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Development of Sophisticated Thinking Blending Laboratory (STB-LAB) to Improve 4C Skills for Students as Physics Teacher Candidate

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Abstract

The 21st Century Learning is an increasingly interactive and attractive learning era. The learning process in the 21st century does not only focus on teaching and learning activities in the classroom and explaining theories. There need to be laboratory activities that help provide visuals to students, especially future physics teacher candidates. Various innovations have been made in the development of laboratory activity models. There are still many laboratory activity models that focus on one activity, namely real or virtual. Laboratory activities in the 21st century do not always have to focus on super skills or 4C skills currently in the spotlight and forget about analytical skills and the balance between LOTS and HOTS. This study aims to develop a mixed laboratory activity model that can build 4C skills focused on analytical skills and balance between LOTS-HOTS; in addition, two activities are combined into one, real and virtual. The method used in this research is in the form of Research and Development using the ADDIE model with three meetings in implementation. The results obtained in this study, namely STB-LAB, obtained good model and guide validity results. N-Gain data showed that in the control class, only creative thinking skills were compelling enough, with a value of 59.47. In contrast, in experiment class, only communication skills have an effective enough category with a value of 57.84, but other aspects have an effective category with a value > 76.00. The hypothesis test showed that using STB-LAB could improve students as physics teacher candidate 4C Skills.

Keywords: 4C skills, blending laboratory, laboratory activities method

INTRODUCTION

Learning in the 21st century is learning that has left various old and traditional ways of student learning (AACTE and P21 2010). Learning models in the 21st century have been developed with various characteristics each to adapt to all the needs educators need. Innovation can arise in various ways, such as combining innovation or modification. Even innovation can arise because creativity needs analysis (Blândul 2015). One of the many innovations developed in laboratory activities is the combination of virtual and real laboratories.

Laboratory activities in education are one of the activities in the learning process needed to observe, activate, and interpret findings (Peña-Ríos et al. 2012; Gunawan, Harjono and Sahidu 2015). In addition, laboratory activities can improve students' understanding of the content rather than just theory. Sulistiowati, in her research, found that students' interest in laboratory activities was very high by showed high interest in learning and understanding after using real and virtual laboratories (Sulistiowati et al. 2013). This laboratory activity can facilitate the process of transferring knowledge from educators to students, as in Putra's (RP Putra et al. 2021) research, he found that 78.4% of the subjects he studied in semesters 2 to 6 students regarding their views on the use of virtual laboratories in learning were felt to be very necessary because apart from just theory, Virtual and actual laboratory activities are needed to describe the theory being studied.

Knowing that laboratory activities are an essential additional requirement in learning, educators must choose the selection of laboratory activity models according to their needs so that students can accept all forms from educators (Nurdyansyah and Fahyuni 2016; Tayeb 2017). Previous research (Hanum 2013) revealed that the learning model, including the monotonous and less attractive laboratory activity model, can cause many shortcomings in learning and laboratory activities. Based on the results of the analysis of researchers in the model of laboratory activities carried out at the Physics Education Study Program, UIN Sunan Gunung Djati, Bandung, for the past four years, it shows that there has been no integration of the integration model of laboratory activities with virtual, sometimes educators only do one of the two types of laboratory activities. With the emergence of the Covid-19 pandemic, laboratory activities are very limited, and not all students get actual laboratory activities. The use of virtual laboratories for a long time will make students not get real skills in using laboratory equipment, as explained in research conducted by Faour (Faour et al. 2018) which states that students who use virtual laboratories for too long will not develop psychomotor skills and operational tools.

Various problems arise in the laboratory activity model, one of which is the concern between real and virtual laboratories (Suryanti et al. 2019). The dilemma faced by educators is when they want laboratory activities but they are not available, but when they want to do virtual laboratory activities, there is no syntactic harmony between real and virtual laboratory activities, Previous study (Nanto et al. 2022) revealed in his research that sometimes laboratory activities are similar. For actual laboratory activities. Another study (Jaya 2012) revealed the main problem in virtual laboratory activities: the absence of alignment of work steps with real laboratory activities. The use of laboratories seems only for verification. The related study (Setya et al. 2021) revealed that in real laboratory activities, sometimes students do not know whether the results of the data obtained after the experiment are correct or not. However, in another study (Riki Purnama Putra et al. 2021) he found no difference in virtual and real laboratories' results. The data values obtained were only 0.1 to 0.2% different.

A previous study (Purnama et al. 2021) shows that the e-module he made could only be used in virtual laboratory activities because the e-module used was HOT-VL based. A study about the development of laboratory activity models seeks to create two different laboratory activities with the HOT-LAB and HOT-VL models. (Malik and Setiawan 2015; Sapriadil et al. 2019). However, another research (Tayebinik and Puteh 2013) shows that blending learning should be made into one model because if there was a separation of models, educators would be confused and would repeat the same thing but on a different platform.

Based on the problems and previous findings, the learning model and the laboratory activity model are deemed to have the main objective of achieving learning outcomes. Especially in the laboratory activity model must have a hierarchy so that the blending of laboratory activities is more focused and clear without having to use the same model on different platforms. Therefore, this study aims to develop a model of laboratory activities based on the sophisticated thinking blending laboratory. This laboratory activity model results from sophisticated thinking, higher order thinking laboratory, and higher order thinking virtual laboratory.

