The Development of Scientific Hybrid Learning Model by Using the *BRILIAN* Application for the Science Field

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Abstract

Scientific learning is a learning process that leads students to a science-based learning experience. Scientific learning implements specific methods for students to discover concepts and theories. This research was intended to develop a hybrid learning model which can be implemented for scientific learning. This was a research and development which aimed to develop a suitable learning model to be implemented in Moodle-based LMS named *Brilian*. Scientific Hybrid Learning (SHL) model tests were conducted in terms of validity and practicality. The results showed (1) that the score for the content validity test on average was 3.71 statistic rα = 0.25 and α = 0.81, the construct validity score on average was 3.82 statistic rα = 0.20 and α = 0.75. (2). The practical validity test score on average was 3.63 statistic rα = 0.91 and α = 0.99. The conclusion is that the SHL model is qualified in terms of the validity of contents and constructs and practicality for students. The research implied that a good SHL model can be implemented to increase students learning outcomes based on science. The continuation of this research can focus on monitoring the SHL model's effectiveness in improving students' learning outcomes on science-based subjects.

Keywords

Hybrid learning, learning model, scientific hybrid learning

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Introduction

Education plays a primary role in producing excellent human resources for complying with the job market, especially in the era of the fourth industrial revolution. The curriculum's demand for the growth of the fourth industrial revolution forced educational institutions to innovate and facilitate 21st century skill-based education (Pandiangan et al., 2017; Suyidno et al., 2018). The required skills in the 21st century include literation, critical thinking, scientific creativity, collaboration, communication and information technology, and problem-solving skills (Erika et al., 2018; Sunarti et al., 2018).

Improving the quality of processes and learning outcomes for graduates is closely related to data literacy and critical thinking skills, which should be done in the learning process (Jatmiko et al., 2018; Sunarti et al., 2018). Data literacy skill relates to data reading skills, data writing skills, and data archiving skills, which are crucial for avoiding plagiarism, duplication, falsification, and fabrication when presenting data in scientific writing. Critical thinking skills as thinking logically and systematically to solve problems.

Critical thinking and literacy skills training should be inserted into the learning process in the university because it is suspected that most university students still do not master these skills. This statement also supports the findings by Pithers and Soden (2000). Furthermore, Pithers and Soden (2000) also found that there are lecturers who do not understand how to teach critical thinking effectively. It influenced the learning outcome, specifically in the critical thinking domain, as found by Martin et al. (2011), which shows that average Indonesian students can recognize basic facts but are still unable to communicate and link several topics in the application of complex and abstract concepts. This finding also supports the finding by Pithers and Soden (2000) that Indonesian students' critical thinking skills are low.

The increment of learning outcomes is influenced by conditions, which consist of three aspects: student characteristics, environmental characteristics, and learning are unchanged by lecturers. Lecturers can develop suitable learning approaches which will enhance learning outcomes (Hariadi, 2015). The mentioned learning approaches can be divided into three categories, namely: organizing strategies, delivery strategies, and management strategies. Organizing strategies include content selection, arrangement, and development of content diagrams, while delivery strategies include delivery approaches and learning media. Lastly, management strategies include structuring learner interaction with organizing strategies and delivery strategies (Borg & Gall, 1983; Budningsih, 2011; Trianto, 2010).

The students' low data literacy and critical thinking skills are related to the implemented learning approaches. Most lecturers still use conventional learning approaches, so they cannot facilitate the development of data literacy and students' critical thinking skills. It is what ultimately results in low student achievement (Jatmiko et al., 2018). Therefore, efforts to enhance the learning process are done by developing a learning model that can facilitate organization, management, and knowledge delivery. A suitable learning model for students, which includes student characteristics, environmental characteristics, and learning goals, is predicted to enhance the learning outcome (Gay et al., 2012). Therefore, a learning

model development that accommodates scientific learning phases is necessary. Scientific hybrid learning (SHL) is a learning model that applies scientific phases, which are implemented in the BRILIAN learning management system and combined with the conventional learning model. BRILIAN is a MOODLE-based learning management system implemented in learning at Univrsitas Dinamika.

