Learning Innovation in the 3T Area:
The Effectiveness of Moodle-Based Blended Learning on Critical Thinking Skills

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Abstract
This research aims to evaluate the effectiveness of blended learning MOODLE-based in improving the critical thinking skills (CTS) of prospective teacher students in 3T (Frontier, Outermost, and Disadvantaged) areas. This research uses mixed research methods (mixed methods). The research design used one group pre-test and a post-test design repeated without control classes. The sample in this study was 34 prospective teacher students in semester 1 of the 2023/2024 academic year at universities in Sumba - NTT - Indonesia. Learning blended combines face-to-face meetings with the usage platform e-learning MOODLE as the primary media. Learning design focuses on active interaction, critical discussion, and problem-solving through online assignments and forums. The instruments used in this research consisted of the CTS test and the student response questionnaire. Data analysis techniques use quantitative and qualitative descriptive, paired t-test, N-Gain, and test-t independent. The research results show that learning blended learning MOODLE-based effectiveness in increasing CTS is shown by (a) there is a statistically significant increase in CTS test scores at an alpha (real level) of 5%; (b) the average CTS N-Gain is at least in the medium category (N-Gain≥.30); and (c) the average N-Gain is consistent (not different) in the three classes The research results concluded that learning blended MOODLE-based is effective in increasing the CTS of prospective teacher students in 3T areas. Hopefully, these findings can become a reference for educational institutions developing creative and responsive learning strategies, especially in areas with limited access to education.

Keywords: Learning Innovation, Blended Learning, MOODLE, Critical Thinking Skills

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Introduction

Students and teachers engage in the classroom while learning. This commitment will assist with establishing an informative learning climate among student and students (Pauline et al., 2023). Many variables impact the progress of student' opportunities for growth in the study hall, one of which is the student's capacity to plan imaginative and intelligent picking up utilizing different learning media that are presently being created (Amanda et al., 2023; Shariful et al., 2023). Students should be mechanically proficient to develop connecting with and dynamic opportunities for growth (Amanda et al., 2023). The significance of the student's part in learning is the key motivation behind for what reason being an instructor needs broad preparation start in school. As a forthcoming student, students are by implication requested to expect a more dynamic job in endlessly learning plan.

Understudy student up-and-comers are forthcoming instructors who assume a significant part in guaranteeing their understudy's prosperity. Imminent students in the age Z generation should be resilient people in light of the fact that, as well as having the option to configuration learning and comprehend understudy attributes, they should likewise figure out the progression of science and innovation (Clarence et al., 2024; Sage et al., 2023; Yan, 2023). Accordingly, to adjust to current logical and mechanical changes, understudy students should be prepared in assorted 21st century thinking capacities that are basic today (Elcine et al., 2018; Hatice et al., 2021; Min et al., 2023). The significance of getting ready for a vocation in the growing computerized time is basic. The fast mechanical change has radically modified the work scene. To contend and prevail in present day cutthroat business market, Age Z should be ready with fundamental abilities and extraordinary adaptability. Student in age Z acquiring needs four abilities, one of which is Critical Thinking Skills (CTS) (Miguel et al., 2024; Sage et al., 2022; Ward et al., 2023).

CTS is a really significant ability in the twenty first century. CTS alludes to an individual's ability to think plainly and normally about what they ought to do. Decisive reasoning permits student to grasp the reason why a variable changes and how one variable influences different elements (Duran & Dökme, 2016). Decisive reasoning necessities reality, reflection, examination (Mutakinati et al., 2018), conviction, and activity. Decisive reasoning is characterized as decisive reasoning with an accentuation on independent direction. Decisive reasoning is the capacity to distinguish deals with any consequences regarding issues in a calculated and dependable methodology (Mundilarto & Ismoyo, 2017). At the tertiary level, CTS is a essential for learning. Student benefit fundamentally from CTS since they are change specialists. Student, as change specialists, need to dissect fundamentally in all circumstances to be delicate and receptive to society difficulties and issues.