METHODS

This research focuses on product development using the Research and Development model and the ADDIE model, which have five stages, namely; (1) Analysis; (2) Design; (3) Development; (4) Implementation; (5) Evaluation. In particular, the flow description can be seen in FIGURE 1.

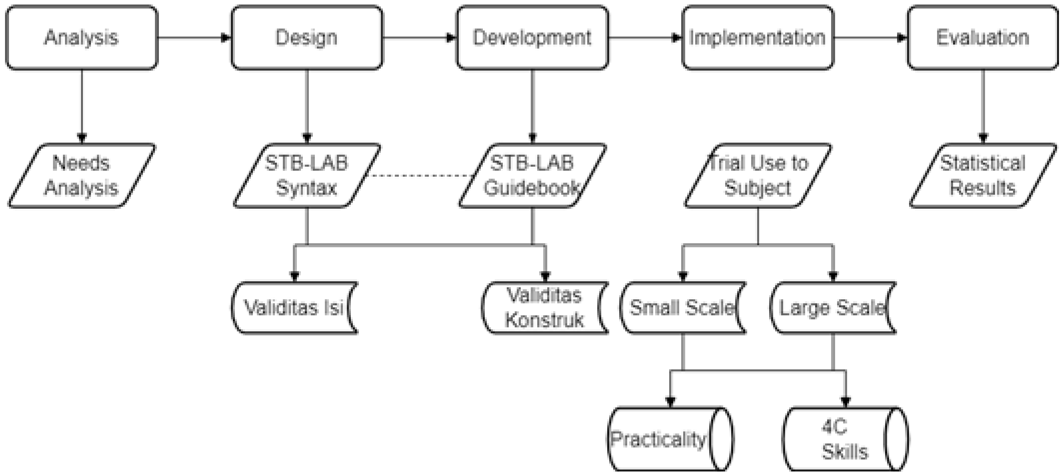

FIGURE 1. ADDIE Flowchart on STB-LAB Development

In the analysis stage, activities will analyze needs such as observing the current situation and the availability of models to analyze the results of evaluating laboratory achievements in previous semesters at the Physics Education Study Program of UIN Sunan Djati Bandung. In the design stage, designing the syntax for the STB-LAB model and adapting it to the available learning theories, for development, namely the development of the STB-LAB guidebook, which then from the design and development stages each will look for validity and construct validity by using a questionnaire sheet and assessed by several lecturers which then the results are averaged to become a proportion with a mathematical equation that can be seen in EQUATION 1 (Sugiyono 2013).

$$X = Average\ Yes\ Answer\ \times 100\% \qquad (1)$$

X is based on the priority or quality of a learning model that can be adapted to it, as seen in TABLE 1 (Sugiyono 2013).

TABLE 1. Product Quality Guide Category

Rate	Category
$X \leq 50\%$	Less/Low
$50\% < X \leq 100\%$	Good/High

Implementation was carried out in 3 meetings, with three different materials, and holding control and experimental classes with 30 subjects in each class and carried out for two semesters or about eight months. Small and large scale tests to determine the practicality results in product assessment as indicated by the percentage value of the observation sheet for lecturers and the results of the 4C skills measured using various rubrics whose aspects can be seen in TABLE 2.

TABLE 2. The Rubric of 4C Skills

Skills	Aspect	Reference
Critical Thinking	Simple Explanation Construction Interference Explanation and Rationality	(Zulmaulida and Dahlan 2018)
Creative Thinking	Originality Fluency Flexibility Elaboration	(Megawan and Istiyono 2019)
Communication	Oral Communication Receptive Communication Understanding Attitude Clarity	(Afriani, Wilujeng and Kuswanto 2019)
Collaborative	Task Focus Team Participation Responsibility Reliable Listen, Think, and Discuss	(de Hei et al. 2020)

The results of each skill will be hypothesized using an independent sample t-test comparing the pretest and N-Gain scores from the two classes with a design that can be seen in TABLE 3.

TABLE 3. Pretest-Posttest Control Group Design

Sample	Class	Pretest	Treatment	Posttest
Cluster Random	Experiment	X_1	T_1	X_2
Sampling	Control	Y_1	-	Y_2

The evaluation shows the results in the form of evaluating the results of statistical tests on the 4C skills values that have been obtained to the results of validation and practicality.

RESULTS AND DISCUSSION

This study aims to develop a complete laboratory activity model with a guidebook to the results that can be in the form of 4C skills using the ADDIE model R&D method. The explanation for each ADDIE stage will be discussed in stages.

Analysis

Models of laboratory activities in general still use conventional models such as cookbooks or inquiry-guided laboratories. A previous study revealed that the need for ICT in learning models must develop because, in the 21st century, students are required to master technology that will develop rapidly in the future. Inline, other research which analyzed learning models, including laboratory activities, that not all learning models can facilitate technological needs. So, students are perceived to only master one ability, and the abilities mastered are still considered basic abilities, not abilities needed in the 21st century (Khoerunnisa and Aqwal 2020). Other related studies had integrated two laboratory activities models, namely PjBL and STEM. They still felt he had to repeat the activities to achieve the two goals (Rochim, Prabowo and Budiyanto 2021). From various problem analyses, previous research found that the needs of the Education students of UIN Sunan Gunung Djati Bandung require integration between two types of laboratory activities, namely the combination of real and virtual. In addition to direct experience, students can also know the use of technology (RP Putra et al. 2021). Researchers took initial data to analyze the needs of educators and students for laboratory activities which can be seen in TABLE 4.

