SHL MODEL USED IN A MOODLE-BASED APPLICATION BRILIAN TO IMPROVE THE LEARNING OUTCOMES OF THE BASIC MATHEMATICS COURSE IN A UNIVERSITY

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ABSTRACT

Learning in the Fourth Industrial Revolution era, especially in mathematics, needs to equip students with life skills that can be used in the future such as critical thinking, problem-solving, literacy, collaboration, decision making, creative thinking, responsibility, and independent learning. This study aims to analyze the effectiveness of the Scientific Hybrid Learning model (SHL) in improving learning outcomes in Basic Mathematics courses. This research is a pre-experiment with a two group, pretest and posttest design. The research sample was 91 students divided into two groups: a control class and an experimental class. Before learning with the SHL Model, both classes were given a learning outcome test, and after learning was completed, the students were again given the same learning outcome test. The data collected were tested by descriptive analysis, normality test using Shapiro Wilk, Mann-Whitney U test, and normalized gain (n-gain) calculation. The results show that the SHL model applied to the Basic Mathematics course effectively improved student learning outcomes as indicated by an increase in learning outcomes that was statistically significant (α = 5%) and an average n-gain that was categorized as effective. In addition to these findings, we also found that learning outcomes related to critical thinking skills resulted in a higher increase (n-gain = 0.76) than literacy skills (n-gain = 0.33). This shows that using the SHL model in the Basic Mathematics course increases critical thinking skills.

Keywords: *SHL model, learning outcomes, critical thinking skills, basic mathematics*

INTRODUCTION

Generation 4.0, also known as Generation Z, is already familiar with electronic devices and gadgets. Electronic devices such as laptops, cell phones, and computers have become items that cannot be left out of the life of this generation. The familiarity of this generation with electronic devices can be used for learning (Hariadi et al., 2019). Data literacy and critical thinking skills are needed in a technology-based education; however, not all students have these two abilities (Wicaksono et al., 2017). In addition to data literacy skills, critical thinking skills also need to be learned in university. This needs to be done because many students do not have critical thinking skills or their skills are relatively low (Brookfield, 2017; Jatmiko, et al., 2018). Therefore, literacy skills are indispensable for the digital native generation. On the other hand, this digital generation also needs critical thinking skills (Hariadi, et al., 2021). Sumarmi et al. (2021) state that digital ecolearning can improve environmental literacy and pedagogical competence.

The current focus on learning mathematics is on conceptual understanding and the ability to provide proof rather than just applying mathematical rules without understanding the reasons (As'ari et al., 2017). To do this, critical thinking skills are needed. Thus, mathematics has a potential role in developing thinking, including critical thinking (Devlin, 2012). Facione (2011) found a way to determine whether a person can think critically. A person possesses critical thinking if they can interpret, analyze, evaluate, conclude, explain, and decide on a given problem. Someone with these six abilities can be said to have higher critical thinking skills than just interpreting, analyzing, and evaluating. Although every human can think critically, the main question is how mathematics learning can improve critical thinking skills (Widyatiningtyas et al., 2015).

In line with critical thinking skills, literacy skills can be improved through learning mathematics. Wijaya (2016) defines literacy skills as effectively accessing and evaluating information to be used and managed to solve problems. On the other hand, Oktiningrum et al. (2016) state that mathematical literacy should start with realistic situations that are categorized into context and content problems. The process begins by identifying a real problem and then formulating it based on the mathematical concepts and relationships inherent in the issue. After obtaining the appropriate mathematical form, the next step is to use specific mathematical procedures to obtain mathematical results and interpret them in light of the initial problem. Rafiepour Gatabi et al. (2012) state that literacy is an essential ability that every mathematics learner must possess, so mathematics learning is expected to improve literacy skills. These two abilities are interrelated because literacy skills affect critical thinking skills (Wikanengsih et al., 2020). Therefore, students can enhance their critical thinking skills by strengthening their literacy skills.

To support learning that utilizes technology to teach literacy and critical thinking skills, an appropriate learning model is needed, namely the Scientific hybrid learning model (SHL). The SHL model integrates the hybrid learning model with the problem-based learning model (Hariadi et al., 2018). Study results show that student learning outcomes with hybrid learning using the BRILIAN application were better when compared to student learning outcomes with conventional learning (Hariadi, 2015; Hariadi & Wurijanto, 2016).