This differs from the data obtained in the field. The facts on the ground reveal that critical thinking skills remain low in Indonesia. According to a World Economic Forum (WEF) study on the 2016-2017 Global Competitiveness Index (GCI), Indonesia was rated 41st out of 138 nations, after Malaysia and Thailand (Nababan, 2019). The worker's educational level, particularly critical thinking and analytical thinking skills, has an impact on this (Changwong et al., 2018). Several studies, including research by Ploysangwal (2018) in Thailand, Manshaee and colleagues (2014) in Iran, Sarigoz (2012) in Turkey, reveal that students' critical thinking skills are also at a low level. This is consistent with the findings of various studies in Indonesia, which reveal that critical thinking skills are inadequate at all levels of schooling in Indonesia. According to a survey done by Setiawati and Corebima (2017) in Pare-Pare, South Sulawesi. Furthermore, Mahanal and colleagues (2016) and Asyari and

colleagues (2017) discovered that students at universities X and Y lacked critical thinking skills. Aside from that, students continue to struggle with critical thinking, particularly in primary school. Critical thinking skills were still low in three elementary schools in the Buleleng District, according to Wijayanti and colleagues (2015). Aside from that, Budiana (2013) demonstrated that the original critical thinking skills test obtained a score of less than 40% for each component, which was still regarded low.

Based on the data identification results, it was discovered that there has been no extensive research on the island of Sumba on critical thinking, teamwork, communication, and creativity as 21st century skills. Sumba Island is divided into four districts: the Southwest Sumba district, the West Sumba district, the Central Sumba district, and the East Sumba district. All areas on the island of Sumba are classified as 3T (frontier, outermost and disadvantaged). The Indonesian government considers four districts on the island of Sumba as underdeveloped areas: Southwest Sumba district, West Sumba district, Central Sumba district, and East Sumba district. Presidential Regulation Number 63 of 2020 specifies this classification. This district has also been recognized as a special region based on geographical characteristics by Minister of Education, Culture, Research, and Technology Decree No. 160/P/2021. The 3T area is a location with insufficient infrastructure, thus only a few people choose to be shifted there (Hasthoro & Aambarwati, 2016). Districts with less developed territory and society than other regions in the nation are considered to be underdeveloped regions, as defined by Presidential Regulation of the Republic of Indonesia Number 63 of 2020. The evaluation of underdeveloped areas takes into account a number of variables, such as the local economy, human resources, infrastructure, amenities, financial capability, accessibility, and regional features. These standards lead to the inclusion of Southwest Sumba Regency in the 3T area. The educational conditions in the 3T area differ from those in other more developed areas of Indonesia. Communities in the 3T area have a low level of awareness about sending their children to school, educational facilities are very inadequate, and the number of teachers and educational staff is limited and of poor quality (Dudung et al., 2018), all of which have an impact on the quality of student learning outcomes, such as the low level of 21st century skills possessed by students in the area.

Issues in decisive reasoning abilities incorporate the discoveries of the 2022 Program for International Student Assessment (PISA), which exhibit that Indonesian student' CTS actually low (OEDC, 2023). One strategy to further develop student' CTS is to make a learning model that prepares their CTS. The learning model that frequently prepares CTS is Issue Based Learning (PBL) (Akhdinirwanto et al., Amin et al., 2020; 2020; Hidayati et al., 2021; Ismail et al., 2017; Kardoyo et al., 2020; Oderinu et al., 2020; Putu et al., 2018; Suarniati et al., 2019; C.- C. Foo et al., 2021; Suryanti & Nurhuda, 2021). The PBL model backings student in associating figuring out how to genuine issues (Hashim and Samsudin, 2020). Nonetheless, the use of the PBL model demonstrated that there were still impediments. Suryanti and Nurhuda (2021) displayed during picking up utilizing the PBL model, a few student showed inactive.

The extent of student who effectively contribute troublesome answers for their companions is not exactly half; be that as it may, modifying student' propensities from inactive to dynamic takes time. Sajidan and colleagues (2022) found that PBL doesn't permit student to team up with different gatherings, prompting compelling critical thinking. Also, when student talk about issues they are not upheld by proof from examination ends. The disadvantages of carrying out the PBL worldview included student actually experiencing issues making clear answers for the issues they uncovered, and it was challenging for the gathering to distinguish

answers for the issues they communicated. What's more, this study's improvement stage needs a lengthy time (Amin et al., 2020).

In accordance with information from a fundamental investigation of understudy CTS levels directed on understudy student competitors in the material science schooling concentrate on program at Weetebula Catholic College, Southwest Sumba, Indonesia, understudy CTS will in general be low, at 49.50%. The four CTS indicators tested were assessed as follows: analysis indicators (56.22% in the medium category), interpretation indicators (43.78% in the low category), inference indicators (42.70% in the low category), and evaluation indicators (55.32% in the medium category). The findings of the data analysis revealed that the inference indicator had the lowest value of the three major CTS indicators. The data reveal that there are still issues in the sector of student CTS. Students with a low CTS will find it more challenging to identify and solve the challenges they present.