TABLE 4. Preliminary Study Results

Target	Aspects	Response (%)	
		Yes	No
Lecturer	Real-Virtual Integration	84.5	15.5
	ICT Application	76.4	23.6
	Effective learning hours	97.3	2.7
	Activity flexibility	100	0
	Hybrid alternative	68.2	31.8
Students	Effective learning hours	42.7	57.3
	Activity flexibility	88.2	11.8
	Use of ICT	100	0
	Real tool knowledge	100	0
	Analytical skills	100	0

A previous study on hybrid activities revealed the various shortcomings of hybrid activities with two or more models, which include; (1) Time will be wasted because there must be more prepared in making assessments; (2) There will be gaps in learning outcomes; (3) Make students confused because the learning process is changing; and (4) Undirected teaching and learning process (Raes et al., 2020).

Design

The design of laboratory activity model of the *Sophisticated Blending Laboratory* (STB-LAB) is designed with the characteristics; (1) Using constructivism learning theory; (2) Oriented to balancing

LOTS with HOTS cognitive which focuses on the disposition of LOTS-HOTS by applying concepts to the material presented; (3) Provide a stimulus for higher-order thinking by utilizing the lower-level as a starting point; (4) Comparing the results between virtual and real as a benchmark for high-level analysis; (5) Using levers as a benchmark for the transition from LOTS to HOTS; (6) Setting of activities is Persuasive-Axiological; (7) Using computing and big data; (8) Real-world problems are constructed with a 1:2 truth ratio with reasons. The STB-LAB laboratory activity model has a syntax with five stages, namely; (1) Disposition Stage; (2) the argumentation stage; (3) Verification Phase; (4) Laboratory Stage; (5) Communication Stage.

The disposition stage will present a problem in everyday life with three or more arguments raised on real-world problems. The arguments raised on real-world problems have a truth ratio of 1:2, intending to understand the initial concept of a material presented and be able to understand what will be done in laboratory activities later, to create imagination and curiosity of students towards answers. In addition, it will make it easier for students in the variables to be studied later. The disposition stages of the STB-LAB are based on the Gestalt and Piaget learning theory which says that learning is needed as a means to build and develop experience (Anidar 2017; Indrawati 2019). In addition, a related study presenting a stimulus to real events experienced daily will stimulate students to understand what will be learned. Students will also realize the importance of seeking information before activities (Malik et al. 2017).

The argumentation stage is carried out in three activities; namely, the first activity in the argumentation stage of the STB-LAB model is an argumentation activity in which students individually determine arguments and describe hypotheses for the selected arguments. The second activity is the description of the basic theory in which students describe related theories with the arguments chosen to put forward are logistical and rational. Then the third activity is argumentation discussions, where students exchange arguments while exchanging thoughts and opinions to get to know each other and learn new things from different points of view. The argumentation stage is in line with Vygotsky’s learning theory, which in learning must build awareness and the foundation for what is being said so that it becomes an idea that people can accept (Sulisworo, Ristiani and Kusumaningtyas 2019). Other research shows that students must be able to build trust in the arguments raised when they have an opinion. Arguments based on theories and concepts will be more easily accepted by people and also support opening new minds for the interlocutor (Harackiewicz and Priniski 2018). Another study revealed that if someone often has an opinion so that they can estimate people’s opinions, a very rapid communication skill will be created (ES 2017). Bruner’s social-constructivism learning theory (Rannikmäe, Holbrook and Soobard 2020) is also in line with the formation of communication skills in which necessary learning takes place between friends and educators, with the aim of being able to build on each other and gain new knowledge so that a broad mindset.

The verification stage is a stage in the STB-LAB model where students will conduct laboratory activities virtually by conducting initial exploration, namely determining and determining the variables used in real laboratory activities. The use of virtual laboratories at the beginning of the activity is also aimed at building students’ understanding of reading data, data collection, and operating tools so that when doing real laboratory activities, students will not be confused later. In addition, students can find out if the data obtained are correct or not by looking at the pattern of values obtained. A previous study (Ramadiani et al. 2022) revealed that the virtual laboratory has no difference in the data generated between the virtual laboratory and a real laboratory. The results obtained are the same, only with a difference of about 0.4% due to environmental errors or human error in taking real laboratory data. Related studies revealed that the research subjects felt less confident when doing a real laboratory and stammered (Aşıksoy and Islek 2017). Still, the results when using a virtual lab first showed that research subjects felt more confident and had no doubts when carrying out real laboratory activities.

The laboratory stage is a stage in the STB-LAB model where students carry out real activities with thought and overall data collection, which will later filter the data according to individual needs to answer the hypotheses proposed statistically. Then, students process and analyze virtual laboratory data and real laboratories, which they will later compare the results between virtual laboratories and real laboratories. The collaborative ability can be seen in laboratory activities, especially when collecting data together. This can be seen from how compact they are in making decisions and their groups in work teams (Malik et al. 2021). A person’s creative thinking ability can be known and measured when carrying out an activity as a team, which measures how proficient a person is in finding new steps or new breakthroughs when collecting data, thus making data collection more flexible and efficient (Khoiri et al. 2017). In addition, the analytical ability when carrying out laboratory activities (Agustian and Seery 2017) explains that analytical thinking skills can be seen when students can distinguish variables and know which data are appropriate to use.

