Pegem Journal of Education and Instruction, Vol. 13, No. 3 , 2023 (pp. 323-336)

RESEARCH ARTICLE WWW.PEGEGOG.NET

Ethnomathematically Controversial Problem-Based Multimodal Approach in Terms of Students' Critical Thinking Ability

I Putu P. Suryawan[1*], Padrul Jana[2], I Gusti N. Pujawan[3], I Gusti N. Y. Hartawan[4], Putu Eka W. Putri[5]

[1, 3, 4, 5]Department of Educational Mathematics, Universitas Pendidikan Ganesha, Bali, Indonesia,

[2]Department of Educational Mathematics, Universitas PGRI Yogyakarta, Yogyakarta, Indonesia,

Abstract

Critical thinking ability is a very important basic ability in learning mathematics. In the era of technological advances and digitalization, a comprehensive learning approach is needed that accommodates critical thinking skills. The controversial problem-based multimodal approach with ethnomathematics is seen as being able to improve this ability. This can be seen from the characteristics of the learning model with the Ethnomathematically Controversial Problem-Based Multimodal approach that accommodates visual, auditory, and kinesthetic learning styles. However, there is no empirical evidence that the combination of that approach and ethnomathematics (Balinese culture) in digital learning can improve students' critical thinking skills. This study aims to comprehend the impact of digital learning with a controversial problem-based multimodal approach, incorporating Meru and Jejaitan Bali ethnomathematics on students' critical thinking skills. Quasi-experimental research uses a Randomized Complete Block Design (RCBD) applied to measure students' initial abilities, namely students with low, medium, and high initial abilities. The instrument used in this research is a test of critical thinking skills which contains controversial issues with ethnomathematical nuances in the cases of the sacred building of Meru. The population consists of 202 grade IX students, with 48 in the experimental group and 52 in the control group. The ANOVA test results demonstrated that using this approach was effective in improving students' critical thinking skills. (This can be seen from the value of sig. 0.00 < =0.05 which means that there is a difference in students' critical thinking skills between the experimental class and the control class). According to the t-test results, students in the experimental group had significantly higher critical thinking skills than students in the control group. Tukey's test shows that critical thinking ability varies depending on the student's beginning ability. In conclusion, this combination is effective in improving students' critical thinking skills, especially on the topic of geometry.

Keywords: Digital Mathematics Learning, Multimodal Approach, Controversial Issues, Balinese Cultural Mathematics, Critical Thinking Skill

Introduction

An extraordinary increase in the flow of knowledge occurs because of the application of digital media and technology in life, marked by the merging of the "space and time" factors which have been the determining aspect of the speed and success of human science mastery. (Egamberdieva L.N., 2022). The learning framework in education is also required to continue to adapt (Umoh, 2020). Students must be equipped with the ability to face the challenges of the 21st century. One of the efforts to face these challenges is to develop critical thinking skills, which lead to mental activities, problem-solving skills, learning to make decisions, analytical skills, and conducting scientific research (Khoiriyah et al., 2018). The ability to think critically equips a person to solve a problem effectively with the right arguments (Özgen, 2021; Lase, 2019). This of course directly poses a challenge for teachers to be digital literate, especially ICT-based (Di Pietro et al., 2020).

The integration of digitalization into learning is indispensable in all disciplines, including mathematics. However, mathematics as a science that studies abstract structures and patterns has several problems when learning is directed at digital systems (Lailiyah et al., 2020; Suarsana & Mahayukti, 2013). In its implementation, digital integration requires consideration of many aspects, such as the use of teaching materials, student interaction, and a learning atmosphere that must be correlated. (Apsari et al., 2020; Sagitarini, 2018; Umbara et al., 2021). This, of course, must be aligned with the characteristics of the student's learning style (Junpeng et al., 2020). Teachers can provide a supportive environment to make it easier for students to absorb information digitally if they already know the students' learning styles.