Literature Review

Learning models

A model is a conceptual framework that is used as a guide in carrying out activities. In learning, the terms "model" can be described as a conceptual framework that illustrates a systematic procedure in organizing learning experiences to achieve a specific learning outcome. A model serves as a guide in planning and implementing learning activities. A Learning model is a term that describes the implementation of the teaching and learning process. A learning model already compromises the implementation of an approach, method, technique, or learning tactics simultaneously (Haerullah & Hasan, 2017; Helmiati, 2012). Moreover, Nurdyansyah and Wahyuni (2016) also defined a learning model as a plan or pattern that can be used to shape the curriculum (long-term learning plans), design learning materials, and guide the learning process in other classes. When developing a learning model, it should have characteristics such as referring to education theories and specific learning theories; having a mission to achieve certain goals; serving as a guide for improving teaching and learning activities in class; having syntax, reaction principles, social systems, and support systems; and there is an impact, resulting from implementing the model (Nurdyansyah & Wahyuni, 2016).

Scientific learning

Scientific learning is a learning model that adopts scientific steps in developing knowledge through scientific methods (Haerullah & Hasan, 2017). Scientific learning is a learning process designed so students can actively develop concepts, laws, or principles by observing, formulating problems, posing hypotheses, collecting data by implementing various techniques, analyzing data, creating conclusions, and presenting them (Musfiqon & Nurdyansyah, 2015). Hence, a learning model is required to form the ability to learn. It means not only the acquisition of knowledge, skills, and attitudes but also how knowledge, skills, and attitudes are acquired by students (Haerullah & Hasan, 2017).

Science learning in Indonesia is designed so that students can fulfill the skills and abilities needed in the 21st century. It is due to the nature of science learning material tha can make humans always curious about their surroundings and then provide conclusions based on scientific studies. This statement is supported by Prahani et al. (2022) who stated that science learning is related much to natural phenomena and experimental activities. Moreover, according to Sumo et al. (2022) , science learning consists of three main elements, namely knowledge, attitudes, and skills. Because of the thoroughness of the elements in science learning, students can be accustomed to conducting investigations into problems and

determining their solutions independently. So, science learning is learning that can train students to make observations, do experiments and create a decision, and develop theories openly and honestly. Learning by using a scientific approach means learning is done scientifically. Therefore, the learning process can be equated with a scientific process (Musfiqon & Nurdyansyah, 2015).

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Scientific learning models

As described before, the scientific learning approach mainly consists of scientific steps for building knowledge through scientific methods. The scientific approach consists of at least three learning models that can be implemented, such as the project-based learning model, the problem-based learning model, and the inquiry-based learning model (Musfiqon & Nurdyansyah, 2015). All learning models implement scientific steps that belong to scientific learning models. Those steps are formulating problems, proposing a hypothesis, collecting data, processing and analyzing the data, and concluding (Pahrudin & Pratiwi, 2019). Haerullah and Hasan (2017) stated the steps for scientific learning are first to observe a phenomenon, formulate problems related to the phenomenon, deliberate to propose hypotheses, design experiments to collect data, collect data using various techniques, analyze data for testing hypothesis, conclude the truth of the hypothesis, communicate the results, and validate conclusion to avoid misconceptions. Thus, social sciences learning and exact sciences learning can implement scientific learning models by inquiry, problem-based or project-based.

Data literacy and critical thinking

Data literacy is the ability to read, analyze, and utilize information (big data) in the digital world (Camilleri, 2018). Data literacy is the ability to use data as information and turn it into knowledge for solving problems. The Harvard Business Review stated that the most attractive job in the fourth industrial revolution is data scientist. It shows that data literacy is a skill that will be very useful in finding a job in the era of the industrial revolution 4.0 (Davenport & Patil, 2012). Therefore, data literacy skill is an urgent skill to be trained through learning models. Data literacy skills in research are manifested as data reading skills, data writing, and data archiving skills in everyday life. Facione (2011) stated that critical thinking is self-regulation in judging something, which produces interpretation, analysis, evaluation, inference, and explanation using proofs, concepts, methodologies, criteria, or contextual consideration on which a decision is made. Critical thinking is paramount as an inquiry tool. Critical thinking skill is an intellectual potency that can be developed through the learning process. Everyone has the potential to grow and become a critical thinker since thinking activity relates to the self-organization pattern that exists in every creature in nature, including humans (Zubaidah, 2010). Some scientists explain that critical thinking skills are cognitive skills that consist of activities like interpretation, analysis, evaluation, inference, explanation, and self-management in solving problems (Bean, 2011; Cheong & Cheung, 2008; Mundilarto & Ismoyo, 2017; Siew & Mapeala, 2016).

