 2.548 in the large category. In both classes (experimental and control), adequate average and standard deviation values were obtained so that the effect size test results obtained large results. This means that the SLBI strategy had great effectiveness in developing digital literacy skills. The magnitude of the effect size obtained on digital literacy skills indicates that the SLBI strategy has a big impact on learning. This impact is in the form of increasing students' average scores when studying with the SLBI strategy.

Table 6. The t-test results (digital literacy skills)

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Results	Equal variances assumed	2.434	.122	13.415	108	.000	9.21682	.68703	7.85500	10.57863
	Equal variances not assumed			13.289	97.482	.000	9.21682	.69356	7.84038	10.59325

Table 7. The effect size test results

Class	N	Mean	Standard Deviation	Cohen's	Effect Size
The experimental class	53	42.3396	4.05701	2.548	High
The control class	57	33.1228	3.11718		

Table 8. T-test results (critical thinking skills)

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Results	Equal variances assumed	.861	.356	4.332	108	.000	6.897	1.592	3.741	10.053
	Equal variances not assumed			4.349	107.862	.000	6.897	1.586	3.753	10.040

Table 9. The results of the effect size test

Class	N	Mean	Standard Deviation	Cohen'ds	Effect Size
The experimental class	53	71.8432	14.34008	1.504	Strong Effect
The control class	57	45.0752	20.67558		

4.3 Results of testing the effectiveness of SLB learning strategies on critical thinking skills

The results of the t-test on critical thinking skills were also carried out. Quantitative analysis was carried out using IBM SPSS Statistics 21 software. Critical thinking skills data analysis used the t-test, with prerequisites in the form of a normality test, a linearity test, and a homogeneity test.

Based on the output results from SPSS software, it can be concluded that the significance value (Sig.) < 0.05 or the data was normally distributed. In addition to checking the normality of the data, it was also important to evaluate the linear relationship between the independent variable and the dependent variable. The linearity test was used to assess the form of relationship between the independent variable and the dependent variable. The linearity test results showed that the sig. Deviation from linearity was 0.443>0.05, which indicated there was a linear relationship between pretest and posttest scores. Next, the prerequisite test carried out was the homogeneity test. The results of the homogeneity test found a significance value (Sig.) based on a mean (pretest) of 0.866 and a mean (posttest) of 0.356, both of which were greater than 0.05. Therefore, it can be concluded that the data variance met the homogeneous criteria. The data met the requirements for normality, linearity, and homogeneity, so it was continued with analysis using the t-test. SPSS t-test data on critical thinking skills is shown in Table 8.

Table 8 shows that the SPSS output results obtained a Sig value. (2-tailed) 0.000<0.05. Therefore, it can be said that there was a significant difference between critical thinking skills in the experimental and control classes. These figures indicated that the alternative hypothesis was accepted, with the conclusion that the use of SLBI learning strategies affected students' critical thinking skills. Apart from that, there was a difference in the mean scores of the experimental and control classes. The mean score for the experimental class was 84.53, and the control class was 77.63. To measure how effective the SLBI learning strategy was, additional analysis was carried out using Cohen's effect size, as shown in Table 9.

Table 9 shows that the average value and standard deviation in the two classes produced different values, and the effect value was found to reach 1.504, which can be categorized as large. A significant difference can be seen in the mean value between the experimental class and the control class, with a difference of 26,768. The difference in data shows that the average achievement of the experimental class was much better than that of the control class. So, it can be said that the SLBI strategy was effective in improving students' critical thinking skills. The effect size value obtained reflects the strong impact of implementing the SLBI strategy on students' critical thinking skills. This impact is not just the average score obtained but also the skills of each indicator of students' critical thinking skills specifically.

In general, the results of this study indicate that the SLBI strategy can effectively improve digital literacy and critical thinking skills with a strong effect size. Both of them produced

findings that students who studied in the experimental group with the SLBI strategy felt better in digital literacy or critical thinking than students who studied in the control group with conventional strategies.