Corresponding Author e-mail: putu.pasek@undiksha.ac.id
https://orcid.org/0000-0001-8148-3785

How to cite this article: Suryawan IPP, Jana P, Pujawan IGN, Hartawan IGNY, Putri PEW. Ethnomathematically Controversial Problem-Based Multimodal Approach in Terms of Students' Critical Thinking Ability. Pegem Journal of Education and Instruction, Vol. 13, No. 3, 2023, 323-336

Source of support: None.

Conflict of Interest: Nil..

DOI: 10.47750/pegegog.13.03.33

Received: 11.07.2022

Accepted: 02.12.2022 **Publication:** 01.07.2023

Many various options to implement digital mathematics learning have been tried in Indonesia, and they are essential in the face of the COVID-19 pandemic (Ishartono et al., 2022). However, because toof lack of variance in capital employed by teachers to assist students in the process of activating learning resources that are appropriate for their learning styles, the quality of mathematics learning is still rather low (Ramadoni & Mustofa, 2022; Almusharraf & Khahro, 2020; Bismala & Manurung, 2021; Mardiana & Umiarso, 2020). A multimodal approach can be used to solve problems in learning digital mathematics. Due to the pandemic, this strategy will be able to adapt to student learning styles, particularly in online contexts.

A multimodal approach interprets the learning process by examining one material topic in several ways of presentation, in which there are texts or digital teaching materials for the accommodation of visual learning styles, contextual learning videos for the accommodation of auditory learning styles, and the use of media or learning applications for the accommodation of kinesthetic learning styles (Sudiarta & Widana, 2019). It is highly integrated with digital learning. Based on the Conference on Cognition and Exploratory Learning in Digital Age (Papageorgiou & Lameras, 2017), it is known that teachers from Finland and Denmark (95% and 100% respectively) indicated that they used technology for collaborative learning practices mediated by multimodal technology. Previous proposer studies (Bismala & Manurung, 2021; Mowla & Kolekar, 2020) and other related research (Parwati & Suharta, 2020; Suarsana et al., 2019) show that the development of e-modules can make learning more interactive, representative, practical, accessible, inexpensive, and self-instructional for students. Various multimodal video features in the form of animations, tutorials, good contextual videos can help students significantly understand abstract mathematical concepts, improve computational, symbolic, manipulative, graphic, and visualization abilities (Al Fajri, 2018). Students use multimodal ICT skills to perform calculations, draw graphs, collect, manage, analyze and interpret data, and exchange information (Juniati & Budayasa, 2017).

Digital learning innovation with a multimodal approach helps students to meet diversity, ensures inclusiveness that fosters intellectual quality, and allows them to build a broad learning experience (Olsson, 2018). Students can choose their own learning objects according to their modal preferences based on the dominant learning style. Digital learning with a multimodal approach is deemed appropriate to facilitate diverse student learning styles. Integration with digital concepts is accompanied by learning content that attracts attention and can be imagined by students so that abstract mathematics learning becomes more meaningful. (Al Fajri, 2018; Meryansumayeka et al., 2022;Farman et al., 2021; Pan & Zhang, 2020)we test the small molecule flexible ligand docking program Glide on a set of 19 non-α-helical peptides and systematically improve pose prediction accuracy by enhancing Glide sampling for flexible polypeptides. In addition, scoring of the poses was improved by post-processing with physics-based implicit solvent MM- GBSA calculations. Using the best RMSD among the top 10 scoring poses as a metric, the success rate (RMSD ≤ 2.0 Å for the interface backbone atoms.

