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Fostering Critical Thinking Skills and Scientific Epistemological Beliefs through Flipbook-Assisted POE2WE

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ABSTRACT
This research aims to improve critical thinking skills and Scientific Epistemological Beliefs (SEB) through Flipbook-Assisted Predict Observe Explain Elaboration Write Evaluation (POE2WE) learning model. Critical thinking and good SEB are educational mandates in the curriculum and 21st-century skills. This research was conducted in two classes, namely classes 7A and 7B at the SIKL. This research was a quantitative experiment using posttest-only nonequivalent group. The instruments used to collect data are critical thinking tests and SEB questionnaires. The results of the critical thinking test were analyzed using the Independent Sample T-test. The t-test results obtained were 0.89, greater than 0.05. The highest indicator of critical thinking ability is Basic Clarification with an average score of 91,37. Meanwhile, students SEB were reviewed from the results of filling out the questionnaire, the highest indicator obtained was source with a response of 56.9%. Thus, using the Flipbook-Assisted POE2WE model can significantly improve students' critical thinking skills and SEB.

Keywords: *critical thinking skills, science epistemological beliefs (SEB), predict observe explain elaboration write evaluation (POE2WE), flipbook, 21st-century skills*

INTRODUCTION

Education is important in preparing the young generation to face future challenges. Entering the 21st century, the world of education is experiencing increasingly complex challenges and changes. 21st-century learning is a learning transition where the developed curriculum guides schools to change their learning approach *theacer centered* become *student-centered* (Haniyah, 2022). To play a meaningful role in the era of globalization in the 21st century, every citizen must have skills that can respond to the demands of contemporary developments or what is usually called 4C (Sartini & Mulyono, 2022). These skills include creativity, critical thinking, collaboration, and communication skills (Kemendikbudristek, 2017). Critical thinking is an important skill to improve, because with this skill students can process information objectively and reach appropriate and effective decisions (Ariadila et al., 2023).

The curriculum refers to a 21st-century learning approach, where students are the center of learning which gives educators the freedom to design learning that suits students' needs (Anton & Trisoni, 2022). Students are also free to explore projects given by educators. It plays a

role in developing 21st-century skills, especially students' critical thinking (Djaja et al., 2023). It can improve critical thinking skills through in-depth analysis, evaluation, and assessment activities (Fakhri Akhmad, 2023), where these activities are included in the process of the nature of science.

According to Ennis, the five critical thinking indicators include basic classification, the basis for decision-making, inference, further clarification, also strategy and tactics (Ennis, 2015). The five indicators are then broken down into eighteen sub-indicators. Basic clarification indicators include focusing on questions, analyzing arguments, asking and answering clarification questions, and using elementary graphs and math. The basis for decision sub-indicators is judging the credibility of a source, observing, and judging observation reports, and using existing knowledge. Inference sub-indicators are deducing, and judging deductions, making, and judging inductive inferences and arguments, making, and judging inductive inferences and arguments, and making, and judging value judgments. Advanced clarification sub-indicators are defining terms, and judging definitions, handling equivocation appropriately, attributing and judging unstated assumptions, thinking suppositionally, dealing with fallacy labels, being aware of, and checking the quality of, their thinking, dealing with things in an orderly manner, employing rhetorical strategies. The sub-indicators of not constitutive, but often helpful if not misused only employ rhetorical strategies.

The five critical thinking indicators have a close relationship with the POE2WE model syntax. One of the examples of this relation is shown in the critical thinking indicators that are basic to decision-making. Basic indicators for decision-making can be trained through the observation stage, where students are asked to make observations and consider the results of the observations. So, students can achieve basic indicators for decision-making through these activities. The research results show that the natural science learning process with the application of the POE2WE learning model in the teaching and learning process is very important for improving student learning outcomes. These activities make the learning situation more enjoyable and attractive to students (Marhento, 2020)(Tri Wulandari & Adam Mudinillah, 2022). From this explanation, it was found that the syntax of the POE2WE model was compatible with critical thinking indicators.

The nature of natural science is a fundamental understanding of natural science which includes three important aspects. These three aspects include product, process, and attitude. Natural science products refer to findings resulting from research. The science process refers to the way to obtain knowledge. Meanwhile, science attitudes include the behavior that teachers expect from students. Science attitudes are closely related to Science Epistemological Beliefs (SEB) because students are expected to have the belief that knowledge is obtained from exploring new concepts in learning. It is important to improve Science Epistemological Beliefs (SEB) so that students can respond to, understand, and interpret scientific knowledge well (Kampa et al., 2016).