BRILIAN

BRILIAN is a Moodle-based Learning Management System (LMS) for Hybrid Learning developed at Universitas Dinamika. The purpose of BRILIAN is to improve the quality of learning. This LMS was built using the concept of Hybrid Learning, which means that learning is not only carried out in the classroom but also cyberspace so that students can learn anywhere and anytime. In the BRILIAN application, lecturers function as facilitators, mentors, and consultants so that students are required to study actively (Tim Brilian, 2015). The BRILIAN logo is presented in Figure 1.

Figure 1. *Home interface of BRILIAN application*

To develop a learning process that accommodates lecturers to act as facilitators and can make students learn actively in the classroom, and cyberspace, this application provides opportunities for lecturers to optimize various models of teaching and learning interactions, as shown in Figure 2.

Figure 2. *Learning activities that can be developed*

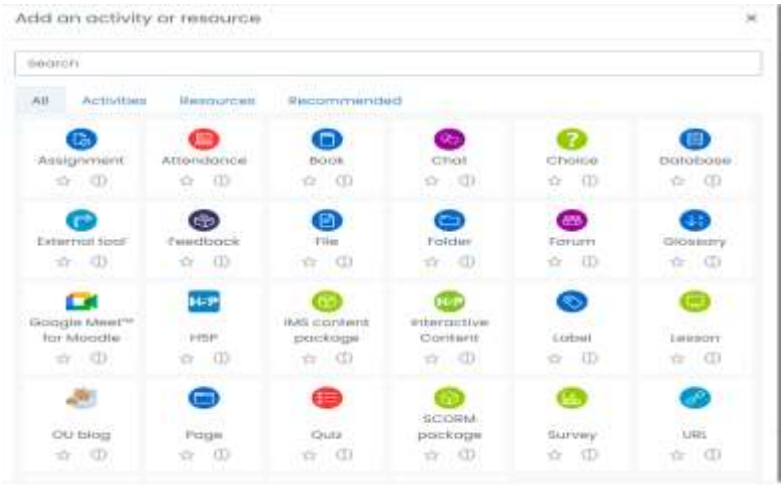
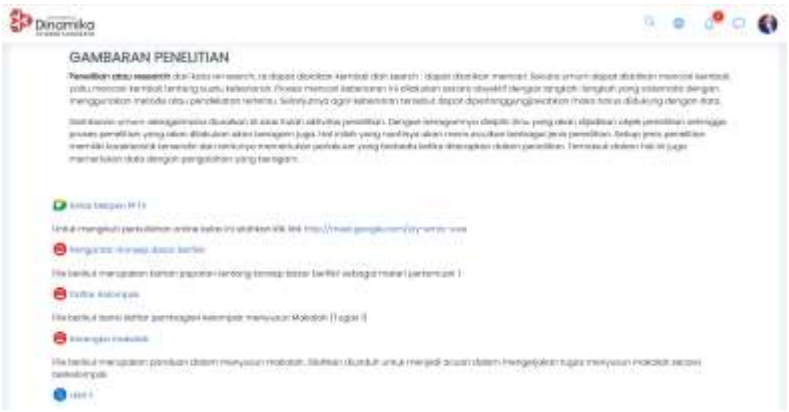


Figure 2 shows that in the BRILIAN application, there are 32 icon options that lecturers can use to make learning interaction patterns with students. The determination of these icon options is adjusted to the learning objectives, learning strategies, and the characteristics of the teaching materials applied in achieving the learning objectives. The ability to master the application and the skills of lecturers in optimizing BRILIAN applications is very influential in achieving learning objectives and improving student learning outcomes. The application of the learning activities in Figure 2 above in learning managed by the lecturer is divided into several meetings or weeks according to the Semester Learning Plan (RPS) for each subject, as shown in Figure 3.