Scientific learning is a learning model with a scientific approach in which scientific thinking steps are applied, from formulating problems, collecting data, and analyzing data to making conclusions (Hariadi et al., 2018). Hybrid learning is a learning model that combines face-to-face learning (synchronous offline) with online learning (synchronous online) (Hariadi et al., 2021). Hybrid learning is also often equated with blended learning, a learning model in which the learning content is combined with various media and learning resources to meet the learning needs of students (Watson, 2008).

The SHL model, which combines a scientific approach with online and offline presentations, is a learning model that can support literacy and critical thinking skills. Online learning has been proven to improve student learning outcomes (Tubagus et al., 2020). Furthermore, the research findings of Hariadi et al. (2022) show that hybrid learning can improve student learning outcomes at the high-level thinking level, which includes analyzing (C4), evaluating (C5), and creating (C6), where this high-level thinking process requires critical thinking and literacy skills. For the implementation of the SHL model, the Moodle Learning Management System (LMS) is used. Further, the LMS has been designed to address students' learning needs. Students can find teaching materials, analyze and discuss them with fellow students or lecturers, and present the results in the application (Hariadi et al., 2018). However, research still needs to be done to determine whether the SHL Model with the BRILIAN application can improve student learning outcomes. From the description above, this study aims to analyze the improvement of student learning outcomes through applying the SHL learning model with the BRILIAN application.

LITERATURE REVIEW

Literacy and Critical Thinking Skills

Literacy skills for students are essential, especially to solve scientific problems that require scientific solutions with proper literacy support. This is in accordance with the National Qualifications Framework of Indonesia (KKNI) in higher education, which requires universities to develop a curriculum so that students are competent with various skills that align with the demands of the 21st century and the Fourth Industrial Revolution, such as literacy skills, critical thinking skills, scientific creativity, and problem-solving skills (Erika et al., 2018; Griffin & Care, 2015; Jatmiko, et al., 2018; Sunarti et al., 2018).

Currently, improving students' data literacy and critical thinking skills through learning is a significant problem faced by the world of education today (Jatmiko et al., 2018; Krulik & Rudnick, 1996; Sunarti et al., 2018). Data literacy is the skill of reading, writing, and archiving data in everyday life (Hariadi et al., 2018). Learning it will broaden horizons and knowledge (Rogers & Gizaw, 2022) and make the brain work more optimally and enhance the ability to acquire and understand information from various sources (Kofol et al., 2022; Malaquias & Malaquias, 2021). In additiona, data literacy can help students think critically when making decisions (Fang et al., 2019). Thus there is a link between data literacy skills and critical thinking skills.

In addition to data literacy skills, critical thinking skills also need to be learning in university. This is important because many students do not have critical thinking skills (Brookfield, 2017; Jatmiko et al., 2018). Learning critical thinking skills, student will have a better ability to make decisions more quickly and accurately (Astuti et al., 2021; Suciati et al., 2022) and be able to analyze problems from various points of view (Hidayati & Sinaga, 2019). The development of critical thinking skills has been considered one of the most important goals of education for more than a century (Farowi et al., 2012; Geertsen, 2003).

Critical thinking skills usually involve an individual's ability to identify the central issues and assumptions in an argument, recognize meaningful relationships (Moon, 2007), make correct inferences from data, make conclusions from the information or data provided, and interpret whether the findings are based on the data provided (Mulnix, 2012). Furthermore, previous researchers explained that critical thinking skills are cognitive skills involving interpretation, analysis, evaluation, inference, explanation, and self-management in problem-solving (Bean, 2011; Cheong & Cheung, 2008; Mundilarto & Ismoyo, 2017; Siew & Mapeala, 2016). Previous research conducted by Aufa et al. (2021) stated that from the research data obtained, they found that the average critical thinking skill were still low. Thus to improve critical thinking skills in students, more training is needed.

SHL Models

The SHL model is a learning model that integrates hybrid learning with problem-based learning (Hariadi et al., 2018). The latest learning theories support the development of the Scientific Hybrid Learning model, such as constructivism, learning through observation, discovery learning, cognitive processes, metacognition, multirepresentation, and empirical foundations from current research. The SHL model refers to the characteristics of learning according to Arends (2012), namely: (1) logical theoretical rationale from the designer, (2) learning objectives to be achieved, (3) lecturer behavior in teaching, which is needed so that learning can be carried out, and (4) a supportive learning environment to achieve learning objectives.