Scientific Epistemological Beliefs (SEB) is the process of forming beliefs held by individuals about scientific knowledge and the basis for thinking about the origin, nature, and types of scientific knowledge. SEB is the most basic provision for students to understand knowledge and create knowledge for themselves. Each student has a different concept of SEB from one another. SEB is considered important in the interpretation of information about scientific knowledge. In the field of educational research, SEB is focused on science learning. SEB was measured using the Conley (2004) instrument. According to Conley, SEB includes certainty, development, source, and justification in knowledge (Schiefer et al., 2022). These four indicators relate to the POE2WE syntax. An example of this connection is in the source aspect, students' beliefs in the source of knowledge come from authorities, for example, teachers and books, which can be constructed through the syntax of the POE2WE model in the observation stage. Meanwhile, the justification aspect is related to student's beliefs about the process of

receiving and justifying knowledge, where this activity can be constructed through the syntax of the POE2WE model at the explanation stage.

In fact, at the Kuala Lumpur Indonesian School, students' critical thinking abilities and SEB are low as evidenced by the results of interviews with science subject teachers. Limited learning activities cause the low critical thinking and SEB abilities of students. Limited learning in question is learning that is only teacher-centered or incomplete implementation student-centered (Kismawati et al., 2022). Teachers provide more explanations rather than paying attention to students' responses to the material presented (Djonomiarjo & Patilanggio, 2018)(Muna, 2017). Lack of media use also limits student learning and responses. So, a learning model is needed that utilizes the use of media to support student-centered learning. One learning model that can be implemented is the Predict Observe Explain Elaboration Write Evaluation (POE2WE) learning model with the help of a flipbook. POE2WE was developed from the Predict Observe Explain (POE) learning model which was first introduced by *White and Gunstone* in 1995 in his book entitled Probing Understanding.

The POE2WE Learning Model is a student-centered learning model with six stages: predict, observe, explain, elaborate, write, and evaluate. The first stage is prediction, students are facilitated to make predictions about the problems presented by the teacher. The second stage is observing, students carry out experiments related to the problems found. The third stage is explaining, students explain the results of their observations through presentations in front of peers. The fourth stage is elaboration, this stage is related to the application of concepts that students have obtained through working on post-test questions or other things. Next, in the writing stage, students write a reflection of the knowledge gained through a summary of the learning material. The final stage of evaluation is where students evaluate the learning process through oral communication with teachers and peers or by filling out questionnaires (Yusni & Supriatno, 2023)(Nana & Surahman, 2020).

Flipbook is a digital book platform that presents learning material interactively and interestingly. In the POE2WE learning context, Flipbooks can be used to present phenomena visually and interactively. In addition, Flipbook allows students to access learning materials anytime and anywhere and provides flexibility in learning (Prasasti & Anas, 2023). Flipbook is equipped with supporting features in the form of advanced navigation and other features that can add hyperlinks, video, and audio, as well as interactive forms that can improve students' critical thinking skills in exploring material in depth. The use of Flipbooks in POE2WE learning provides significant added value. Based on the results of previous research, flipbooks prove an improvement and are said to be effective by showing success in learning. So that students can understand the material better (Putri Kumalasani & Eilmelda, 2022)(Sugianto et al., 2017).

Previous research related to the POE learning model was carried out by Li Zhao who advised educators to use the POE model in Natural Sciences (IPA) courses to improve students' Science Epistemological Beliefs abilities (Zhao & Liu, 2021). Other research related to the POE model conducted by Ayi Jaja Jamaludin stated that POE-based learning makes students more interested in science learning so POE can be an alternative learning method for training scientific literacy (Jamaludin & Sriyansyah, 2023). Meanwhile, Sofian Azhari et al. (2023) stated that after implementing the POE2WE learning model, Miftahul Khair Middle School student's critical thinking skills in science subjects had improved (Sofian Azhari et al, 2023). However, research that combines the POE2WE model with the help of Flipbook media is still very limited. The novelty of this research lies in the combination of the use of POE2WE with the help of flipbooks, which improves the student learning experience.

This research aims to improve the critical thinking skills and SEB of Indonesian School Kuala Lumpur students through the implementation of the POE2WE model assisting with Flipbook.