According to the findings, the PBL model's concerns are found in the third stage, which includes driving individual and gathering examinations. In this stage, the student urges student to get the fundamental information, direct examinations, and look for clarifications and arrangements so student can explore on the subjects instructed. The discoveries show that student keep on battling with considering choices while drawing derivations, taking care of issues, and pursuing choices in view of the responses to issues given, frequently alluded to as deduction. This calls for an extreme measure of investment, and procedures are expected to show student how to put together their choices with respect to the answers for the issues that are introduced. The strategy that can be utilized is mind mapping. Mind mapping can help student concentrate on more proficiently and further develop their CTS (Zubaidah et al. 2018). Mind mapping is valuable for arranging, imparting, being more imaginative, critical thinking, centering consideration, coordinating and offering viewpoints, recollecting better, learning all the more rapidly and productively, and preparing to make sense of an entire thought.

Mind mapping helps student how to get determinations from different thoughts, make ideal ends, sum up, and show associations between thoughts. Mind mapping is otherwise called a learning method for critical thinking, idea association, maintenance, narrating, and thought trade (Kernan et al., 2018). Mind mapping empowers student to review, hold however much happy as could be expected, normally group it, and accomplish prompt and direct access (Arini et al., 2017). Mind mapping is a helpful hierarchical reasoning strategy that works with information maintenance in the cerebrum and recovery from outside the mind (Zahro et al., 2018). Thus, it is basic to foster a PBL model that can help student to utilize mind maps.

Amin and colleagues (2020) found that PBL significantly impacts students' CTS and suggests combining it with e-learning or mixed learning. Mixed learning is crucial for students to adapt to rapid advancements in science and innovation. MOODLE, an open-source LMS, is a creative, easy-to-use, and versatile e-learning platform available on Android, making it an ideal choice for students. Student approach gaining materials from anyplace and whenever (Ait et al., 2024; Peter et al., 2024). Subsequently, coordinating LMS MOODLE inside the educational experience might further develop guidance as well as learning exercises.

This study reveals that students struggle with applying the PBL worldview in learning, especially when combined with LMS. To address this, a MOODLE-based MMSB model learning approach was proposed. This approach aims to meet 21st-century students' needs while providing a hypothetical and exact framework. The fourth phase of the MOODLE-

based model focuses on developing inference indicators and mind mapping from research results, enabling students to make conclusions based on findings.

This research aims to evaluate the effectiveness of blended learning MOODLE-based in improving the critical thinking skills of prospective teacher students in 3T (Frontier, Outermost, and Disadvantaged) areas. The findings of this research can become a reference for educational institutions developing creative and responsive learning strategies, especially in areas with limited access to education.

Literature Review

District 3T Area (Outermost, Frontier, and Disadvantaged)

The Indonesian government categorizes 3T areas based on regional boundaries, physical conditions, and special positions. "Frontier and Outermost" areas are defined by physical conditions, while "Frontier and Disadvantaged" areas are categorized based on economic conditions, human resources, development facilities, regional finance, barrier access, and features. Leading and underdeveloped areas have direct boundaries with neighboring countries, while outermost and underprivileged areas are classified differently and have no commonalities in features. The phrase 3T area is frequently used in educational development efforts, such as the equitable distribution of primary and secondary school teachers (Dikdasmen). The 3T area tends to be the government's top priority in pursuing fair development in a variety of ways. The 3T region is an Indonesian territory with less developed physical, social, economic, and cultural characteristics than other regions on a national scale. The 3T zone also serves as a gateway to Indonesia's borders with other countries. The 3T region suffers a number of issues that restrict its people's development and well-being. Some of the major issues affecting 3T areas include (1) inadequate accessibility, (2) low educational quality, (3) bad public health, and (4) poverty and social inequality (Purwanda et al., 2023).