The communication stage is the final stage in the STB-LAB model where students make reports on laboratory activities which can be in the form of videos, reports, and articles which will be equipped with hypothesis test results to determine the final hypothesis as well as the initial hypothesis of what has been in the argumentation session. Relevance with John Dewey's learning theory (Williams 2017), in which learning tools must build a typical stage so that he can master and dare to speak in line or carry out tests later. In addition, the ability to think analytically will work (Seery et al. 2017). Analytical thinking skills will be seen when students can describe their findings based on statistical testing and alignment between discussions (Ghani et al. 2017).

The design stage also provides expert validity results focusing on content and construct validity proportionally. This validation is carried out before conducting product trials. The results of input and suggestions from the validator can be seen in TABLE 5.

TABLE 5. Product Revision Results

Before Revision	After Revision
The learning theory used is not appropriate and not well described	Readjusting learning theory and adding learning theory according to the stages in the syntax
The sentences used in the syntax are less operational, and the flexibility of educators is not described	Sentences are replaced by using operational sentences and change the flexibility of educators by combining two stages, namely disposition, and argumentation
Lack of clarity on learning activities at the stage of laboratory activities	Clarify the stages of laboratory activities by adding what educators and students should do
There are errors in spelling and writing in foreign languages	Improve spelling and writing of foreign languages
Skills or achievements at the disposition stage are not clearly described, and there is a lack of references at the disposition stage	Add and hierarchical references to skills or achievements that students will obtain

After carrying out the syntax revision stage from the expert validation results as in TABLE 5, it is then re-assessed by the content and construct validity date validators which can be seen in TABLE 6.

TABLE 6. The Results Assessment of STB-LAB Model

Aspects	Indicator	Percentage (%)	Total (%)	Category
Content Validity	Syntax support theory	80	90	Good
	Activity description	100		
	Implementation	80		
	Clarity of content	100		
Construct Validity	Component	100	95	Good
	Hierarchy	100		
	Accuracy	80		
	Clarity of achievement	100		

The results from TABLE 6, the assessment of the STB-LAB model, show that the final result of validity gets a value of 90%, and construct validity gets a value of 95%, which shows that both validity states are valid or feasible for testing to students.

Development

The development carried out is the development of the STB-LAB model with the guidebook—the STB-LAB laboratory activity model guide book it can be seen in TABLE 7.

TABLE 7. Description of the STB-LAB Model Guidebook Section

No	Section (Indonesian)	Section (English)	Description
1.	Cover	Cover	Consists of the title of the guidebook, and the name of the author
2.	Kata Pengantar	Foreword	Thanks and hope for the author for education in the future to hope for the readers
3.	Daftar Isi	Table of Content	Information page for all chapters and sub-chapters
4.	Bab I (Pendahuluan)	Chapter I (Introduction)	
5.	Karakteristik STB-LAB	STB-LAB Characteristic	Explain the characteristics of the STB-LAB and why the STB-LAB was created
6.	Sistematika	Systematics	Explain the systematics of the STB-LAB model for hybrid alternatives
7.	Diagram Alur STB-LAB	STB-LAB Flowchart	Explaining the systematics of the STB-LAB model in a flow chart
8.	Tahapan Model STB-LAB	STB-LAB Model Stages	Explain the steps that must be carried out on the STB-LAB model
9.	Bab II (Panduan Virtual Laboratory)	Chapter II (Virtual Laboratory Guide)	
10.	Perbandingan HTML 5 dan Java	HTML 5 and Java Comparison	Comparing HTML 5 and Java and their advantages and disadvantages
11.	Instalasi Java	Java Installation	Guide how to install Java for virtual laboratory use
12.	Bab III (Panduan Data Analysis)	Chapter III (Data Analysis Guide)	
13.	Analisis Data Dalam Eksperimen	Data Analysis in Experiment	Explain the purpose of data analysis in experiments
14.	Jenis Data	Type of Data	Explain the types of data in experiments
15.	Analisis Data Penelitian Kualitatif	Qualitative Research Data Analysis	Explain how the flow of qualitative research data analysis
16.	Pola Data Kualitatif	Qualitative Data Pattern	Explain the data patterns used in qualitative research
17.	Metode Analisis Data Penelitian Kualitatif	Qualitative Research Data Analysis Method	Describe what methods are used in qualitative research
18.	Analisis Data Penelitian Kuantitatif	Quantitative Research Data Analysis	Explain how the flow of quantitative research data analysis
19.	Metode Analisis Data Penelitian Kuantitatif	Quantitative Research Data Analysis Method	Describe what methods are used in quantitative research
20.	Pertimbangan/Masalah Dalam Analisis	Considerations/Problems in Analysis	Describes what must be considered or problems that arise when conducting an analysis to how to overcome them
21.	BAB IV (Petunjuk Model STB-LAB)	CHAPTER IV (STB-LAB Model Instructions)	
22.	Capaian Pembelajaran	Learning Outcomes	Describes what are the achievements obtained when carrying out STB-LAB laboratory activities that are adjusted to the KKNI for Physics Education
23.	Deskripsi Petunjuk Praktikum	Description of Practical Instructions	Describes the general use of the STB-LAB model
24.	Petunjuk Penggunaan	Instructions for use	Describe the instructions for use one by one in laboratory activities on the STB-LAB model
25.	Contoh Modul	Module Example	Explain the example of the module along with the answer key for each question/argument posed on a real world problem

After the guidebook is completely made as in TABLE 7, the validity test is carried out by the validator which is reviewed on content and construct validation. The results of the validity can be seen in TABLE 8.