In this research, research limitations were found in the form of sample areas, which were only in two regions. These limitations may mean that these findings cannot be generalized outside the area of this study. Another reason is that there are geographical, cultural, and other differences that influence the conditions of students in each region.

5. DISCUSSION

The research results showed that the SLBI strategy was effective in improving digital literacy skills. These findings had strong reasons. According to the definition, the SLBI strategy is a strategy that can train students to be skilled in using digital devices, such as storing, sending, and downloading information, as well as solving problems. Students were also taught to think critically when searching for and evaluating information, choosing appropriate software to complete assignments, communicating both written and verbally through digital media, and collaborating by utilizing digital technology [53]. They could search for reliable information and evaluate this information to solve various problems [54].

The results of this research are in line with previous findings, which show that the LS-based smart teaching model can increase students' digital literacy [55]. The development of this model can also improve the quality of educators' pedagogical competence in teaching and be able to form creative innovations for educators, which can directly impact improving the quality of learning in the classroom. Also, other research states that smart learning is effective in increasing students' cognitive literacy compared to conventional models [56]. Similar findings indicate that the smart learning environment has a significant influence on student information literacy. The development of students' information literacy is getting better after using a smart learning environment [57]. The results of this research are also supported by previous researchers who concluded that the use of digital-based devices was proven to produce digital literacy skill scores in the medium group [58], and most students' skills were at the elementary and intermediate level [59].

Students had good digital literacy in line with the digital technology used. With SLBI, students had a chance to learn to use digital technology wisely, access accurate information, and adapt to ever-changing technological developments [60]. The increase in students' digital literacy was caused by SLBI strategy steps that helped them search for information on the internet, select and save relevant information, create digital reports, and publish digital reports on social media. This shows that the SLBI strategy was effective in increasing students' digital literacy. Apart from that, other factors that caused an increase in digital literacy skills include active use of online media, academic achievement, the role of parents or family in reading intensity, and digital literacy skills [61].

The SLBI strategy was also effective in improving students' critical thinking skills. The SLBI strategy was effective in developing students' critical thinking skills, which included skills such as asking questions, responding to explanations or challenges, making observations and considering the results of observations, finding the basis for decisions, and making deductions to reach the right conclusions. During the investigation stage, students could apply their critical thinking skills to solve problems, identify solutions to the problems faced, and summarize the results found. At this stage, students were also able to link different concepts to overcome the challenges they faced.

Critical thinking is an important skill for facing problems and making good decisions [62, 63]. Someone is said to have critical thinking skills if they can analyze information carefully, identify the assumptions underlying arguments, consider various points of view, make decisions based on logic, and overcome bias in their thinking [64, 65]. The use of technology as part of smart learning also contributes to maximizing students' critical thinking skills. As found by previous researchers, the use of technology in education can improve students' critical and creative thinking skills through project- and discovery-based learning [66].

Smart learning supported students' critical improvement because there were many demands that students had to fulfill. This finding is in line with previous research, which states that smart learning is able to critically increase students' knowledge [67]. Other findings support the results of this research, which states that learning designs that use smart technologies based on inquiry learning can improve critical thinking skills in early-age students [68, 69].

In line with the ongoing process, students were asked to carry out a series of investigations regularly. This series was part of the inquiry steps as an integral part of the SLBI strategy. Based on research, investigative activities supported students' critical thinking processes because there were commands that had to be carried out to achieve a goal [70]. In addition, inquiry strategies have also been proven to improve students' critical thinking skills. This strategy focused on students' active role in the learning process, allowing them to independently build their own knowledge from the problems given. Therefore, the SLBI strategy was able to significantly improve students' critical thinking skills.