Figure 3. *Implementation of learning activities for one semester in the BRILIAN application*

Figure 3 shows the detailed implementation of learning activity icons for each meeting based on the lesson plans. Meanwhile, Figure 4 shows examples of learning content for the first meeting.

Figure 4. *Example of learning content for the first meeting*



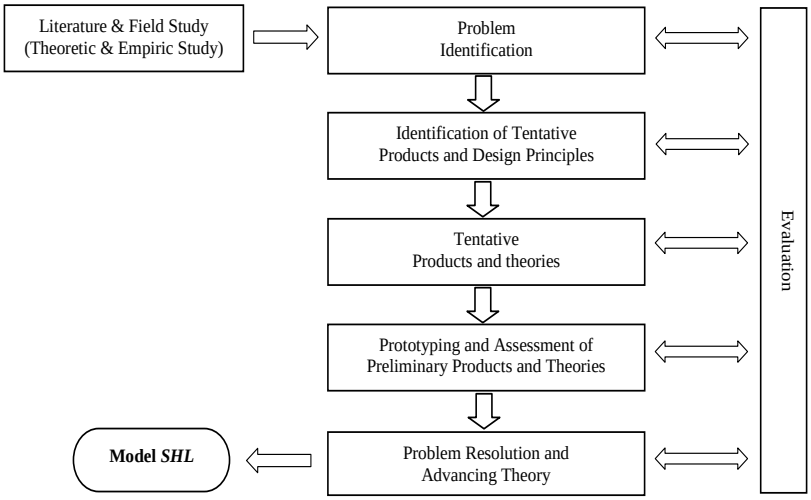
Students can take utilize all the learning activity facilities that have been designed by lecturers in the BRILIAN application. As an example, Figure 4 shows students and lecturers can carry out synchronous learning online through the Google Meet link. In addition, several learning tools, such as lecture materials and student activity sheets, can be downloaded by students and submitted again to the BRILIAN application for scoring.

Methodology

Research design

Development of the SHL Model refers to the design of the Generic Design Research Model (GDRM) development research model by Wademan. According to Nieveen (1999) and Plomp (2013), GDRM development steps consist of problem identification, tentative identification of product and design principles, tentative theory and product, developing prototypes and assessing products, and improving product quality. The development stage of the SHL model by modifying the GDRM from Plomp (2013) is in Figure 5 below.

Figure 5. *Development research phases of generic design research model*



(Wademan's adaptation in Plomp & Nieveen, (2013))

Product quality assessment is carried out through expert validation regarding the content and construct of the SHL model draft and its feasibility for use by students. Content validity means that there is a need for a learning model and its design based on current knowledge. Furthermore, construct validity is the fulfillment of a logically designed learning model (Nieveen et al., 2007). The results of this expert's assessment were used as a reference to revise the SHL model draft.

Data collection

This research uses a questionnaire adopted from Nieveen et al. (2007) as an instrument to collect data from expert and student respondents. The questionnaire for experts consists of two parts, namely questionnaire to measure content validity and a questionnaire to measure construct validity. Student questionnaire to measure the feasibility or attractiveness of learning tools and activities for the SHL model.

The research procedure consists of Preliminary research, which is carried out to obtain related data, such as student learning outcomes, PBL and hybrid learning models, factors that support learning, student, and lecturer opinions towards learning; SHL model draft design, including formulating the SHL model syntax; validity testing and feasibility of the SHL model draft; Revision of the SHL model according to the results of the questionnaire.

Data analysis

An analysis was carried out using descriptive statistics, namely the average score of the questionnaire that had been filled in by experts. The average score criteria use Single measures Interrater Coefficient Correlation (ICC) and Cronbach's coefficient alpha (Malhotra, 2011; Pandiangan et al., 2017).