Critical Thinking Skills (CTS)

Critical thinking is a crucial skill for life, work, and overall functioning, initiated and processed by the left brain. It involves evaluating and analyzing information based on experts' opinions. Critical thinking motivates students to find answers and understand, evaluating implicit thoughts and their own thought processes. It is often referred to as high-level process skills, helping students connect knowledge from multiple sources for a deeper understanding. Akhdinirwanto and colleagues (2020) explained that critical thinking skills are one of the essential skills for students to live in the 21st century where the phase of life is entering the era of digital revolution 4.0. and is the most important skill in school and life in the future (Amin et al., 2020; Toheri et al., 2020). In the current era of digital revolution, critical thinking skills are an important aspect in modern education (Elmouhtarim, 2018; Walter & Walter, 2018), important competencies in successful student performance (Hasanpour et al., 2018; Verawati et al., 2019); and the most important real-life skills (Mutakinati et al., 2018). These are essential abilities that students must have in solving problems (Özgenel, 2018; Silviariza et al., 2021) and the process for making the right decisions (Özgenel, 2018) so that what we think is best about the truth we can obtain and do correctly. Critical thinking helps students to absorb knowledge and improve their performance.

CTS are very important to be taught, trained as early as possible and carried out continuously according to students' ability to observe various problems that may occur in learning activities and think about solutions to these problems (Rahmadita et al., 2021). Critical thinking skills consist of cognitive abilities that help students to improve academic achievement related to solving social and scientific problems found in everyday life (Abbasi & Izadpanah, 2018; Halpern, 2005; Sendag & Odabasi, 2009). The benefit of students having CTS is that it helps students to have broad insight, independent assessment which results in interpretation, analysis and evaluation as well as inference (Agbi & Yuangsoi, 2022; Saputro et al., 2020). Students who are active in trying to solve problems related to everyday life are critical students (Elmouhtarim, 2018; Walter & Walter, 2018). Facione (2015) identifies basic and higher-order thinking abilities, with this study examining critical thinking skills like analysis, interpretation, evaluation, and inference, adapted from his suggested indicators. Table 1 shown data regarding indicators and operational definitions of critical thinking skills indicators.

Table 1: Indicator and Operational Definiton of CTS

No.	Indicator of CTS	Operational Definitions
1	Interpretation	Interpretation is also referred to as categorization, deciphering meaning, and clarifying meaning.
2	Analysis	Examining ideas and evaluating arguments are both examples of analysis.
3	Inference	Inference is referred to as looking for evidence, guessing, alternatives, and drawing conclusions.
4	Evaluation	Evaluation is also known as assessing claims and assessing arguments.

Source: Fascione (2015)

MOODLE-Based Mind Mapping Science Blended (MMSB) Learning Model

The results of practical and theoretical investigations into the drawbacks of applying the PBL model to enhance students' CTS were used to develop the MOODLE-based MMSB model in this study. This sort of guidance joins face to face guidance in the classroom with online guidance by means of LMS MOODLE, which students and student can access from anyplace whenever. A few CTS pointers can't be prepared while utilizing the PBL learning model to improve CTS, as indicated by the discoveries of information examination connected with the model. Thusly, the suitable strategy for preparing the leftover low level CTS pointers in unambiguous, the surmising marker is to foster a MOODLE-based MMSB model.

One strategy that may be utilized is mind mapping. Student that utilization mind mapping can further develop their review strategies and foster their decisive abilities to reason (Zubaidah et al. 2018). With mind maps, clients can coordinate data through colors, images, pictures, and profound worth (Polat & Aydın, 2020). According to Kernan and colleagues (2017), mind mapping is likewise depicted as a learning system utilized for thought trade, narrating, memory upgrade, critical thinking, and idea organizing. However much information as could be expected might be learned, coordinated, and put away by student utilizing mind mapping, which additionally takes into consideration regular order and gives fast and simple access (Arini et al., 2017). As per Zahro and colleagues (2018), mind mapping is a strong hierarchical reasoning device that works with the capacity of information in the cerebrum and the recovery of data from sources outside the mind. Thus, a MOODLE-based MMSB model a PBL model that can show student' CTS through mind mapping should be made.

The syntax of the MOODLE-based MMSB model has 6 (six) stages or phases, namely: phase 1 Orientation; phase 2 Organization; phase 3 Investigation; phase 4 Developing Mind Mapping; phase 5 Create and present the work; phase 6 Evaluate. Learning with the MOODLE-based MMSB Model is carried out in a blended manner, namely synchronous (learning by carrying out face-to-face learning activities in class) and asynchronous (learning by accessing material or assignments online on MOODLE).