The application of the SHL model in learning includes five phases as follows:

Phase I: Internt of Things and Big Data-based orientation

This phase aims to attract students' interest, focus their attention, and motivate them to play an active role in the learning process. In this phase, the BRILIAN application plays an important role in the success of Phases 2, 3, 4, and 5 because the ability of lecturers to use the BRILIAN application will facilitate classroom management.

Phase 2: Investigating

Phase 2 aims to collect information with the help of Student Activity Sheets (LKM). In this phase, the lecturer guides the students to carry out step-by-step investigations using the BRILIAN application and look for explanations and solutions to build data literacy and critical thinking skills through scientific inquiry activities.

Phase 3: Analysing

This phase aims to guide students in making analyses, conclusions, and discussions of the investigation results. Data literacy and critical thinking skills will be developed in this phase. Students are encouraged to optimize their analysis of data from investigation results as material to answer problems in Phase 2.

Phase 4: Presenting

The purpose of this phase is to assist students in making conclusions and discussing the results of investigations in various representations, as well as assisting and guiding students in planning, preparing, and presenting their work. Presentations are conducted offline and online (hybrid learning), where the presentation is based on the Internet of Things and Big Data. Students' data literacy and critical thinking skills will be improved in this phase because students are encouraged to optimize their analysis of investigative data to answer problems in Phase 3.

Phase 5: Evaluating

This phase aims to evaluate the problem-solving process of investigations and processes based on the Internet of Things and Big Data. Then, lecturers review students' work as evidence of learning and facilitate follow-up learning through the provision of structured assignments using the BRILIAN application.

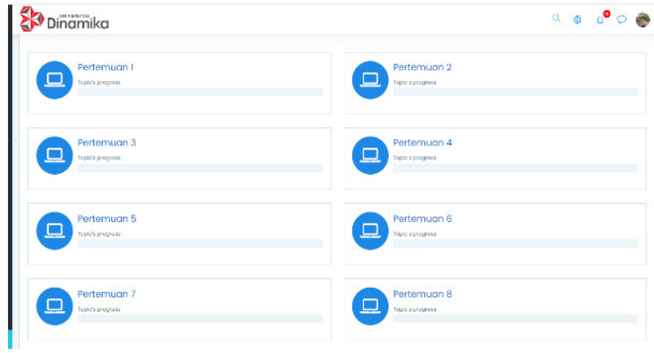
BRILIAN Application with Moodle

The BRILIAN application is a hybrid learning LMS that Universitas Dinamika has developed since 2014. This application has undergone several modifications. Initially, this application was built by optimizing Google Apps for Education (Gafe) (Hariadi et al., 2019; Tim-Brilian, 2015). The last

Figure 1.
Initial Display of Basic Mathematics Courses on the BRILIAN Application

version of the BRILIAN application is based on Moodle. The figures below show the interface of BRILIAN.

Figure 2.
Display of the Basic Mathematics Course Material Menu on the BRILIAN Application



SHL can be integrated with this BRILIAN application because both rely on hybrid learning. SHL, by using the Internt of Things, is perfect for collaborating with the BRILIAN application to further maximize the utilization of both. By using digital technology in BRILIAN, along with Moodle, it is hoped that BRILIAN can improve learning outcomes as well as students' critical thinking skills.

Basic Mathematics Course

The Basic Mathematics course aims to familiarize students with using correct logic to solve problems in everyday life and business. This is in line with Surya et al. (2017), who stated that Mathematics is one of the essential supporting sciences in everyday life and in supporting the progress of science and technology.

In general, the order of learning materials in the Basic Mathematics course is arranged according to a specific topic. Thus, a student must learn particular topics before proceeding to the next one (Surya et al., 2013). In this Basic Mathematics course, more emphasis is placed on solving problems in the business world using basic mathematics. Critical thinking skills and literacy skills are the two abilities we targeted in this study to be achieved in basic mathematics courses through the SHL model .

There are five Course Learning Outcomes (CLOs) in the Basic Mathematics course, two of which are used to train critical thinking skills while

Table 1.
CLOs and Supported Capability Types

CLO Number	Description	Skills
1	Students solve daily or business issues using logic, sets, relations, and functions.	Literacy
2	Using their logic, the students can express their opinion rationally.	Critical Thinking
3	Students can solve issues in business using a linear function, quadratic function, and exponent function.	Critical Thinking
4	Students can give suggestions for optimizing a problem in business with matrices and linear programs.	Critical Thinking
5	Students can practice the rules of matrix and linear programs to optimize critical solutions in business.	Literacy

the other three are used to teach literacy skills (as seen in Table 1). In this study, we used the material in CLO 1 and CLO 2, with each CLO containing one question about learning outcomes that support critical thinking and literacy skills.