Learning content that triggers students' thinking skills is content in which there is a cognitive conflict and two conflicting results (Nugroho et al., 2018). This arises after being faced with controversial issues because it raises the desire to recognize contradictions and explore in depth, then a clarification process occurs (Mueller & Yankelewitz, 2014). Learning content that students can imagine is content that contains cultural elements so this is used as the author's solution in raising controversial problems in learning (Gülburnu & Yildirim, 2021). The relationship between mathematics and culture is an effective solution to convey formal mathematics to students through mathematical values that exist in everyday life, known as ethnomathematics (Sirate, 2015). Each region has a unique culture to be introduced as ethnomathematics, including Bali which is an area famous for its cultural diversity (Rahman et al., 2022)technology, engineering, and mathematics (STEM. Efforts to provide a meaningful mathematics learning experience to students in Bali can be done through the integration of cultural values that are easily found and known in all levels of Balinese society, for example, the architecture of traditional Balinese buildings can be studied in-depth as learning resource content in discovering mathematical concepts meaningfully (Suryawan & Juniantari, 2021).

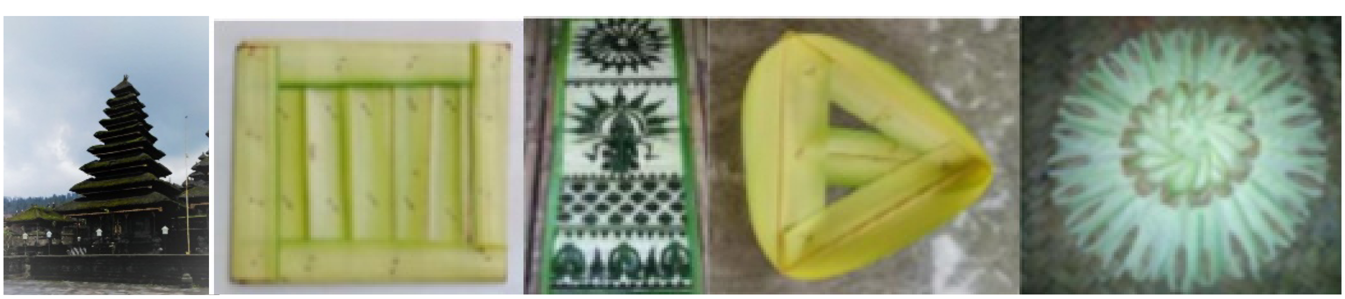


Fig. 1: *Meru* and *Jejaitan* Bali

Meru building uses the concept of similarity in the construction of each roof sequence, so it would be very appropriate if it is used as a multimodal digital mathematics learning context to facilitate the meaningfulness of each student's learning style in geometry (Abiam et al., 2016; Pujawan et al., 2020*). Students are expected to learn mathematical concepts and cultural values such as taledan, ituk-ituk, lamak, porosan, and others in the geometry field that are closely related to the material of plane.*

In previous studies, researchers have studied ethnomathematics in traditional Balinese buildings located in Penglipuran, Bangli. The study found that the application of mathematical content in traditional Balinese buildings can be used as a meaningful solution for learning mathematics, especially in geometry (Suryawan & Juniantari, 2021). Many mathematical concepts in the ethnomathematics of traditional Balinese buildings can be applied to geometric representations (Naufal et al., 2021; Suarsana et al., 2019). In addition, other relevant research related to ethnomathematics reveals that when studying mathematics, paying attention to this element can improve students' cognitive and affective domains (Rudhito & Prasety, 2016; Suryawan & Juniantari, 2021); furthermore (Rachmawati, 2012) explains that ethnomathematical-based mathematics learning can improve problem-solving abilities and build students' positive character. If the integration of *Meru* Bali ethnomathematics is presented in the form of digital teaching texts, contextual videos, and mathematical software application simulations, digital learning with a multimodal approach will be able to optimize the use of technology and information in facilitating visual, auditory, kinesthetic, global, and analytical student learning styles in understanding mathematical concepts on the topic of geometry (Juniati & Budayasa, 2017; Suarsana et al., 2019).