Methods

Research Design

This type of research is mixed research methods (mixed methods). This research design uses the one group pre-test post-test design (Fraenkel et al, 2012) which involves two classes, namely class A and class B. The one group pre-test post-test design is shown in Table 2.

Table 2: The One Group Pre-test Post-test Design

Kelas	O1	X	O2
A	Pre-test	Treatment	Post-test
B	Pre-test	Treatment	Post-test

Information: O1: Pre-test to measure students' initial CTS
O2: Post-test to measure students' final CTS
X: Learning with the MOODLE-based MMSB learning model
A, B: Class where testing activities are carried out

Sample and Data Collection

This research was conducted from August to October 2023 involving 2 (two) classes in the physics education study program - Weetebula Catholic University, Indonesia. The sampling technique uses a saturated sample technique, namely taking all members of the population to be used as research samples. The number of class A students was 19 students while class B students were 15 students, so the total sample size in this study was 34 students.

Research Instrument

The effectiveness of the MOODLE-based MMSB model is assessed using the CTS Test and student response assessments.

Analyzing of Data

The study uses CTS test results to assess the effectiveness of the MOODLE-based MMSB model. Four CTS indicators are measured using twelve questions, and data analysis is conducted using SPSS 22 and inferential statistics. The N-Gain value is calculated using the formula (Hake, 1998).

$$N - Gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$

Information : N-Gain = normalized gain value (normalized gain)
              Spost   = CTS post-test score
              Spre   = CTS pre-test value
              Smax   = maximum CTS value

The data resulting from the N-Gain calculation is then converted into criteria are present in Table 3.

Table 3: N-Gain Criteria

Nilai N-Gain	Kriteria
.70 < N-Gain	High
.30 ≤ N-Gain ≤ .70	Moderate
N-Gain < .30	Low

(Source : Hake,1998)

The results of the generated N-Gain were subsequently analyzed through a parametric test with a paired t-test. With the use of SPSS 22, a statistical analysis of the paired t-test was performed. The MOODLE-based MMSB model is said to be effective if 1) there is a statistically significant increase in CTS test scores at an alpha (real level) of 5%; 2) the average CTS N-Gain is at least in the medium category (N-Gain≥.30); 3) the average N-Gain is consistent (not different) in the three classes (Lestari et al., 2021).

Result and Discussion

Students take a CTS test in order to assess the increase in their CTS. During a sixth meeting, tests will be given at the beginning and end of the lecture. The number of tests given was 12 questions which were divided into 4 indicators related to CTS, namely: (1) analysis indicators; (2) interpretation indicators; (3) inference indicators; and (4) evaluation indicators. The average pre-test, post-test and N-Gain CTS scores of students are shown in Table 4.

Table 4: Average Pre-test, Post-test, dan N-Gain CTS

Description	Class A		Class B	
	Pre-test	Post-test	Pre-test	Post-test
Lowest value	13.33	43.33	31.67	51.67
The highest score	40.00	88.33	48.33	88.33
Average value	28.33	67.54	40.78	68.22
Number of Students	19	19	15	15
N-Gain Average	.55		.46	
Category	Moderate		Moderate	

The data in Table 4 shows that the average N-Gain value for class A is .55 (medium category) and class B is .47 (medium category). For average value data N-The gain in class A and class B is shown in Figure 1.
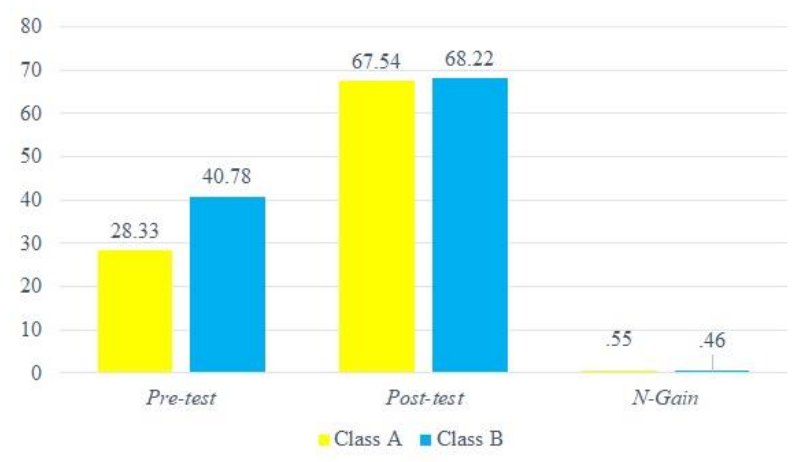
Figure 1: Differences in N-Gain in Class A and Class B

In this study, there were 4 (four) CTS indicators that were trained. The average N-Gain value for each CTS indicator is shown in Table 5.