Question 1 measures CLO 1, which supports the literacy skills of students. In question 1, students will be asked to complete the relationship between statements in mathematics, which will be applied to the business world. The indicators in question 1 include hands on literacy skills, namely (a) formulating real problems in problem-solving, (b) using mathematics in problem-solving, (c) interpreting solutions in problem-solving, and (d) evaluating solutions in problem-solving progress by comparing the initial test and the final test.

While question 2 is a question to measure CLO 2, it supports students' critical thinking skills. In question 2, students will be asked to solve problems in the business world using the concept of linear functions. Therefore, question 2 include indicators in critical thinking skills, namely (a) identifying problems, (b) forming new things, (c) integrating information to design solutions, and (d) concluding (Kane et al., 2016).

METHOD

This is an experimental study with a two-group pretest and posttest design (Fraenkel & Wallen, 2009). This framework for our research is as follows:

In this model,

O_1 X O_2

O_3 - O_4

O_1 = the initial test score of the treatment group before learning (pretest),

X = learning with the SHL model,

O_2 = the final test score of the treatment group after learning (posttest),

O_3 = the initial test score of the group without treatment before learning (pretest),

- = conventional learning (not the SHL model),

O_4 = the final test score of the group without treatment after learning (posttest).

This research was conducted in two classes of Universitas Dinamika Information System students that included a sample of 91 students who were divided into an experimental group that received the SHL model using the BRILIAN application and a control group that received conventional learning. The two groups (experimental class and control class) were taught by the same lecturer—only the trearment differed between the two classes. The division of the control and experimental classes is shown in Table 2.

Table 2.
Research Sample

	Controlled Class (P)	Experimental Class (Q)	Total
Sample	46	45	91

The research process began with developing the Basic Mathematics course tools, including (1) Semester Lesson Plans (RPS), (2) Daily Lesson Plans (RPP), (3) Student Teaching Materials (BAM), and (4) a test of basic mathematics learning outcomes. This learning outcome test consisted of four subjective test questions with case studies that refer to the high level of the cognitive domain according to Bloom's Taxonomy: analysis, synthesis, and evaluation.

In learning, the teacher must have a plan or guideline for implementing learning, which can be in the form of a semester learning plan and a learning implementation plan. The RPS is a learning planning document that is prepared as a guide for students in carrying out lecture activities for one semester to achieve predetermined learning outcomes (Ilmiani et al., 2020). Unlike the RPS, the RPP is made to assist teachers in teaching in accordance with the Competency Standards and Basic Competences for that day (Nagro et al., 2019). Every educator is obliged to compile a complete and systematic lesson plan so that learning takes place in an interactive, inspiring, and fun way.

In learning, student teaching materials are needed to support student understanding. BAMs are arranged according to the needs of the material to be taught in the form of a set of materials that are arranged systematically to assist teachers/instructors in carrying out learning activities and enable students to learn (Bouckaert, 2019). In the preparation of teaching materials, teachers must pay attention to several principles, including the principle of relevance or linkage, so that closely related learning material will be relevant to the learning outcomes of the course (Aydin & Aytekin, 2018). In addition, teachers must adhere to the principles of consistency and adequacy in the preparation of teaching materials, and the material presented should be sufficient enough to achieve basic competence.

Furthermore, our learning device was validated by experts, and the results were analyzed using descriptive statistics, namely the average score of the completed questionnaire. The average score criteria used was the single measures Interrater Coefficient Correlation (ICC) and Cronbach's coefficient alpha (Pandiangan et al., 2017), as shown in Table 3. The validity and reliability of the RPS, RPP, BAM, and basic mathematics test instrument are shown in Table 4.

Table 3.
Assessment Validity Criteria of Learning Instruments

Interval Score	Assessment Criteria	Description
$3.30 < P \leq 4.00$	Significantly valid	Used without revision
$2.30 < P \leq 3.30$	Valid	Used with minor revision
$1.80 < P \leq 2.30$	Less valid	Used with major revision
$1.00 < P \leq 1.80$	Not valid	Cannot be used and consultation is needed

Adapted from Erika et al. (2018)

Table 4. Validity and Reliability of RPS, RPP, BAM, and Basic Mathematics Test Instrument

Learning Instrument	Validity	Category	Reliability (%)	Category
RPS	3.56	Significantly valid	90.2%	Reliable
RPP	3.75	Significantly valid	93.7%	Reliable
BAM	3.61	Significantly valid	90.5%	Reliable
Test instrument	3.72	Significantly valid	92.9%	Reliable

Table 4 shows that the validity and reliability of the RPS, BAM, and basic mathematics test instrument were all categorized as very valid and reliable. This means that the learning tools and basic mathematics test instruments were feasible and could be used in this study.