6. CONCLUSIONS

Based on the results of the research, it can be concluded that the SLBI learning strategy has proven effective in improving students' digital literacy and critical thinking skills in elementary school. The effectiveness of the SLBI strategy is in line with each stage implemented, namely: (1) orientation, (2) conceptualization, (3) investigation, (4) design of a digital report, (5) reflection, and (6) publishing. Every SLBI's steps accommodate increasing digital literacy and critical thinking skills. Integrating smart learning strategies with inquiry is in line with the process of acquiring critical thinking. Inquiry has stages of finding something new, either in the form of solving a problem or an idea. The discovery process requires critical thinking patterns. Likewise, smart learning strategies relate to technology-based learning. This learning aims at students' ability to manage digital-based information. This process is part of literacy. Therefore, the SLBI strategy is effective for improving critical thinking skills and digital literacy.

Practically, the findings of this research can be used as a reference for teachers to consider effective learning methods to improve students' critical thinking skills and digital literacy. Teachers should accept challenges for the sake of educational progress by using modern learning strategies that are in line with current technological developments, such as smart

learning. Teachers can consider integrating this strategy into an independent curriculum in accordance with the curriculum currently being implemented.

Further researchers are suggested to apply the SLBI strategy to various learning topics such as electricity, magnetism, and alternative energy. The researchers hope that future researchers can also apply the SLBI strategy to other elementary school learning topics. In addition, teachers need to make preparations, learning plans, facilities, and infrastructure that can support learning activities to implement the SLBI strategy so that it runs optimally.

Then, taking into account the limitations of this research, the researcher recommends that future researchers test a similar strategy with a wider population area and sample size so that the results obtained can be widely generalized. Research similar to strategy development can also be carried out by future researchers to improve 21st-century skills. For example, testing project-based smart learning strategies on students' problem-solving and critical thinking skills. Also, the strategies can be adapted for different learning environments or age groups. Future researchers are advised to use a similar strategy on samples with a higher level (high school or university students).

ACKNOWLEDGMENT

The author would like to thank Universitas Negeri Malang which has provided complete facilities in the research process and to the research participants who have collaborated in data collection until the end of the research.

REFERENCES

[1] Chen, X., Zou, D., Xie, H., Wang, F.L. (2021). Past, present, and future of smart learning: A topic-based bibliometric analysis. International Journal of Educational Technology in Higher Education, 18: 1-29. https://doi.org/10.1186/s41239-020-00239-6

[2] Kong, S.C. (2014). Developing information literacy and critical thinking skills through domain knowledge learning in digital classrooms: An experience of practicing flipped classroom strategy. Computers & Education, 78: 160-173. https://doi.org/10.1016/j.compedu.2014.05.009

[3] Prayitno, L.L., Sulistyawatii, I., Wardani, I.S. (2016). Profil kemampuan berpikir kritis siswa sd di kecamatan bulak. Jurnal Pendidikan Dasar Nusantara, 1(2): 67-74.

[4] Yana, A.U., Koes-H, S., Taufiq, A., Kusairi, S. (2022). Online-based assessment of students' conceptual understanding of energy and momentum using quizizz. Journal of Physics: Conference Series, 2392(1): 012011. https://doi.org/10.1088/1742-6596/2392/1/012011

[5] Zhong, Z. (2011). From access to usage: The divide of self-reported digital skills among adolescents. Computers & Education, 56(3): 736-746. https://doi.org/10.1016/j.compedu.2010.10.016

[6] Hague, C.P., Sarah. (2011). Digital literacy across the curriculum. Education, Computer Science.

[7] Ramadhan, G.M.J.C. (2021). Pengaruh kompetensi literasi digital mahasiswa PGSD dalam memanfaatkan Google Apps terhadap perilaku conten evaluation [The influence of PGSD students' digital literacy competencies in using Google Apps on content evaluation behavior]. COLLASE (Creative of Learning Students Elementary Education), 4(6): 958-967. https://doi.org/10.22460/collase.v4i6.9727

[8] Harjono, H.S. (2018). Literasi digital: Prospek dan implikasinya dalam pembelajaran bahasa [Digital literacy: Prospects and implications in language learning]. J Pena: Jurnal Pendidikan Bahasa Dan Sastra, 8(1): 1-7.