Tabel 5: Average N-Gain in CTS Indicator

No.	CTS Indicator	Class	N-Gain indicator	Categori
1	Analysis	A	.43	Moderate
		B	.33	Moderate
2	Interpretation	A	.56	Moderate
		B	.50	Moderate
3	Inference	A	.57	Moderate
		B	.50	Moderate
4	Evaluate	A	.54	Moderate
		B	.43	Moderate

The results of the N-Gain value analysis from class A and class B were then continued with normality tests. Normality testing was carried out using the Shapiro-Wilk test for the average N-Gain value of the 2 (two) classes used. Normality test results are shown in Table 6.

Table 6: Normality Test Results

Class	Shapiro-Wilk Test			Conclusion
	Data	Statistic	Sig.	
A	N-Gain	.979	.934	Normal
B	N-Gain	.906	.117	Normal

The N-Gain normality test results in class A and class B showed Sig.>.05, indicating a normally distributed population. A paired t-test was conducted to determine the increase in CTS scores after learning using the MOODLE-based MMSB model, as shown in Table 7.

Table 7: CTS Paired t-Test Results

Class	N	Paired t-test, α = 5%				
		Mean	Std. error mean	T	Df	P
A	19	-	39.208	2.629	-14.915	18
B	15	-	17.335	3.332	-5.202	14

The paired t-test results indicate a difference between pre-test and post-test, indicating an increase in students' CTS scores after learning with the model. The population variance homogeneity test, using the Levene Test, as shown in Table 8.

Table 8: Homogeneity Test Results

Class	Levene's Test		Conclusion
	Data	Sig.	
A - B	N-Gain	.270	Homogen

The results of the analysis of the similarity test of two variances using the Levene Test Sig value.>.05, namely Sig.=.270. So it can be concluded that Ho is accepted, which means that the variance values for class A and class B are the same (homogeneous).

The last test carried out was the independent-t samples test. The purpose of this test is to find out whether the average N-Gain for both classes A and B is different or not. This test was carried out using the SPSS version 22 program. The results of the independent-t samples test are shown in Table 9.

Table 9: Independent-t Samples Test Results

Uji Statistic Test	Data	Sig.	Information
Independent t-Test	N-Gain	.197	Consistent

Based on the results of the independent samples test in Table 9, it was found that the Sig. (2-tailed) =.197 where the Sig value. (2-tailed)>.05. From the results obtained, it is known that Ho is accepted, meaning that the average value of N-Gain CTS for students in both classes is not different (consistent).

Discussion

The MOODLE-based MMSB model introduces students to learning through authentic problems, focusing on decisive critical thinking. It uses the MOODLE Learning Management System to train students in adapting to science and innovation. The model includes five key components: linguistic structure, social framework, response standard, emotionally supportive network, informative effect, and influence. The MOODLE-based MMSB model created should meet the rules of being validity, practicality and effectiveness (Hasyim et al., 2024; Jatmiko et al., 2018; Prayogi et al., 2018; Setiani et al., 2019; Siswanto et al., 2018; Wahyuni et al., 2020).

The effectiveness of the MOODLE-based MMSB model is able to be seen in several techniques, involving the average value of the pre-test, post-test, and N-Gain CTS, the Shapiro-Wilk test, the paired t-test, the Levene test, and the independent-t samples test, as shown in Tables 4, 6, 7, 8, and 9. Tables 5 shows that the average N-Gain value for each CTS indicator in the two groups fell below the medium range. Meanwhile, in Table 9 it is shown that the average N-Gain CTS score for students in both classes is not different (consistent). The study found a significant increase in students' CTS test scores after using the MOODLE-based MMBS model. The average N-Gain CTS for both classes was medium, and the average N-Gain remained consistent. This suggests that the MOODLE-based MMSB model effectively trains students' CTS by integrating indicators at each stage. Phase 1 Orientation in education uses theoretical studies like ARCS theory, attention theory, and dual code theory to

support learning activities. ARCS theory relates learning material to students' needs and conditions, while the Curves hypothesis emphasizes consideration, certainty, and satisfaction. The double code hypothesis suggests that both outward and verbal information is better remembered. This stage focuses on decisive reasoning abilities, such as understanding the pointer, using Moodle effectively, and implementing clear proof exercises. The interpretation indicator is the key indicator of CTS achieved.