Table 1. *Learning model validity assessment criteria*

Interval Score	Assessment Criteria	Description
$3.30 < P \leq 4.00$	Very valid	Applicable without revision
$2.30 < P \leq 3.30$	Valid	Applicable with little revision
$1.80 < P \leq 2.30$	Less valid	Applicable with several revisions
$1.00 < P \leq 1.80$	Invalid	Not applicable and still requires consultation

Adopted from Erika et al. (2018)

These criteria are also used as an analysis of the quality of the SHL model that has been developed.

Findings and Discussion

SHL model characteristics using the BRILIAN application

The Scientific Hybrid Learning (SHL) model is a learning model that integrates the Hybrid Learning Model with the PBL Model. The development of the SHL Model is supported by several learning theories and empirical experiences. Supporting Learning theories such as constructivism theory, learning through observation, discovery learning, cognitive processes, metacognition, and multiple representations. Furthermore, the

development of the SHL model is also supported by empirical foundations from the latest research publications. The SHL model developed refers to the characteristics of the learning model proposed by Arends (2012) namely the logical theoretical rationale for its design, learning objectives, lecturer behavior in teaching, and supportive learning environment to achieve learning objectives. Succinctly, the characteristics of the SHL model are as follows.

Theoretical rationale

The SHL model is developed from several fundamental theories, such as constructivism theory, observational learning theory, discovery learning theory, cognitive process theory, metacognition theory, and multiple representation theory (Hariadi et al. 2018). These theories form the basis for compiling the steps of the SHL Model, which consists of the orientation phase based on LMS and big data, the investigative, the analysis phase, the presentation phase, and the evaluation phase, in which each phase is carried out using the BRILIAN application. The five phases in detail are expected to achieve the learning goal because Widodo and Nurhayati (2015) stated the phases in constructivist learning consist of introduction, exploration, restructuring, application, and review and evaluation. Meanwhile, according to Siswanto et al. (2017), the phases of learning through observation consist of orientation, investigation, multiple representations, application, and evaluation. According to Al-Mahiroh and Suyadi (2020), the phases in learning cognitive process theory are motivational, recognition, acquisition, retention, calling, generalization, performance, and feedback. The phases in metacognition learning according to Adi (2013) are the collaborative group formation phase, the initial schemata activation phase, the creation of cognitive conflict, the concept construction planning phase, the concept construction phase, the class presentation phase, the individual test phase, and group recognition phase. Finally, according to Siswanto (2019), the phases of multi-representational learning are orientation, investigation, multi-representation, application, and evaluation. Based on the fundamental theories and phases in the learning model, the developed SHL model has five phases.

Learning goal

The development of the SHL model aims to improve data literacy and critical thinking skills. In addition to these two objectives, there are several objectives, such as generating motivation, activity, and student responses in learning. To achieve these goals, the SHL Model is carried out through collaborative and cooperative activities, a scientific approach, hybrid learning, integration of the BRILIAN applications, social interaction through independent and group learning experiences, and the presentation of contextual problems based on LMS and big data. Literacy skills are paramount in science learning. Based on research by Greenleaf et al. (2011), science learning designed by the teacher for ten days effectively can improve students' problem-solving and reasoning abilities. Likewise, during the final exam, students in the control class showed better results than the regular class.

Meanwhile, according to Kazmi (2000), critical thinking skills are abilities that can be trained in science subjects because they are already included in science lessons, even though they have not been applied explicitly by lecturers.

Lecturer's teaching behaviour

To optimize the instructional impact and increase data literacy students' critical thinking skills, the model implementation related to the lecturers' way managed the learning process should include planning tasks, interactive tasks, learning environment and task management, and evaluation. Matters to be taken care of in the planning tasks are formulating objectives, selecting content, performing task analysis, and planning time and space. The behavior of educators in teaching must be well-planned. Research by Noori et al. (2021) stated that students had positive perceptions of lecturer behavior in teaching, regardless of sex.