TABLE 8. The Results Guidebook of STB-LAB Model Validation

Aspects	Indicator	Percentage (%)	Total (%)	Category
Content Validity	Suitability	80	85	Good
	Clarity of typing	60		
	Implementation	100		
	Clarity of content	100		
Construct Validity	Component	80	75	Good
	Hierarchy	80		
	Accuracy	80		
	Clarity of achievement	60		

Implementation

This STB-LAB laboratory activity model is implemented for the subject. The subjects in the control class were 30 students in the early semester of the Physics Education Study Program at UIN Sunan Gunung Djati Bandung. Then the experimental subjects were carried out on the second-semester students of the Physics Education Study Program at UIN Sunan Gunung Djati Bandung; 30 people have collected again. The laboratory activity model in the control class is laboratory-guided inquiry, while the experimental class performs maintenance using the STB-LAB model. Initial results at the implementation stage can be seen in TABLE 9 for the control class N-Gain and TABLE 10 for the experimental class N-Gain and graphs, which can be seen in FIGURE 2 for the control class, and FIGURE 3 for the experimental class.

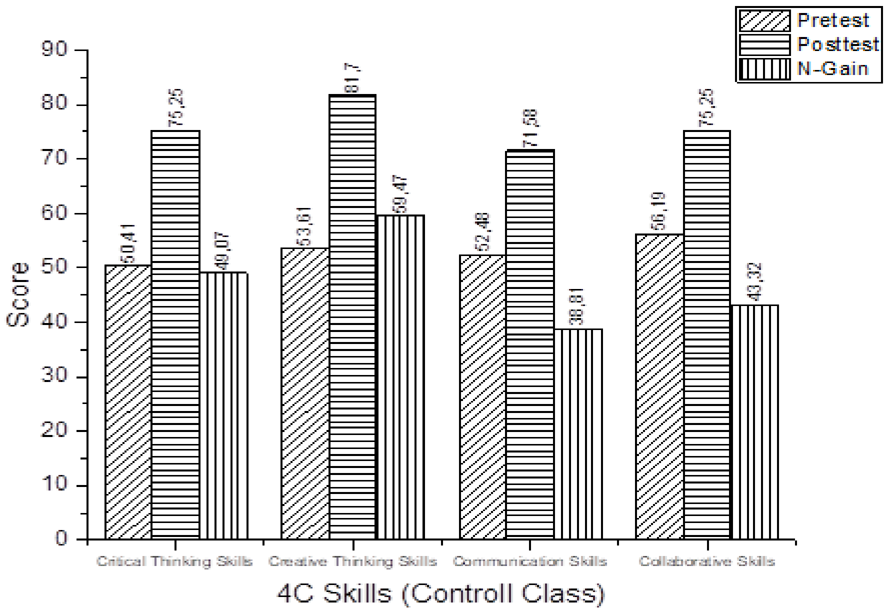

FIGURE 2. Graph of The Average Pretest, Posttest, and N-Gain Score of 4C Skills in Control Class

TABLE 9. Average of Pretest, Posttest, and N-Gain Score of 4C Skills in Control Class

Aspects	Type	Score	Category
Critical Thinking Skills	Pretest	50.41	Enough
	Posttest	75.25	Good
	N-Gain	49.07	Less Effective
Creative Thinking Skills	Pretest	53.61	Enough
	Posttest	81.70	Good Enough
	N-Gain	59.47	Effective Enough
Communication Skills	Pretest	52.48	Enough
	Posttest	71.58	Good
	N-Gain	38.81	Not Effective
Collaborative Skills	Pretest	56.19	Enough
	Posttest	75.25	Good