[9] Cha, S.E., Jun, S.J., Kwon, D.Y., Kim, H.S., Kim, S.B., Kim, J.M., Kim, Y.A., Han, S.G., Seo, S.S., Jun, W.C., Kim, H.C., Lee, L.G. (2011). Measuring achievement of ICT competency for students in Korea. Computers Educational Leadership, 56(4): 990-1002. https://doi.org/10.1016/j.compedu.2010.11.003

[10] Savage, M. (2015). Digital Literacy for Primary Teachers. Critical Publishing.

[11] Metzger, M.J., Flanagin, A.J. (2013). Credibility and trust of information in online environments: The use of cognitive heuristics. Journal of Pragmatics, 59: 210-220. https://doi.org/10.1016/j.pragma.2013.07.012

[12] Savickas, M.L. (2020). Career construction theory and counseling model. Career Development and Counseling: Putting Theory and Research to Work.

[13] Anisimova, E. (2020). Digital literacy of future preschool teachers. Journal of Social Studies Education Research, 11(1), 230-253.

[14] Voogt, J., Erstad, O., Dede, C., Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. Journal of Computer Assisted Learning, 29(5): 403-413. https://doi.org/10.1111/jcal.12029

[15] Yildirim, S. (2000). Effects of an educational computing course on preservice and inservice teachers: A discussion and analysis of attitudes and use. Journal of Research on Computing in Education, 32(4): 479-495. https://doi.org/10.1080/08886504.2000.10782293

[16] Ekawati, R., Setiawan, A., Wulan, A.R., Rusdiana, D. (2019). The use of classroom assessment based on multi-representation ability in Mechanics concept. Journal of Physics: Conference Series, 1157(3): 032061. https://doi.org/10.1088/1742-6596/1157/3/032061

[17] Lazonder, A. W., Walraven, A., Gijlers, H., Janssen, N. (2020). Longitudinal assessment of digital literacy in children: Findings from a large Dutch single-school study. Computers & Education, 143: 103681. https://doi.org/10.1016/j.compedu.2019.103681

[18] Levy, P., Petrulis, R.J.S. (2012). How do first-year university students experience inquiry and research, and what are the implications for the practice of inquiry-based learning? Studies in Higher Education, 37(1): 85-101. https://doi.org/10.1080/03075079.2010.499166

[19] Dewey, J. (1997). How We Think. Courier Corporation.

[20] Ahaddin, M.A., Jatmiko, B., Supardi, Z.A.I. (2020). The improvement of critical thinking skills of primary school students through guided inquiry learning models with integrated peer instructions. Studies in Learning and Teaching, 1(2): 104-111. https://doi.org/10.46627/silet.v1i2.39

[21] Duran, M., Dokme, I. (2016). The effect of the inquiry-based learning approach on student's critical-thinking skills. Eurasia Journal of Mathematics Science and Technology Education, 12(12): 2887-2908. http://doi.org/10.12973/eurasia.2016.02311a