Ethnomathematical-based mathematics learning can improve problem-solving skills and build students' positive character (Utami et al., 2018). Moreover, the nuances of *Jejaitan* Balinese ethnomathematics are presented in the form of digital teaching texts, contextual videos, and GeoGebra application simulations so that the use of ICT can continue to be optimized in learning mathematics in accordance with the demands of industrial revolution 4.0 education during the COVID-19 pandemic (Jannah Akmal et al., 2020).

Based on the description above, in this digitalization era, teachers should take advantage of the development of technology and information through digital mathematics learning with a multimodal approach and integrate the ethnomathematics of traditional sacred and *Jejaitan* Balinese buildings based on controversial issues that will provide new nuances for teachers and students in the learning process (Al Fajri, 2018). Multimodal is not a new concept for learning and teaching. The results of research by (Papageorgiou & Lameras, 2017) show that there is a significant relationship between the creation of multimodal meaning descriptions, teaching approaches and the technology used for teaching and learning. However, in reality, there is no empirical and unequivocal information states that the combination of *Meru* and *Jejaitan* Bali's multimodal and ethnomathematical approaches in digital learning can improve students' critical thinking skills. In addition, (Su et al., 2016) mention that the assignment of controversial issues or problems can improve critical thinking skills and appreciation of cultural diversity. Research has not clearly revealed how to present a meaningful mathematical experience in the classroom. Therefore, the author raises the issue of improving students' critical thinking skills through an ethno-mathematically controversial problem-based multimodal approach.

The main contribution of the research is, firstly, to show empirical evidence regarding the ethnomathematically controversial problem-based multimodal approach in terms of the aspect of students' critical thinking skills. The second explores Balinese culture, especially *Meru* and *Jejaitan* in an ethnomathematical frame in digital learning to improve student's critical thinking skills.

This study aims to comprehend the impact of digital learning with a controversial problem-based multimodal approach, incorporating Meru and Jejaitan Bali ethnomathematics on students' critical thinking skills. Thus, the hypothesis of this research is how the ethnomathematically controversial problem-based multimodal approach is viewed from the aspect of students' critical thinking skills. Second, how is the profile of students' critical thinking process in solving controversial problems with ethnomathematical nuances through multimodal presentation.

Methods

Research Design

This type of research is a quasi-experimental that uses a Randomized Complete Block Design (RCBD) (the design can be seen in Table 1), with the consideration that there are differences in students' initial abilities, namely students who have low, medium, and high initial abilities (Olsson, 2018). This research was conducted on grade IX students at a superior junior high school in the city of Singaraja, Bali, Indonesia, which consisted of eight classes with a total of 202 students. The formation of class IX at the junior high school was carried out randomly with a proportional composition, so it can be assumed that the classes formed have relatively the same abilities. Therefore, sampling was carried out to obtain 2 classes as control classes and 2 classes as experimental classes (Parwati & Suharta, 2020). The independent variable in this study is the ethnomathematically controversial problem-based multimodal approach and conventional learning, while the dependent variable is students' mathematical critical thinking skills on the topic of geometry.

Sample and Data Collection

Sampling was carried out on class IX students of junior high schools in the city of Singaraja, Bali, Indonesia, using a cluster random sampling technique. Thus, there were 48 students in the experimental class and 52 students in the control class. In each class there are students with high, medium, and low initial abilities as indicated by the previous student report cards.

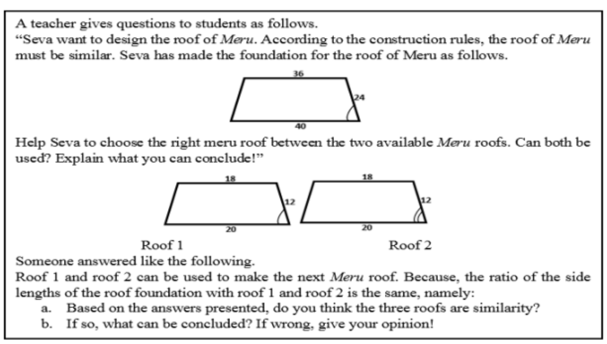
The instrument in this study uses a description in the form of a critical thinking ability test, which contains controversial issues with ethnomathematical nuances in the cases of the sacred building of *Meru* (see instrument in Figure 2) and *Jejaitan* (see instrument in Figure 3).