	N-Gain	43.32	Less Effective

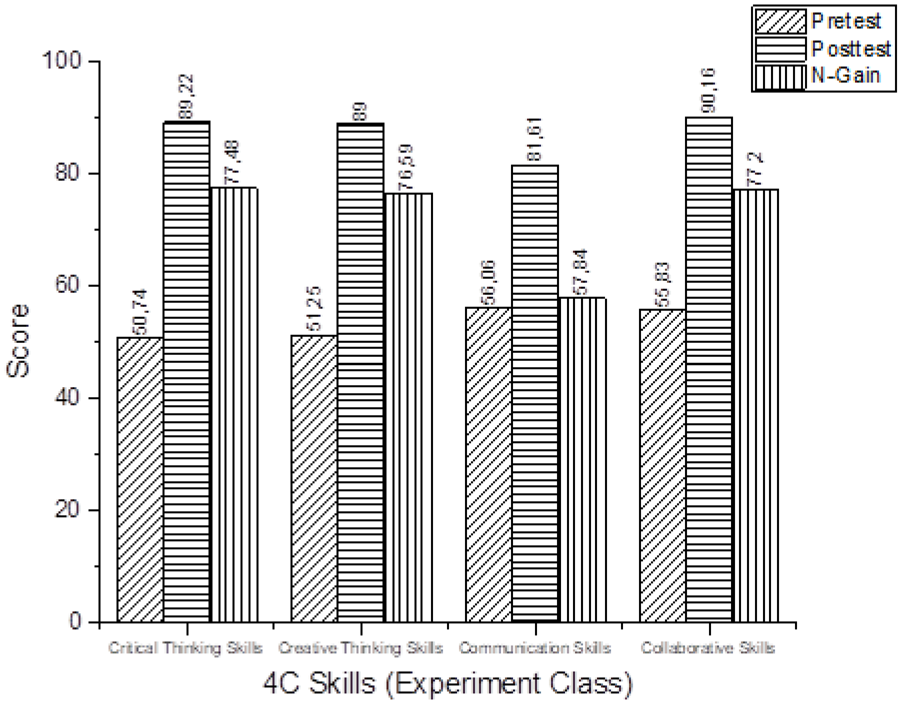

FIGURE 3. Graph of The Average Pretest, Posttest, and N-Gain Score of 4C Skills in Control Class

TABLE 10. N-Gain Score of 4C Skills in Experiment Class

Aspects	Type	Score	Category
Critical Thinking Skills	Pretest	50.74	Enough
	Posttest	89.22	Good Enough
	N-Gain	77.48	Effective
Creative Thinking Skills	Pretest	51.25	Enough
	Posttest	89.00	Good Enough
	N-Gain	76.59	Effective
Communication Skills	Pretest	56.06	Enough
	Posttest	81.61	Good Enough
	N-Gain	57.84	Effective Enough
Collaborative Skills	Pretest	55.83	Enough
	Posttest	90.16	Excellent
	N-Gain	77.20	Effective

The results of the N-Gain in FIGURE 2 and TABLE 9 show that the effectiveness in the control class that gets the sufficient category is in the aspect of creative thinking skills. In contrast, the other three aspects get the category below are quite effective. Meanwhile, in the control class shown in the results of the N-Gain FIGURE 3 and TABLE 10, it shows that the effectiveness of the experimental class is effective in three skills; (1) Critical Thinking Skills; (2); Creative Thinking Skills; and (3) Collaborative Skills. FIGURE 3 and TABLE 10 show that using the laboratory activity model can improve 4C Skills in the N-Gain category.

Evaluation

The final stage of developing the STB-LAB model is to determine the statistical improvement of 4C Skills starting from normality and homogeneity, then an independent sample t-test for each aspect. The normality and homogeneity test results in each aspect can be seen in TABLE 11.

TABLE 11. Results of Normality and Homogeneity Test in 4C Skills

Aspect	Score in	Class	Mean Score	Normality	Homogeneity
Critical Thinking Skills	Pretest	Control	50.41935484	0.200	0.311
		Experiment	50.74194	0.112	
	N-Gain	Control	49.0703245	0.200	0.071
		Experiment	77.48856567	0.063	
Creative Thinking Skills	Pretest	Control	53.61290323	0.112	0.955
		Experiment	51.25806452	0.055	
	N-Gain	Control	59.47311919	0.200	0.957
		Experiment	76.59841173	0.119	
Communication Skills	Pretest	Control	52.48387097	0.066	0.085
		Experiment	56.06451613	0.101	
	N-Gain	Control	38.81364099	0.200	0.932
		Experiment	57.84621547	0.136	
Collaborative Skills	Pretest	Control	56.19354839	0.083	0.486
		Experiment	55.83870968	0.077	
	N-Gain	Control	43.32210904	0.150	0.901
		Experiment	77.2	0.200	

Normality and homogeneity tests are the main requirements in the paired sample t-test which will later become a reference in determining the hypothesis of 4C skills improvement. Based on TABLE 11, the critical thinking skills aspect results showed that the normality of the pretest control class got a result of 0.200 with = 0.050, then sig. > data is normally distributed, while the experimental class shows the result of 0.112, then sig. > data is normally distributed, the homogeneity shows a value of 0.311 which means sig. > homogeneous data. While the N-Gain shows that the control class has a normality of 0.200 and the experimental class of 0.063, it shows that the N-Gain normality in both classes is normally distributed with sig. >, the homogeneity shows a value of 0.071 which means sig. < homogeneous data.

Based on TABLE 11, the creative thinking skills aspect shows that the normality of the pretest control class gets 0.112 results with = 0.050, then sig. > data is normally distributed, while in the experimental class, the results are 0.055, so sig. > data is normally distributed. The homogeneity shows a value of 0.955 which means sig. > homogeneous data. While the N-Gain shows that the control class has a normality of 0.200 and the experimental class of 0.119, it shows that the N-Gain normality in both classes is normally distributed with sig. >, the homogeneity shows a value of 0.957 which means sig. < homogeneous data.