METHODOLOGY

This research uses a quasi-experimental method with a posttest-only Nonequivalent Group design (Ishtiaq, 2019). This research was conducted at the Kuala Lumpur Indonesian School with a population of all class VII students, where two classes received different treatment from the researchers. Class VII-A is an experimental group with 27 students who received the POE2WE learning model treatment and class VII-B is a control group. This research was carried out using blended learning via the Google Classroom platform. Blended learning is a combination of online and offline learning (Wulandari et al., 2022).

The instruments used by researchers in this research were post-tests and questionnaires. The instruments were designed based on proven theories and indicators. Each indicator was adjusted to POE2WE and Flipbook. The instruments were validated through expert judgment. The results were tested using the Aiken formula which can be seen in Table 1.

Tabel 1. Instrument Validity

	Validator	Category
Critical Thinking Test Instrument	90%	Very Valid
Questionnare SEB Instrument	94%	Very Valid

The critical thinking test was compiled based on Ennis critical thinking indicators. The post-test instrument used by researchers consisted of 15 multiple-choice questions to measure students' critical thinking skills on each indicator. The quality of each post-test item was measured through critical thinking ability indicators and an analysis was carried out on the highest indicator. Critical thinking indicators according to Ennis (2015) can be seen in Table 2.

Table 2. Critical Thinking Indicators

No.	Critical Thinking Indikator
1	Basic Clarification
2	Bases for a Decision
3	Inference
4	Advance Clarification
5	Not Constitutive, But Often Helpful If Not Misused

(Ennis, 2015)

The instrument to measure SEB refers to the instrument developed by Conley (2004). The questionnaire consists of 25 items based on four aspects of SEB. The items are in the form of statements where students are asked to rate the statement on a scale of 1-4 with the specifications 1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree (Kampa et al., 2016). SEB can be seen in Table 3.

Table 3. Science Epistemological Beliefs Indicators

No.	SEB Indicator
1	Source
2	Certainty
3	Development
4	Justification

(Schiefer et al., 2022)

The results of the post-test and questionnaires in the experimental and control classes were analyzed descriptively statistically. Descriptive statistical analysis is used to state the average of post-test and questionnaire results. Next, the results of the post-test and questionnaire were

subjected to inferential statistical analysis. Inferential statistical analysis is used to test hypotheses. In the descriptive analysis, researchers looked at the average critical thinking abilities which researchers categorized in Table 4.

Table 4. Category

Score	Category
0-19	Very less
20-39	Not enough
40-59	Enough
60-79	Good
80-100	Very good

(Sofian Azhari et al, 2023)

Before the parametric test is carried out, the data is first subjected to a prerequisite test stating that the data is normally distributed and homogeneous. A parametric test is carried out if the data is considered normal and homogeneous. This test is carried out to compare the average post-test and questionnaire of the experimental class after receiving treatment with the POE2WE learning model with the average post-test and questionnaire of the control class after receiving treatment with the conventional learning model. The following are the steps taken by researchers in the study.

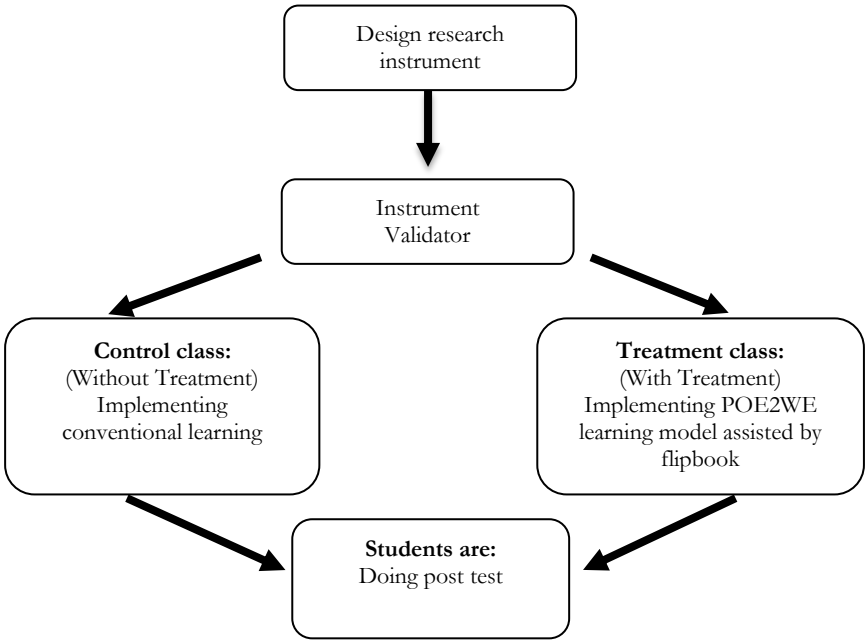

Figure 1. Research Flow

RESULT AND DISCUSSION

The data obtained by researchers is quantitative in the form of scores from the critical thinking ability posttest and the results of the Science Epistemological Beliefs (SEB) questionnaire. After conducting research in the form of a posttest, the average critical thinking ability of students was obtained based on the Ennis indicators which can be seen in Table 5.