Phase 2 of the MOODLE-based MMSB model involves the development of students' critical thinking skills through social constructivism and collaborative learning. Students engage in conversation exercises with others, select data, create theories, and make choices to incorporate new experiences into their past knowledge. The Zone of Proximal Development (ZPD) states that students learn best when in their nearest development zone. Mixed learning can further develop students' initial decisive reasoning abilities, helping them tackle issues. The CTS indicators trained in this phase are analytical indicators. Phase 3 involves the investigation phase, focusing on Vygotsky's learning hypothesis, social constructivism, cooperative learning, and mind mapping. MOODLE impacts cooperation and correspondence, while mind mapping aids in critical thinking, recall, and group effort.

The MOODLE-based MMSB model focuses on the development of mind mapping, a concept supported by memory and cognitive learning theories. Students in groups create mind maps from data to solve problems, which are then uploaded to Moodle. This phase helps students learn better and develop their thinking skills, enhancing critical thinking, memory, and presentation. In the create and present work phase, students engage in conversations to create critical thinking arrangements based on mind mapping, with the outcomes introduced as work. The inference indicator evaluates the CTS achieved in this phase. In this phase, the indicator of CTS achieved is the inference indicator. Experimental examinations from related research results, to be specific exploration results which express that decisive critical thinking skills are the cycles and capacities engaged with normal navigation (Latifa et al., 2017); Moodle LMS makes it conceivable to make conversation discussions and submit tasks from anyplace (Ricardo et al., 2020); Psyche planning helps decisive reasoning, recollecting, show abilities, bunch joint effort and critical thinking (Sari et al., 2018).

The evaluate phase in the MOODLE-based MMSB model is supported by ARCS (Attention, Confidence, and Satisfaction), retention theory, and feedback theory. It involves students presenting, appreciating, and making conclusions based on input from other groups, with the lecturer providing feedback. The results of the group discussion and conclusions are uploaded to the link in Moodle. Study of research results related to activities in this phase, namely research results which state that Moodle is used as a tool in blended learning which facilitates assignments, online forums and quizzes (Bayyat, 2021); Moodle is used for students to be active in taking exams online at any time (Ricardo et al., 2020). The indicators of CTS achieved in this last phase of activities are evaluation indicators.

Increasing student CTS with the MOODLE-based MMSB model is in accordance with the consequences of exploration directed by Fikriyati and colleagues (2022); Kardoyo and colleagues, (2020); Mundilanto and colleagues, (2017); Prayogi and colleagues, (2018), which expresses that the utilization of a learning model is viable in preparing student' CTS. The mixed learning model affects expanding student' CTS (Phakakat et al., 2020; Srikan et al., 2021). The utilization of brain planning in learning assists student with recognizing significant ideas so student can be prepared to make surmisings from the issues given (Kernan et al., 2017). Increasing student CTS with the MOODLE-based MMSB model is

also supported by the ARCS theory (Attention, Confidence, and Satisfication); dual core theory; cooperative learning; social constructivism theory; ZPD (Zone of Proximal Development), Vygotsky's learning theory; memory theory; cognitive learning theory; retention theory; and feedback theory.

Based on the data that has been obtained, it can be concluded that the MOODLE-based MMSB learning model developed is: valid, practical and effective in training CTS for prospective teacher students. In theory and empirically, the MOODLE-based MMSB model developed is suitable for use as a learning model to train students' CTS.

Implications of Using the MOODLE-Based MMSB Model in Learning

The MOODLE-based MMSB model enhances student critical thinking skills and technology independence. It blends classroom and online learning, promoting critical thinking and asynchronous learning. Students can access material from lecturer explanations, MOODLE links, and videos, promoting flexible study methods.

Conclusion

This research aims to describe the validity, practicality and effectiveness of the MOODLE-based MMSB learning model for training students' CTS. The research results show that the MOODLE-based MBBS model is effective, as indicated by an increase in the CTS score which is statistically significant at the real level of .05, the average N-gain for class A and class B is .55 and .47 respectively in the medium category, the average N-gain is not different in the two classes. Thus, students can train their CTS through science lessons using the MOODLE-based MMSB model.

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