Based on TABLE 11, the aspect of communication skills shows that the normality of the pretest control class gets a result of 0.066 with = 0.050, then sig. > the data is normally distributed, while the experimental class shows the result of 0.101 then sig. > data is normally distributed. The homogeneity shows a value of 0.085 which means sig. > homogeneous data. While the N-Gain shows that the control class has a normality of 0.200 and the experimental class of 0.136, it shows that the N-Gain normality in both classes is normally distributed with sig. >, the homogeneity shows a value of 0.932 which means sig. < homogeneous data.

Based on TABLE 11, the collaborative skills aspect shows that the pretest normality of the control class gets a result of 0.083 with = 0.050, then sig. > data is normally distributed, while in the experimental class, the results are 0.077, so sig. > data is normally distributed, the homogeneity shows a value of 0.486 which means sig. > homogeneous data. While the N-Gain shows that the control class has a normality of 0.150 and the experimental class of 0.200, it shows that the N-Gain normality in both classes is normally distributed with sig. >, the homogeneity shows a value of 0.901 which means sig. < homogeneous data. The results of normality and homogeneity in both classes of each aspect do not show abnormal or non-homogeneous data, the next step is to find the significant value in the paired sample t-test, the results of which can be seen in TABLE 12.

TABLE 12. Paired Sample T-Test Results on 4C Skills aspect

Aspects	Paired Sample T-Test	
	Control	Experiment
Critical Thinking Skills	0.318	0.000
Creative Thinking Skills	0.001	0.000
Communication Skills	0.058	0.013
Collaborative Skills	0.077	0.000

TABLE 12 shows that the statistical analysis of paired sample t-test on 4C skills shows that in the control class, only creative thinking skills get sig. < α, while in the experimental class, none of the values obtained sig. > α. Based on the hypothesis H0 = there is an increase in ability, and Ha = there is no increase in ability. The hypothetical decisions taken in the control class from table 12 are; (1) Reject H0, accept Ha for critical thinking skills; (2) Accept H0, reject Ha for creative thinking skills; (3) Reject H0, accept Ha for communication skills; (4) Reject H0, accept Ha for collaborative skills. The hypothetical decisions taken in the experimental class from TABLE 12 are in every aspect of the 4C skills: accept H0 and reject Ha.

CONCLUSION

Based on the results of the development and statistical results found, it can be concluded that the Sophisticated Thinking Blending Laboratory (STB-LAB) laboratory activity model has been successfully developed by showing the results of content validation of 90% and construct validity of 95%, the results of both validations on the STB-LAB model shows good category. In the STB-LAB guidebook, the content validation results are 85%, and construct validity is 75%, the results of the two validations in the preparation of the STB-LAB guidebook show a good category. In general, the STB-LAB model consists of 5 stages, namely; (1) Stages of disposition; (2) Stages of Argument; (3) Verification stage; (4) Laboratory Stages; (5) Communication stages. The results of the 4C skills evaluation show that in the control class N-Gain test, only aspects of creative thinking skills are categorized as quite effective, while the other three aspects get results below. Meanwhile, the results of the N-Gain test in the experimental class showed that only communication skills were categorized as quite effective. At the same time, the other three aspects got the above results. The results of the paired sample t-test show that in the control class, only creative thinking skills can improve, while in the experimental class, all 4C skills can improve. It is hoped that in further research, the use of STB-LAB in this laboratory activity will focus on improving 4C skills and other abilities.

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Appendix

Appendix 1. Forms / Assessment Techniques

Type	Skills	Technique	Forms	Execution time	Information
Cognitive	*Critical Thinking Skills*	Written Test and Observation	Essay and/or Multiple Choice	Disposition/Argumentation Session, Verification Session/Lab Session	Pretest-Posttest and Observation Analysis
	Creative Thinking Skills	Modules and Observations	Observation sheet	Disposition/Argumentation Session, Verification Session/Lab Session, Communication Session (Modules and Video)	Analysis of Module Question Answers and Observations
	Communication Skills	Articles and Observations	Questions in Module	Disposition/Argumentation Session, Verification Session/Lab Session, Communication Session (Videos and Articles)	Article Grammar Analysis and Observation
	Collaborative Skills	Observation and Response Questionnaire	Observation sheet	Disposition/Argumentation Session, Verification Session/Lab Session.	Observation and Response Analysis

Appendix 2. Critical Thinking Skills Assessment Rubric for Stb-Lab-Based Laboratory Activities

NO	Critical Thinking Ability	Sub Critical Thinking Ability	Details
1	Giving a simple explanation	Focusing argument	Can identify the basic theory of the arguments presented and can formulate the basic theory of the arguments presented
		Analyzing Arguments	Can sort out the variables thrown in the argument so as to create an initial conclusion on the selected argument
2	Basic Skill Construction	Determine how to handle the problem	Can determine a series of research to answer scientific arguments and based on test results
3	Trial Interference in conclusion	Deducing and considering a deduction	Interpreting questions
		Induce and consider an induction	Generalize and conduct research in order to obtain experimental data to support the selection of arguments
4	Manufacture in Further Explanation	Definition of terms in problems	Classify and give analogies based on the findings
		Identifying Assumptions	Identify assumptions and reasons not stated
5	Strategy and Tactics	Communicating with other people	Constructing a statement

Appendix 3. Creative Thinking Skills Assessment Rubric for Stb-Lab-Based Laboratory Activities