Table 5. Average Critical Thinking Ability per Indicator

Critical Thinking Indicators	Experiment		Control	
	Rate-rate	Criteria	Rate-rate	Criteria
Basic Clarification	91,37	Very good	81,50	Very good

Critical Thinking Indicators	Experiment		Control	
	Rate-rate	Criteria	Rate-rate	Criteria
Bases for a Decision	85,20	Very good	86,43	Very good
Inference	53,07	Enough	48,13	Enough
Advanced Clarification	74,10	Good	72,87	Good
No Constitutive, But Often Helpful If Not Misused	74,07	Good	86,43	Very good

Based on Table 5, The highest critical thinking indicator is basic clarification, where this indicator gets the highest score compared to other indicators. In the experimental class, the basic clarification indicator got a score of 91,37 and the control one of 81, 50. This is the same as previous research by Alfiyanti which stated that POE can improve critical thinking skills on basic analysis indicators which scored 83 in group 1 and 81 in group 2 (Alfiyanti et al., 2020). However, this is different from Leni (2024) research which states that the basic clarification thinking indicator is an indicator that obtained a score of 47.08 in the very low category (Septiany et al., 2024).

Basic Clarification is an indicator that refers to data analysis capabilities. If related to POE2WE, basic clarification is related to prediction syntax where students are asked to carry out basic clarification by formulating a hypothesis. This indicator becomes very high, supported by the use of flipbooks at the beginning of learning. The flipbook feature in the form of data visualization can help students understand the material before formulating a hypothesis. Apart from that, the whiteboard feature also helps students write down hypotheses as well as a medium for discussion with peers. This is reinforced by the dual coding theory by Allan Paivio which states that visual emphasis in learning can train information retention.

Bases for a decision are indicators that refer to the basis for decision-making. These indicators relate to the POE2WE syntax for the observation stage. At the observation stage, students are asked to collect relevant information to support the hypothesis that students have made. This activity is in line with constructivism theory, where students build knowledge through direct observation and with additional assistance in the form of flipbooks to gain understanding based on real experience.

Advanced Clarification is an indicator that refers to the ability to explain an idea. This ability is trained through POE2WE syntax in the elaboration and writing stages, students connect the information obtained with additional knowledge through information media such as flipbooks. This is related to the theory of meaningful learning by David Paul, where meaningful learning is learning that connects new information with concepts that are relevant to a person's cognition (Gagne et al. 2022).

No constitutive, but often helpful if not misused is an indicator that refers to strategies and tactics in learning. These strategies and tactics are trained through the POE2WE syntax in the evaluation stage. Educators provide feedback regarding the learning that students have obtained through post-tests and questionnaires. This is facilitated by educators through the hyperlink feature that educators have provided in the flipbook. Pramesty explained that evaluation is a form of strategy to find out the results of the learning process that students have gone through (Pramesty and Suratno 2022). This stage can be a guide for further learning to be better.

The lowest indicator of critical thinking is inference. The inference indicator got a score of 53.07 in the experimental class and 48.13 in the control class. Inference is an ability that refers to drawing conclusions based on available information. This indicator is related to the POE2WE syntax for the explain stage, where in this syntax students are asked to explain the results of the findings that were trained through observation activities in front of their peers. Monica stated that explaining activities can increase self-confidence, train students' communication skills, and

provide students with opportunities to be active in learning activities (Pramesty and Suratno 2022). The lack of students' ability to explain the results of observations causes students' inference abilities to be very low. This is because flipbooks do not facilitate students' inference abilities.

The parametric test was started with the prerequisite test. The results of the normality test can be seen in Table 6.