The indicator is contentious, which means there are differing viewpoints and it piques students' interest. Meanwhile, in this study, the students' critical thinking ability test was compiled using the Ebiendele Ebosele Peter, 2012 (Alfiani Athma, 2021) indicator, as shown in Table 2.

Initially, the critical thinking ability test consisted of 7 descriptive items. After being validated, the test was piloted with 26 students. Thus, five valid questions and two invalid questions were obtained (see Table 3). At the 0.05 significance level and 24 degrees of freedom, the rtable value is 0.3882. The five questions have a robserved higher than rtabel which mean that the five questions are valid and worthy of being used as

Table 1: Randomize complete block design

Groups	*Students' Initial Ability Group*	*Treatments*	*Post-tests*
Experimental	High		
	Medium	Ethnomathematics controversial problem-based multimodal approach	Critical thinking skills
	Low		
Control	High		
	Medium	Conventional Teaching Approach (CTA)	Critical thinking skills
	Low		



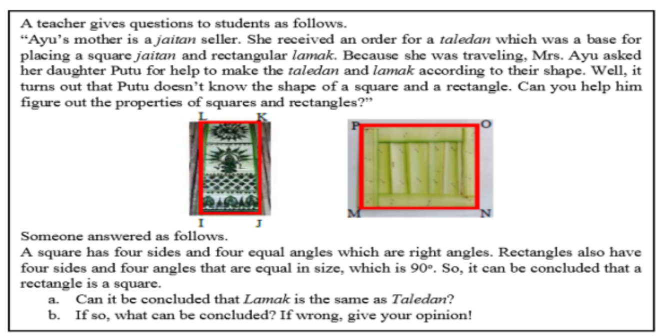
A teacher gives questions to students as follows.
"Seva want to design the roof of *Meru*. According to the construction rules, the roof of *Meru* must be similar. Seva has made the foundation for the roof of Meru as follows.

Help Seva to choose the right meru roof between the two available *Meru* roofs. Can both be used? Explain what you can conclude!"

Someone answered like the following.
Roof 1 and roof 2 can be used to make the next *Meru* roof. Because, the ratio of the side lengths of the roof foundation with roof 1 and roof 2 is the same, namely:

a. Based on the answers presented, do you think the three roofs are similarity?
b. If so, what can be concluded? If wrong, give your opinion!

Fig. 2: Worksheet on Controversial Problems with Ethnomathematics in the Case of the Sacred Building of Meru Bali



A teacher gives questions to students as follows.
"Ayu's mother is a *jaitan* seller. She received an order for a *taledan* which was a base for placing a square *jaitan* and rectangular *lamak*. Because she was traveling, Mrs. Ayu asked her daughter Putu for help to make the *taledan* and *lamak* according to their shape. Well, it turns out that Putu doesn't know the shape of a square and a rectangle. Can you help him figure out the properties of squares and rectangles?"

Someone answered as follows.
A square has four sides and four equal angles which are right angles. Rectangles also have four sides and four angles that are equal in size, which is 90°. So, it can be concluded that a rectangle is a square.

a. Can it be concluded that *Lamak* is the same as *Taledan*?
b. If so, what can be concluded? If wrong, give your opinion!