Study environment and assignment management

In teaching and learning activities using the SHL model, lecturers plan activities in a structured and strict manner through the BRILIAN application. The success of this learning model is determined by the preparation of a good learning environment and learning media, in this case, the BRILIAN application. Lecturers and students can interact with the help of the BRILIAN application through one of the 24 icons in the BRILIAN application while paying attention to the pattern of interaction and scheduled deadline.

Research by Gopo (2022) stated that technology cannot be separated from students' lives today. Even though there were some negative impacts, the two researchers stated that the positive effects outweighed the negative. Therefore, in this SHL model, the learning environment and assignment management cannot be separated from technological superiority.

SHL model syntax formulation

The syntax can be interpreted as the steps or plans that must be carried out in learning, which are detailed in the lesson plan. Five phases are carried out when implementing the SHL Model in learning, which are LMS and big data-based orientation phase, the investigation phase, the analysis phase, the presentation phase, and the evaluation phase (Hariadi et al., 2018). The description of the five phases is as follows.

The first phase is an LMS and big data-based orientation, which aims to attract students' interest by focusing attention and motivating students using the BRILIAN application. In this phase, the lecturer's ability to operate the BRILIAN application is needed for offline classroom management. This phase is paramount for the success of the following phases.

The second phase is the investigation, which aims to gather information related to the achievement of learning objectives. In this phase, students are assisted by using Student Activity Sheets (SAS/LKM) and guided by lecturers in carrying out step-by-step

investigations through the BRILIAN application. This phase also builds literacy skills and critical thinking skills through the ability to find answers that are relevant to the questions and scientific steps in the LKM.

The analysis or analyzing phase has the aim of guiding students in carrying out an analysis which is continued with discussion and making conclusions from the results of the investigations that have been carried out previously. In this phase, students are trained to optimize data literacy skills and think critically in solving problems that have arisen in the second phase.

After drawing conclusions based on the analysis in the third phase, it continues with a presentation in the fourth phase. This fourth phase aims to assist and guide students in planning, preparing, and presenting the work that has been done in the third phase. Presentations can be held both online and offline to optimize hybrid learning. Presentations can also use offline data that has been generated from the previous phase of the analysis process or by utilizing online data in real terms, such as big data and the internet of things from the cloud. This phase also accommodates the process of increasing students' data literacy skills and critical thinking.

The fifth phase is an evaluation that aims to evaluate the problem-solving process of the investigations that have been carried out by students in the previous phases. Lecturers see the results of students' work as evidence of learning outcomes and facilitate follow-up learning by distributing structured assignments. All these activities are carried out through the BRILIAN application as an implementation of hybrid learning that has been designed to optimize learning outcomes.

SHL model assessment result

The SHL model has fulfilled the validity model test and the feasibility model test assessed by education experts. The results of the research are in Table 2 and Table 3.

Table 2. *The analysis result of the SHL model's validity assessment*

Content Validity	Validity Score	Score Criteria
Necessity of SHL Model Development	3.75	
State of the art of the SHL Model	3.68	
The framework for the creation of the SHL model	3.69	Very Valid
SHL Model Description	3.70	
Construct Validity		
SHL Model Development Consistency	3.95	
The framework for the creation of the SHL model	3.61	Very Valid
SHL Model Learning Description	3.90	

Table 2 shows that the content and construct validity of the SHL model are considered very valid. The content validity of the SHL model, which includes the necessity of developing the

SHL model, the state of the art of the SHL model, the framework for the creation of the SHL model, and the description of the SHL model, has an average validation score of 3.75, 3.68, 3.69, and 3.70. These scores are classified as very valid. The construct validity of the SHL model, which includes the SHL model development consistency, the framework for the creation of the SHL model, and the SHL Model Learning Description, has an average validation score of 3.95, 3.61, and 3.90. These scores are also classified as very valid.

According to Ghazali et al. (2018), content validity refers to the process of determining how well the dimensions and elements of a concept can be successfully defined, while the function of content validity is to validate each item in the instrument that represents the measure built. By obtaining the content validity value for the SHL model with an average of 3.71. that the conclusion is the model development, the novelty of the model, the frame of mind, and the description of the model have met the implementation criteria. Furthermore, the feasibility of the SHL Model is in Table 3.