[22] Koes-H, S., Yuenyong, C., Sutaphan, S., Somprach, K.,

Sranamkam, T. (2021). Developing the lesson plan of the manufacturing fish drying STEM Education. Journal of Physics: Conference Series, 1835(1): 012048. https://doi.org/10.1088/1742-6596/1835/1/012048
[23] Kusuma, E.D., Gunarhadi, G., Riyadi, R. (2018). The strategies to improve critical thinking skills through problem-based quantum learning model at primary school. International Journal of Multicultural and Multireligious Understanding, 5(4): 123-127. http://dx.doi.org/10.18415/ijmmu.v5i4.213
[24] Syahgiah, L., ZAN, A.M., Asrizal, A. (2023). Effects of inquiry learning on students' science process skills and critical thinking: A meta-analysis. Journal of Innovative Physics Teaching, 1(1): 16-28. https://doi.org/10.24036/jipt/vol1-iss1/9
[25] Chen, X., Zou, D., Xie, H., Wang, F.L. (2021). Past, present, and future of smart learning: A topic-based bibliometric analysis. International Journal of Educational Technology in Higher Education: 18: 1-29. https://doi.org/10.1186/s41239-020-00239-6
[26] Promrub, S., Sanrattana, W. (2022). Online program to empower teacher learning to develop students' digital literacy skills. Education Quarterly Reviews, 5(2): 469-483. https://doi.org/10.31014/aior.1993.05.02.506
[27] Churchill, N. (2020). Development of students' digital literacy skills through digital storytelling with mobile devices. Educational Media International, 57(3): 271-284. https://doi.org/10.1080/09523987.2020.1833680
[28] Liang, Q., Jimmy Law, N. (2021). Do background characteristics matter in Children's mastery of digital literacy? A cognitive diagnosis model analysis. Computers in Human Behavior, 122(1): 106850. https://doi.org/10.1016/j.chb.2021.106850
[29] Liu, C.B., Bano, M., Zowghi, D., Kearney, M. (2021). Analysing user reviews of inquiry-based learning apps in science education. Computers & Education, 164: 104119. https://doi.org/10.1016/j.compedu.2020.104119
[30] Vincent-Lancrin, S. (2023). Fostering and assessing student critical thinking: From theory to teaching practice. European Journal of Education, 58(3): 354-368. https://doi.org/10.1111/ejed.12569
[31] Yasa, A.D., Rahayu, S. (2023). A survey of elementary school students' digital literacy skills in science learning. AIP Conference Proceedings, 2569(1): 060015. https://doi.org/10.1063/5.0113483
[32] Gardner, H. (2021). Disciplined Mind: What All Students Should Understand. Simon & Schuster.
[33] Ennis, R.H. (1985). A logical basis for measuring critical thinking skills. Educational Leadership, 43(2): 44-48.
[34] Jonassen, D.H., Carr, C., Hsiu-Ping, Y. (1998). Computers as mindtools for engaging learners in critical thinking. TechTrends-Washington DC, 43(2): 24-32.
[35] Sayari, K.T. (2023). Digital mapping as a tool for the development of critical thinking skills in digital education. In Perspectives on Enhancing Learning Experience Through Digital Strategy in Higher Education, 241-261. https://doi.org/10.4018/978-1-6684-8282-7.ch011
[36] Assingkily, M.S., Putro, K.Z. (2020). Children learn about god SWT (Studying god with primary children 6-12 years). AIUA Journal of Islamic Education, 2(1): 11-26.