Table 6. Normality Test

Class	Uji Kormolog-Smirnov		
	Statistic	**df**	**Say.**
Experimental Class Posttest	0.159	27	0.076
Control Class Posttest	0.147	27	0.137

The commonly used significance level is 0.05. The normality test in Table 6 shows a significance value in the experimental class of 0.076 which is greater than 0.05. So it can be concluded that the experimental class posttest data is normally distributed. Then the significance value in the control class is 0.137 which is also greater than 0.05. So it can be concluded that there is not enough evidence for both data to reject Ho, both data are normally distributed. The second prerequisite test is the homogeneity test, the results of which can be seen in Table 7.

Table 7. Homogeneity Test

Levene Statistic	df1	df2	Say.
1.062	1	52	0.308

After the data was tested for homogeneity, a significance value of 0.308 was obtained. The significance value is greater than 0.05 which states that the variance of the groups being compared is homogeneous. After carrying out the two prerequisite tests in the form of the normality test shown in Table 5 and the homogeneity test in Table 6, the data can be subjected to further statistical tests. In this study, researchers conducted an Independent Sample T-test to determine whether the average of the two groups was significant. The results of the Independent Sample T-test can be seen in Table 8.

Table 8. Independent Sample T-test

	T	df	Sig. (2-tailed)
Experimental Class Posttest	0.139	52	0.890
Control Class Posttest	0.139	51.205	0.890

Based on Table 8, the significance result is 0.89 which is greater than 0.05. So it can be concluded that there is no significant difference between critical thinking skills in classes that use the POE2WE learning model and classes that use conventional learning models. This is because both learning models are aimed at improving students' critical thinking abilities. Apart from that, the learning process of the POE2WE and discovery learning models is similar. The POE2WE learning process begins with prediction, observation, presentation, elaboration, and evaluation. Meanwhile, the discovery learning model starts with stimulation, data collection, data analysis, verification, and evaluation. However, the POE2WE learning model focuses more on scientific processes and clear steps. Meanwhile, the conventional learning model prioritizes student exploration independently.

Several studies have stated that the POE2WE learning model is superior to other learning models. This was proven in research conducted by Fitriani which stated that the POE2WE model could significantly improve critical thinking skills compared to the Problem Based Learning (PBL) learning model. Meanwhile, in research conducted by Simarmata, the POE2WE

model was able to improve critical thinking skills significantly compared to the Think Pair Share (TPS) model (Alfiyanti et al., 2020; Fitriani, 2020; Simarmata & Djulia, 2019).

In the final stage, students fill out the SEB questionnaire to determine the extent to which students' scientific epistemological beliefs have increased. The results of filling out the SEB questionnaire can be seen in Table 9.

Table 9. Kuesioner Science Epistemological Beliefs (SEB)

SEB Indicator (%)	Experiment				Control			
	STS	TS	S	SS	STS	TS	S	SS
Source	2,96	11,10	63	22,94	2,96	16,28	58,54	22,20
Certainty	4,93	16,03	57,43	21,58	3,08	17,88	59,88	19,11
Development	5,18	19,88	52,62	22,20	5,18	21,46	47,40	25,90
Justification	4,52	8,57	54,74	32,11	2,46	14,80	58,04	24,66
Rate-rate	**4,39**	**13,89**	**56,94**	**24,70**	**3,42**	**17,60**	**55,96**	**22,97**

From Table 9, we can see that the majority of students in the experimental class and control showed an affirmative response to the SEB questionnaire. In the experimental class, 56.9% of students agreed that the POE2WE learning model could increase students' SEB. Meanwhile, in the control class was 55.96%. In the data above, the indicator that has the highest response is the source indicator. In line with this result, Lin's (2013) stated that the highest indicator was development because students tend to believe that science is influenced by cultural contexts, is tentative, and involves the element of creativity (Lin et al., 2013).

The source indicator is an indicator that refers to students' confidence in learning sources that come from authority, whether from educators, books, or other sources. The source indicator is closely related to the POE2WE syntax for the prediction and observation stages, where students believe in the correctness of predictions through direct data collection. This indicator got a good response because the flipbook facilitates interactive features that connect with information sources to assist students in collecting data (Fitriyanti & Suciptaningsih, 2024).

The certainty indicator refers to how students believe in absolute knowledge. This belief is trained in students through the POE2WE syntax at the explanation stage, students are asked to explain their findings so that they are then universally recognized by their peers. Based on Albert Bandura's theory in his writing entitled Social Learning Theory, it is emphasized that when an individual becomes a peer tutor, the individual not only becomes a tutor but also learns through peer feedback.