Table 3. *The analysis result of the SHL model's feasibility assessment*

Advisability	Validity Score	Score Criteria
Formulation of learning objectives	3.53	Very Valid
Syntax Clarity and Suitability	3.82	
Clarity and linkage of the support system	3.55	
Clarity and association of the social system	3.52	
Clarity and capability of the reaction principle	3.72	

After conducting a feasibility test of the SHL model that includes the formulation of learning objectives, syntax clarity and suitability, clarity and linkage of support systems, clarity and association of social systems, and clarity and capability of the reaction principle, an average validation score of 3.53, 3.82, 3.55, 3.52, and 3.72 are obtained. These scores are classified as very valid. Hence, the SHL model is feasible to be implemented in the field of science in higher education.

The feasibility analysis of the SHL model is supported by the theories and findings of previous studies. The first reference, as in Table 3, is effectiveness which is measured by achieving objectives. The learning model is said to be effective if it can achieve the main objective as an instructional impact of learning. The instructional impact of the SHL model that wants to be achieved by using the BRILIAN application is an increase in student learning outcomes. In addition, there are also the expected accompanying effects with the application of the SHL model using the BRILIAN application, which are mastery of the concept, technological literacy, positive student activity towards learning, and positive student response to learning.

The SHL model syntax consists of five phases, namely the orientation phase based on LMS and big data, the investigation phase, the analysis phase, the presentation phase, and the evaluation phase (Hariadi et al., 2018). Each phase is described and carried out in learning according to the lesson plan by using the BRILIAN application. Hence, the learning

activities carried out by lecturers and students must be following the learning phases of the SHL model.

The support system for a learning model is all facilities, materials, and tools for implementing the SHL model using the BRILIAN application. The implementation of this learning model is also equipped with a support system consisting of learning tools according to the needs of the SHL model, which include RPS, RPP, Student Activity Sheets (SAS/LKM), Student Teaching Materials (STM/BAM), and learning outcomes evaluation instruments; BRILIAN application which is the primary support in learning; and Learning media in virtual form along with internet networks for access to data literacy. These support systems become part of the learning tools that provide a conducive atmosphere for teaching and learning activities and could improve learning delivery.

As described above, the SHL model social system refers to Vygotsky's constructivist-based learning model (Chamaz, 2011; Stigligz, 2014). . It is described in the syntax of the SHL model, including the relationship between fellow students and between students and lecturers. The emphasis on this social system is the construction of knowledge that is carried out by each student actively. This construction will be stronger if done collaboratively. Hence, building collaborative groups will have a positive impact on learning outcomes. Based on the syntax that has been prepared, the suggested social system is each student is proactive in learning activities by contributing to study groups. The role of the lecturer is as a guide, moderator, facilitator, consultant, and mediator in learning, and SHL model implementation divided into 70% the job experience, 20% of mentoring and coaching, and 10% of classroom, course, and reading (Watson, 2008; Woolf, 2010).

The latter is the clarity and principle of reaction. The principle of reaction can be described as how students pay attention to and treat their friends and students respond to questions, answers, responses, or what other students do. As previously described, the implementation of this SHL model uses the BRILIAN application. Afterward, communication, teaching, and learning interactions are carried out through the BRILIAN application. Therefore, lecturers should motivate and remind students to always emphasize higher order thinking by utilizing data literacy and technology literacy. Lecturers should also always give feedback, praise, and opportunities for students to ask questions, argue and criticize the lecture process so that higher-order thinking-based learning outcomes can increase. Lastly, lecturers should emphasize the implementation of the SHL model by strengthening more on-the-job experience (70%) (Watson, 2008; Woolf, 2010).

Conclusion

The results showed that the SHL model had an average of 3.71 in content validity and an average of 3.82 in construct validity. Thus, based on expert judgment, the quality SHL model is valid in content and construction. The average score on the feasibility test (practically used by students) is 3.63. Therefore, students agree that the SHL model is feasible to use. The results of this research imply that a quality SHL model can be used to improve science-based learning outcomes. Further research can be focused on examining the effectiveness of the SHL model in improving student learning outcomes in science-based courses.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest.

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