[37] Seruni, R., Munawaroh, S., Kurniadewi, F., Nurjayadi, M. (2020). Implementation of e-module flip PDF professional to improve students' critical thinking skills through problem based learning. Journal of Physics: Conference Series, 1521(4): 042085. https://doi.org/10.1088/1742-6596/1521/4/042085
[38] Putri, S.D., Ulhusna, M., Zakirman, Z., Gusta, W. (2020). Improvement of student science literacy skills through edmodobased teaching materials in learning science in elementary school. International Journal of Scientific & Technology Research (IJSTR), 9(3): 4649-4652.
[39] Hoskins, B. (2008). The discourse of social justice within European education policy developments: The example of key competences and indicator development towards assuring the continuation of democracy. European Educational Research Journal, 7(3): 319-330. https://doi.org/10.2304/eerj.2008.7.3.319
[40] Jongsermtrakoon, S., Nasongkhla, J. (2015). A group investigation learning system for open educational resources to enhance student teachers' digital literacy and awareness in information ethics. International Journal of Information Education Technology, 5(10): 783-788. https://doi.org/10.7763/IJIET.2015.V5.611
[41] Phuapan, P., Viriyavejakul, C., Pimdee, P. (2016). An analysis of digital literacy skills among Thai University seniors. International Journal of Emerging Technologies in Learning, 11(3): 24-31. http://dx.doi.org/10.3991/ijet.v11i03.5301
[42] Bravo, M.C.M., Chalezquer, C.S., Serrano-Puche, J. (2021). Meta-framework of digital literacy: A comparative analysis of 21st-century skills frameworks. Revista Latina de Comunicacion Social, 79: 76-109. https://doi.org/10.4185/RLCS-2021-1508
[43] OECD. (2018). Program for international student assessment (PISA) Result from PISA 2018. https://www.oecd.org/pisa/publications/pisa-2018-results.htm.
[44] Park, H., Kim, H.S., Park, H.W. (2020). A scientometric study of digital literacy, ICT literacy, information literacy, and media literacy. Journal of Data and Information Science, 6(2): 116-138. https://doi.org/10.2478/jdis-2021-0001
[45] Eshet, Y. (2004). Digital literacy: A conceptual framework for survival skills in the digital era. Journal of Educational Multimedia and Hypermedia, 13(1): 93-106.
[46] Nurhayati, E., Rizaldi, D.R., Fatimah, Z. (2020). The correlation of digital literation and STEM integration to improve indonesian students' skills in 21st century. Online Submission, 1(2): 73-80. https://doi.org/10.46966/ijae.v1i2.36
[47] Sasan, J.M., Rabillas, A.R. (2022). Enhancing English proficiency for Filipinos through a multimedia approach based on constructivist learning theory: A review. Science and Education, 3(8): 45-58.
[48] Siedlecki, S.L. (2020). Quasi-experimental research designs. Clinical Nurse Specialist, 34(5): 198-202. https://doi.org/10.1097/NUR.0000000000000540
[49] Maknuna, J. (2019). The development of critical thinking skills in vocational high school students in Indonesia. Development, 7(12): 237-258.
[50] Fijar, N.A., Saptono, S. (2019). Implementation of guided inquiry learning to improve the critical thinking skills of junior high school students. Journal of Innovative Science Education, 8(3): 306-314. https://doi.org/10.15294/jise.v8i1.30216
[51] Lumentut, Y., Lengkoan, F. (2021). The relationships of