Aspects of Creative Thinking Skills	Sub-Aspects of Creative Thinking Skills	Score			
		1	2	3	4
Originality	The Success of Practicum Experiment Ideas	Provide an overview of the practical series as directed by the instructor	Provide an overview of a series of practicums that have been done by many others	Provide an overview of a series of practicums that have been carried out by many others but have made modifications	Provide an overview of a series of practicums that other people and instructors have never thought of
	Authenticity of Answers	Give the same answer as directed by the instructor	Giving the same answer as everyone else	Giving the same answer as everyone else but making modifications	Give answers that have never been thought of by other people or instructors
Fluency	Giving Idea in Argumentation	Not adding new ideas to the argument	Gives new ideas to arguments but just like everyone else	Give new ideas on the same argument as others but make modifications	Give new ideas to arguments that have never been thought of by other people or instructors
Flexibility	Completing Data Processing	Did not complete data processing as a whole	Complete data processing partially	Completed data processing as a whole but something went wrong	Complete data processing as a whole properly and correctly
	Completing Calculations	Didn't complete the whole calculation	Complete the partial calculation	Completed the whole calculation but something went wrong	Complete the overall calculation properly and correctly
	Completing Data Analysis	Didn't complete of data analysis	Complete partial data analysis	Completed data analysis according to the initial hypothesis variable but something went wrong	Completing data analysis in accordance with the initial hypothesis variables properly and correctly
Elaboration	Module Equipment	Does not complete the module	Complete module partially	Complete modules only in their respective activities	Complete the module as a whole
	Video Equipment	Didn't make videos of laboratory activity results	Make a video of the results of laboratory activities but it is not complete	Make a complete video of the results of laboratory activities but the same as everyone else	Make a complete video of the results of laboratory activities

Appendix 4. Communication Assessment Rubric for Stb-Lab-Based Laboratory Activities

Assessment Aspect	Sub-Aspect	Score	Indicator
Oral Communication	Sound Volume	4	Practitioners are able to communicate with a strong voice volume, appropriate intonation, and clear articulation and the background is not too loud
		3	Practitioners sometimes communicate with a strong voice volume, appropriate intonation, and clear articulation but are disturbed by the background sound that is too loud
		2	Practitioners sometimes communicate with a strong voice volume, appropriate intonation, and clear articulation
		1	The practitioner does not communicate with a strong voice volume, appropriate intonation and clear articulation
	Attractiveness	4	Practicing two-way communication and not being distracted
		3	Practicing two-way communication but sometimes gets distracted
		2	Practitioners only communicate one way
		1	The practitioner does nothing during the presentation
Reseptive Communication	Identification	4	Practitioners are able to determine facts, opinions to identify and summarize the main ideas that will be conveyed accurately and in their entirety
		3	Practitioners are able to determine facts, opinions to identify and summarize the main ideas that will be conveyed accurately but not in its entirety
		2	Practitioners are able to determine facts, opinions to identify and summarize the main ideas that will be conveyed but are not correct at all
		1	The practitioner is not able to determine facts, opinions to identify and summarize the main ideas that will be conveyed
	Reading	4	Practitioners deliver presentations not by reading the text in its entirety and not by displaying full-text and not haltingly
		3	Practitioners deliver presentations not by reading the text in its entirety and not by full-text display but sometimes stuttering
		2	Practitioners deliver presentations by reading the text in its entirety but not in full-text display
		1	Practitioners deliver presentations by reading the text in its entirety with a full-text display
	Listening	4	The practitioner listens to directions from the instructor and can identify facts in a message/information
		3	The practitioner listens to directions from the instructor but there is a miscommunication in identifying facts in a message/information
		2	The practitioner listens to the instructions from the instructor but is unable to identify the facts in a message/information.
		1	Practitioners do not listen to directions from the instructor so they cannot identify facts in a message/information
Understanding	Understand the purpose/purpose of communication	4	The practitioner is able to translate messages properly and correctly
		3	The practitioner is able to translate the message well but it is not complete
		2	The practitioner is able to understand the main idea of a message but needs help in translating it.

Appendix 5. Collaboration Thinking Skills Indicators For Stb-Lab-Based Laboratory Activities

Indicator	**Exceeding Expectations (4)**	**Expected (3)**	**Near Expected (2)**	**Not Meeting Expectations (1)**
Focus on the task	Consistently stay focused on the task	Focus on the task most of the time	Rarely focus on task	Not focused on the task
Participation in groups	Effectively participates in overall group efforts and is able to lead discussions	Participate in group efforts	Sometimes participates in group efforts	Letting others do the work and not participating in group efforts
Share responsibility	Consistently on time with assignments and responsible for distributing tasks evenly	On time with duties and responsibilities	Sometimes punctual with his duties and responsibilities	Not on time with his duties and responsibilities
Reliable	Do the assigned tasks and don't depend on others to do the work	Follow most of the assigned tasks	Rarely follows the given task	Not following the assigned task
Listen, think, and discuss in groups	Consistently and respectfully listen, interact, discuss, and contribute to the group and help the group to reach mutual agreement	Respectfully listen, interact, discuss, and contribute to the group.	Sometimes listening, interacting, discussing, and contributing to the group.	Not interacting, discussing, and contributing to the group.