Development indicators are students' confidence in recognizing the development of science. This is related to the POE2WE syntax at the elaboration stage, where students process data obtained through observation with data obtained through additional media such as flipbooks. This is related to David's theory, where meaningful learning focuses on how students integrate new information with existing information (Gagne et al., 2022). The development indicator is the indicator with the lowest response, with 52.62% of students agreeing in the experimental class and 47.40% of students agreeing in the control class. This indicator is very low due to students' limitations in accessing online open resources other than flipbooks.

The justification indicator is trained through the POE2WE syntax at the evaluation stage because at that stage students are in the process of receiving and justifying the knowledge gained during learning. This process is supported by a post-test and questionnaire provided via the hyperlink feature on the flipbook. Evaluation is very important in learning because it functions as an educator's tool to justify student achievements. This is reinforced by Bano's research which states that evaluation activities cannot be separated from learning considering the importance of teachers evaluating each question item that has been created (Bano, 2022).

SEB descriptive statistics results can be seen in Table 10 and Table 11.

Table 10. Descriptive Statistics of Experimental Class SEB

SEB Indicator	Experiment				
	N	Min	Max	Mean	Std. Dev
Source	27	1	4	3.1852	0.6814
Certainty	27	1	4	2.7407	0.8590
Development	27	1	4	2.9259	0.7299
Justification	27	1	4	3.0741	0.6751

Table 11. Descriptive Statistics of Control Class SEB

SEB Indicator	Control				
	N	Min	Max	Mean	Std. Dev
Source	27	1	4	2.8889	0.8473
Certainty	27	2	4	2.9259	0.7299
Development	27	1	4	2.8889	0.9337
Justification	27	2	4	2.7778	0.5773

Based on Table 10 and Table 11, we can see that students in the experimental class gave a fairly high assessment of the source indicator with a mean of 3.1852, and a low assessment of the certainty indicator with a mean of 2.7407. Meanwhile, students in the control class gave a fairly high assessment on the certainty indicator with a mean of 2.9259, and a low assessment on the justification indicator with a mean of 2.7778. After carrying out descriptive statistical tests, was tested using the Mann-Whitney test, the results of which can be seen in Table 12.

Table 12. Rank Mann-Whitney Test

SEB Indicator	Experiment		Control	
	Mean Rank	Sum of Ranks	Mean Rank	Sum of Ranks
Source	27.54	743	27.46	741
Certainty	28.35	765	26.65	719
Development	26.78	723	28.22	762
Justification	29.81	805	25.19	680

Based on the results of the test in Table 12, data was obtained where the experimental class obtained a higher average than the control class on the source, certainty, and justification indicators. Meanwhile, in terms of development indicators, the experimental class obtained a lower average than the control class. However, to find out whether the difference is significant or not, it can be seen in Table 13.

Table 13. Mann-Whitney Statistic Test

	Source	Certainty	Development	Justification
Mann-Whitney U	363.500	341.500	345.000	302.000
Wilcoxon W	741.500	719.500	723.000	680.000
WITH	-0.018	-0.403	-0.341	-1.088
Asymp. Sig. (2-tailed)	0.986	0.687	0.733	0.276

Based on Table 13, the significance value for each indicator shows a number greater than 0.05. This shows that there is no significant difference between the two groups. The POE2WE and discovery learning models use the same approach, namely the scientific approach. In the scientific approach, students are expected to have a scientific attitude in the form of Science Epistemological Beliefs (SEB). Fitriani said that apart from improving critical thinking skills,

POE2WE can also significantly improve students' science attitudes (Fitriani, 2020). Ajayi also stated that POE2WE was able to increase students' confidence in science (Ajayi & Audu, 2021).

This research shows that the use of POE2WE and conventional learning models can increase students' experience in exploration activities and students' understanding of how scientific knowledge is obtained. This research also adds to students' experience in working on questions that students have never done before. So, students can improve their critical thinking skills and Science Epistemological Beliefs (SEB).

CONCLUSION

Based on this research, it can be concluded that the application of the POE2WE learning model can improve the critical thinking skills of class VII students at the Indonesian School in Kuala Lumpur. This is indicated by the average post-test score for critical thinking skills of 75.56 which is classified as good. Apart from improving students' critical thinking skills, the POE2WE learning model also increases scientific epistemological beliefs or what is usually called Science Epistemological Beliefs (SEB) as shown by the majority of students giving high responses to the questionnaire. The POE2WE learning model is an alternative for teachers to improve student's critical thinking skills through a fun learning process. A fun learning process can also be complemented by the use of flipbooks so that students are more interested and makes it easy to follow the learning process.

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