psycholinguistics in acquisition and language learning. Journal of English Culture, Language, Literature and Education, 9(1): 17-29. https://doi.org/10.53682/eclue.v9i1.1894
[52] Ng, W. (2012). Can we teach digital natives digital literacy? Computers & Education, 59(3): 1065-1078. https://doi.org/10.1016/j.compedu.2012.04.016
[53] Kammerer, Y., Amann, D.G., Gerjets, P. (2015). When adults without university education search the Internet for health information: The roles of Internet-specific epistemic beliefs and a source evaluation intervention. Computers in Human Behavior, 48: 297-309. https://doi.org/10.1016/j.chb.2015.01.045
[54] Raes, A., Schellens, T., De Wever, B., Vanderhoven, E. (2012). Scaffolding information problem solving in web-based collaborative inquiry learning. Computers & Education, 59(1): 82-94. https://doi.org/10.1016/j.compedu.2011.11.010
[55] Bahri, A., Arifin, A.N., Bin Jamaluddin, A., Muharni, A., Hidayat, W. (2023). Smart teaching based on lesson study promoting stundent's digital literacy in the rural area. European Journal of Educational Research, 12(2): 901-911. https://doi.org/10.12973/eu-jer.12.2.901
[56] Sastradika, D., Defrianti, D. (2019). Optimizing inquiry-based learning activity in improving students' scientific literacy skillsP Publishing. Journal of Physics: Conference Series, 1233(1): 012061. https://doi.org/10.1088/1742-6596/1233/1/012061
[57] Shi, Y., Peng, F., Sun, F. (2022). A blended learning model based on smart learning environment to improve college students' information literacy. IEEE Access, 10, 89485–89498.
[58] Yasa, A.D., Rahayu, S. (2023). A survey of elementary school students' digital literacy skills in science learning. AIP Conference Proceedings, 2569(1): 060015. https://doi.org/10.1063/5.0113483
[59] Putri, P.A.W., Rahayu, S., Widarti, H.R., Yahmin, Y. (2022). Chemistry students' digital literacy skills on thermochemistry context "hydrogen fuel issue." Eurasia Journal of Mathematics, Science and Technology Education, 18(2): em2198. https://doi.org/10.29333/ejmste/12699
[60] Baterna, H.B., Mina, T.D.G., Rogayan Jr, D.V. (2020). Digital literacy of STEM senior high school students: basis for enhancement program. International Journal of Technology in Education, 3(2): 105-117.
[61] Williams, A., Bangun, C.S., Shino, Y. (2022). The urgency of digital literacy in Indonesia on COVID-19 pandemic. Startupreneur Business Digital (SABDA Journal), 1(2): 183-190. https://doi.org/10.33050/sabda.v1i2.143
[62] Carlgren, T.J.I. (2013). Communication, critical thinking, problem solving: A suggested course for all high school students in the 21st century. Interchange, 44(1-2): 63-81. https://doi.org/10.1007/s10780-013-9197-8
[63] Irwanto, Saputro, A.D., Rohaeti, E., Prodjosantoso, A. (2018). Promoting critical thinking and problem solving skills of pre-service elementary teachers through process-oriented guided-inquiry learning (POGIL). International Journal of Instruction, 11(4): 777-794.
[64] Cunliffe, A.L. (2016). Republication of "On becoming a critically reflexive practitioner." Journal of Management Education, 40(6): 747-768. https://doi.org/10.1177/1052562916674465
[65] Rahayu, S., Setyosari, P., Hidayat, A., Kuswandi, D. (2022). The effectiveness of creative problem solving-flipped classroom for enhancing students' creative thinking skills of online physics educational learning. Jurnal Pendidikan IPA Indonesia, 11(4): 649-656. https://doi.org/10.15294/jpii.v11i4.39709
[66] Tharakan, J. (2020). Using educational technology to enhance creative and critical thinking skills through open ended design projects. Journal of Engineering Education Transformations, 33: 225-232.
[67] Nguyen, L.T., Kanjug, I., Lowatcharin, G., Manakul, T., Poonpon, K., Sarakorn, W., Tuamsuk, K. (2022). How teachers manage their classroom in the digital learning environment–experiences from the University Smart Learning Project. Heliyon, 8(10): e10817. https://doi.org/10.1016/j.heliyon.2022.e10817
[68] Ma, S., Spector, J.M., Liu, D., Bhagat, K.K., Tiruneh, D., Mancini, J., Kinshuk. (2022). Smart learning in support of critical thinking: Lessons learned and a theoretically and research-based framework. In: Albert, M.V., Lin, L., Spector, M.J., Dunn, L.S. (eds) Bridging Human Intelligence and Artificial Intelligence. Educational Communications and Technology: Issues and Innovations. Springer, Cham. https://doi.org/10.1007/978-3-030-84729-6_22
[69] Murthy, S., Iyer, S., Mavinkurve, M., Spector, M., Lockee, B., Childress, M. (2016). Pedagogical framework for developing thinking skills using smart learning environments. In Learning, Design, and Technology: An International Compendium of Theory, Research, Practice, and Policy. https://doi.org/10.1007/978-3-319-17727-4_14-1
[70] Gunawan, G., Harjono, A., Hermansyah, H., Herayanti, L. (2019). Guided inquiry model through virtual laboratory to enhance students'science process skills on heat concept. Jurnal Cakrawala Pendidikan, 38(2): 259-268. http://dx.doi.org/10.21831/cp.v38i2.23345