Before learning was carried out in this study, both groups of students were given a test of their basic mathematics learning (pretest). Furthermore, after learning, the two groups of students were again given a test of learning outcomes on the same material (posttest). For the learning process, the experimental class was assigned the SHL model using the BRILIAN application. In contrast, for the control class, learning was carried out as usual without applying the SHL model using the BRILIAN application.

To analyze students' learning progress through BRILIAN, the data, in the form of pretest and posttest scores, were analyzed using SPSS version 24 data processing software through three stages, namely: (1) testing the normality of the two groups of students with Shapiro Wilk, (2) tested the similarity of the two pretest-posttest means in the two groups of students, and (3) calculated the mean n-gain in the two groups of students.

The SHL model using the BRILIAN application effectively improved learning outcomes. Based on the findings, student learning outcomes were significantly increased (the significance level $\alpha = 5\%$). Further, the average n-gain was categorized as moderate ($.3 < g < .7$), and the average percentage of n-gain was at least 0.56–0.75, which means it was moderately effective.

To test for an increase in learning outcomes in the Basic Mathematics course, first, the assumption of normality was tested for the pretest on both groups of students using Shapiro Wilk, followed by a different test for the two groups using Mann-Whitney. Meanwhile, the mean n-gain was calculated using the formula from Hake (1999):

The results of the above formula were further grouped into four categories as follows: (a) the

$$\text{n-gain} = \frac{[\text{posttest score} - \text{pretest score}]}{[100 - \text{pretest}]}$$

ineffective category if n-gain was < .40; (b) the less effective category if the n-gain was .40–.55; (c) the quite effective category if the n-gain was .56–.75; and (d) the effective category if n-gain was > .76.

FINDINGS

Basic Mathematics course learning outcomes scores of students in the control class and experimental class before learning and after learning were carried out in each group of students: control class P and experimental class Q. The average pretest and posttest scores are presented in Table 5.

Table 5.
Average Pretest and Posttest Scores of the Two Groups of Students

Score	Control Class	Experimental Class
Pretest	44.13	48.83
Posttest	52.28	77.67

Table 5 shows that the scores of the students' Basic Mathematics course learning outcomes before learning in the control class were 44.13 and in the experimental class were 48.83. This means that the two groups of students are still low, namely less than 50 in the score range 0–100. Meanwhile, the average score of learning outcomes in the two groups of students in the posttest increased. In the control class, it reached 52.28, whereas in the experimental class, i.e., the class that was using the SHL model, the increase was relatively high, reaching 77.67. Thus, the posttest results in the experimental class were greater than those in the control class.

The results of the normality assumption test for the pretest scores for the control class and the experimental class are shown in Table 6.

Table 6.
Normality Test Results with Shapiro Wilk for the Pretest of the Two Groups of Students

Class	Nilai	N	Shapiro Wilk		
			Statistic	df	p
P	Pretest	46	.960	46	.110
Q	Pretest	45	.896	46	.001

*$p < .05$

Table 6 shows that the *p*-value of the experimental class was < .05 while the *p*-value of the control class was > .05; this shows that the data in the experimental class did not come from a normally distributed population. In other words, the assumption of normality in the experimental class was not met. Because the assumption of normality was not met, the results of the P and Q groups were tested using the Mann-Whitney test. The results are shown in Table 7.

Table 7.
Mann-Whitney Test Results on the Mean Pretest and Posttest Scores for Two Groups of Students

Class	Score	N	Mann-Whitney		
			Z	P (2-tailed)	Description
P	Pretest and posttest average	46	−5.791	.000	< .05
Q	Pretest and posttest average	45			

*$p < .05$

Table 7 shows that the *p*-value for both groups of students was < .05, which shows the difference between the pretest and posttest mean scores. In addition, the Z value of the two groups was −5,791. Because the Z scores in both groups of students were negative, the average score of students' Basic Mathematics course learning outcomes after using the SHL model was higher than before SHL was used. In other words, after using the SHL model, there was an increase in student learning outcomes.