Fig. 3: Worksheet on Controversial Problems with Ethnomatics in the Case of Jejaitan Bali

Table 2: Indicators of critical thinking skills

Critical Thinking Criteria	*Score*	*Indicator*
Identify	2	Mention the main problem
	1	Mention the main problem, but not quite
	0	Misspelled the Subject
Define	2	Mentioning the facts that limit the problem include: a) mentioning the information needed includes what is known and asked in the question and b) mentioning information that is not used
	1	Mentioning the facts that limit the problem include: a) mentioning the information needed including what is known and asked in the question and b) mentioning information that is not used, but is less precise
	0	Incorrectly mentioning the facts that limit the problem include: a) mentioning the information needed including what is known and asked in the question and b) mentioning information that is not used
Enumerate	2	Mention the choices of ways and answers that make sense
	1	Mention the choices of ways and answers that don't make sense
	0	Mentioning choices of ways and answers that don't make sense

Critical Thinking Criteria	*Score*	*Indicator*
Analyze	2	Analyze options to choose the best way and answer
	1	Analyzing options to choose the best way and answer, but not quite right
	0	Wrongly analyze the options to choose the best way and answer
List	2	Mention the right reasons for the method and the best answer chosen
	1	Mention the reasons that are not appropriate for the method and the best answer chosen
	0	Mention the wrong reasons for the best way and the best answer chosen
Self-Correct	2	Thoroughly re-check the answer process
	1	Re-checked the answer process, but not comprehensive
	0	Do not re-check the answer process

Table 3: Item validity of critical thinking skills

Items	$r_{observed}$	*p*	*Criteria*
Question 1	0.466	0.016	Valid
Question 2	0.34	0.089	Invalid
Question 3	0.629	0.001	Valid
Question 4	0.629	0.001	Valid
Question 5	0.620	0.001	Valid
Question 6	0.423	0.031	Valid
Question 7	0.180	0.379	Invalid

a post-test. After being analyzed, the reliability coefficient of Cronbach's alpha was 0.72.

Procedure

Before treatment in the experimental class, researchers developed digital mathematics learning with a multimodal approach based on controversial issues with ethnomathematical nuances of *Meru* and *Jejaitan* Bali, such as lesson plans, students' worksheets, learning videos, and geogebra simulations that were integrated in the form of digital modules that are able to facilitate each student's learning style. It looks more interactive when digital text materials are given to students with visual learning styles. Contextual learning videos for students with audio-visual learning styles and Geogebra simulations to practice for students with kinesthetic learning styles. Then, three experts validated all the learning resources.

When the researcher began to research, students in the experimental group were taught through an ethnomathematics controversial problem-based multimodal approach, and students in the control group were taught using a conventional learning approach. At the end of the study, both groups were given the same test, namely the post-test, to determine the score of the students' critical thinking skills.

Before analyzing data by using the One-Way Anova test, assumption checking is needed and must be fulfill it. In this study, we used the Kolmogorov-Smirnov test for checking normal assumption and the Levene test for homogeneity assumption

Table 4: Kolmogorov-smirnov test output

Groups		*Kolmogorov-Smirnov*		
Statistic		*df*	*p*	
Critical Thinking Skills	Exprimental	.117	52	.072
	Control	.120	48	.083

Table 5: Output Levene's test results

Dependent Variables	*F*	*df1*	*df2*	*P*
Critical Thinking Skills	1.954	5	94	.093

Analyzing of Data

The normality test with the Kolmogorov-Smirnov test and the homogeneity of variance test with the Levene test. In this study, SPSS software was used for calculation and analysis. Table 4 shows the results of the Kolmogorov-Smirnov test.

Based on table 4, the significance value of learning outcomes in both the experimental and control groups is greater than 0.05, implying that H_0 is accepted and the data is from a normally distributed population. Then the results of the homogeneity of variance test are shown in table 5 below.

Based on the output above, the significance value is 0.093 > 0.05, so H_0 can be accepted, so it can be concluded that the variance of the two groups is not different (homogeneous). The average critical thinking ability of students who were taught using an ethno-mathematically controversial problem-based multimodal approach was higher than that taught by conventional learning. Furthermore, Tukey's test was conducted to see which initial ability group was best among the high, medium, and low groups in terms of students' critical thinking skills. The test was carried out with the help of SPSS to analyze the data at a significance level of 0.05.