The effect of the BRILIAN application in learning basic mathematics to improve critical thinking skills can be known by using the normalized gain test. The results of calculating the mean n-gain for the two groups of students are shown in Table 8.

Table 8.
Mean n-gain for Two Groups of Students

Group	Control Class (P)	Experimental Class (Q)
Sample: N	46	45
n-gain average	.12	.56

Based on the category of n-gain calculation results according to Hake (1999), the n-gain for the experimental class was .56 and it was in the quite effective category because the n-gain was in category 56–75. This means that learning basic mathematics using the SHL model with the BRILIAN application was quite effective.

The average n-gain of the experimental class was then checked again to corroborate the results that had been obtained and previously analyzed. This process was carried out by highlighting the learning outcomes of literacy and critical thinking skills based on the test questions. Then from the test results, the average n-gain was obtained, which is shown in Table 9.

Table 9.
Mean n-gain of Literacy Skills and Critical Thinking Skills for the Experimental Class

Skills	Literacy	Critical Thinking
Sample: N	45	45
n-gain average	.33	.76

Of the 45 samples, an n-gain in literacy skills was obtained by .33, so literacy was categorized as ineffective because the n-gain was in the category < .40. However, an n-gain critical thinking skills of .76 classified it as effective. This means that there was a significant difference in the results between literacy skills and critical thinking skills. The n-gain difference of the two skills was that critical thinking skills were .43 higher than literacy skills. Thus, the SHL model using the BRILIAN application in learning Basic Mathematics improved critical thinking skills.

DISCUSSION

The findings in Table 5 show that the value of students' learning outcomes in basic mathematics for the two groups was low. This is possible because they did not understand the basic mathematics material being tested. However, after learning was completed, the average value of the learning outcomes increased, especially for the experimental class, i.e., the students who learned using the SHL model. This result was achieved because the students understood the basic mathematics material after using the SHL model through the Moodle-based BRILIAN application. In this application, the student learning process was directed according to the five phases of the SHL model. The increase in scores from pretest to posttest, which were relatively high in the experimental class, was supported by the statistical test results. These results showed a significant increase in learning outcomes in the Basic Mathematics course with a significance level of α = 5%. Additionally, the average n-gain of the data was in the moderate category, and the mean n-gain was significantly different in the two groups of students. The n-gain for the experimental class has a higher value than the control class. In addition, the literacy skills and critical thinking skills show significant differences, where the SHL model is more effective in improving critical thinking skills. This is because the n-gain analysis in Table 9 shows that for literacy skills the resulting category is ineffective. This was reflected in Tables 5, 6, 7, 8, and 9. These results support the opinion of Hariadi (2015) and Hariadi & Wurjanto (2016), who state that student learning outcomes using the BRILIAN application are better when compared to student learning outcomes in a conventional learning mode. Further, the research findings of Chang et al. (2012) reveal that the learning that was carried out via smartphones yielded very effective results in meeting the information needs of the trainees. Likewise, Tubagus et al. (2020) indicate that elearning is an effective way of teaching and learning to improve student learning outcomes. Our finding is in line with previous research conducted by Rambe (2012), which states that social media could enhance social learning, increase digital literacy, and provide knowledge coproduction in learning communities. Reinforcing previous studies, the findings of Goh et al. (2017), Widyaningsih et al. (2021), and Makruf et al. (2022) show that elearning is most suitable for helping students because of the ease of interaction with fellow students. Learning basic mathematics with the SHL model provides an opportunity for communication between students through the use of the BRILIAN application. This is in line with the findings of McCarthy (2010), which affirms that hybrid learning, accompanied by face-to-face discussions, helps increase understanding of the material being studied and the level of group involvement. Likewise, Amin et al. (2020), Hariadi et al. (2022), and Li (2022) assert that hybrid learning can improve student learning outcomes at high-level thinking levels that require critical thinking skills and literacy skills.

CONCLUSIONS

Based on the results of the research and discussion above, we concluded that learning basic mathematics with the SHL model using BRILIAN is quite effective in improving student learning outcomes. Furthermore, the results show significant increase in the experimental class's learning outcomes at the significance level $\alpha = 5\%$, and the mean n-gain in the experimental class is categorized as quite effective. This research has implications in the field of education because it can provide innovation in the form of BRILIAN applications that successfully help improve learning outcomes in basic mathematics courses. In addition, the implications of this research can also be seen by students who encounter new learning experiences with the SHL model in this BRILIAN application. From this, we recommend conducting future research in order to develop similar applications with response variables other than learning outcomes.

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