Finding and Discussion

Finding

The Effect of a Controversial Problem-Based Multimodal Learning Approach with Ethnomathematical nuances on Students' Critical Thinking Ability

After passing the assumption test, the analysis moved on to the one-way Anova test with the RCBD design, the results of which are shown in Table 6. According to Table 6, the significant value is that Ho is rejected. Thus, it can be concluded that there is an effect on students' critical thinking skills of using digital mathematics learning with a controversial problem-based multimodal approach with the nuances of ethnomathematics of the sacred buildings of *Meru* and *Jejaitan in* Bali. The diversity of experimental units within each group is minimized by this design, while the differences between groups are maximized. Thus, it can be assumed that the only difference in students' critical thinking skills between experimental and control classes was caused by the treatment, namely digital mathematics learning with a controversial problem-based multimodal approach with ethnomathematical nuances of sacred buildings *Meru* and *Jejaitan* Bali.

Thus, the variant that occurs is the treatment's effect, which is the result of using digital mathematics learning with a multimodal approach based on controversial issues and the nuances of ethnomathematics of *Meru* and *Jejaitan* Bali. The author is also interested in seeing if the average critical thinking ability of students taught by digital mathematics learning with a controversial multimodal approach based on the ethnomathematical nuances of *Meru* and *Jejaitan* Bali is higher than that of students taught by conventional learning. As a result, an independent t-test was performed on the data in table 7From this data, it can be concluded that Ho can be rejected, namely the critical thinking ability of students who are taught digital mathematics learning with a controversial problem-based multimodal approach with ethnomatematical nuances of the sacred buildings of *Meru* and *Jejaitan* Bali is higher than that taught by conventional learning.

Furthermore, Tukey's test was used to determine which initial ability group in students' critical thinking skills was better among the high, medium, and low groups. Table 8 displays the Tukey test results.

Others feel the same way about students who have low abilities as compared to children who have diverse learning results. All pairs of student groups have various affects; for example, students' critical thinking skills change between low and medium groups, between high and medium groups, and between high and low group.

Students' Critical Thinking Process in Solving Controversial Problems with Ethnomathematical Nuances through Multimodal Presentation

Based on the results of analysis on test and interview data, students' cr itical thinking skills for the six indicators in

Table 6: One way anova test results

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
Corrected Model	5820.140a	3	1940.047	38.040	.000
Intercept	335707.215	1	335707.215	6582.441	.000
Treatment	2352.872	1	2352.872	46.134	.000
Group	3052.679	2	1526.339	29.928	.000
Error	4896.040	96	51.000		
Total	369530.358	100			
Corrected Total	10716.180	99			

Table 7: T- test result

	Treatment	*N*	*Average*	*Std*	*t-count*	*t-table*
Critical thinking	Experiment	52	64.97	9.72	5.852	1.67
	Control	48	54.43	8.17		

Table 8: Tukey test result

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Low	Average	-10.2876*	1.86619	.000	-14.7303	-5.8450
	High	-14.4828*	1.76998	.000	-18.6964	-10.2692
Average	Low	10.2876*	1.86619	.000	5.8450	14.7303
	High	-4.1952*	1.68454	.038	-8.2054	-.1849
High	Low	14.4828*	1.76998	.000	10.2692	18.6964
	Average	4.1952*	1.68454	.038	.1849	8.2054

solving controversial problems with *Meru* nuances can be seen as follows.

Identify

- S: Ma'am, this question is asked to determine the roof of *Meru*, which is congruent with the foundation of *Meru*'s roof that has been made, right, Ma'am?
- R : Yes, it is true.
- S : But in my opinion, the answer is still wrong, Ma'am, the ratio of the length of the *Meru* roof to roof 2 is not 2/1, right?

The excerpt of the conversation shows that students can mention the main problem by finding the keyword question, which is "congruent", but the steps taken are to find the ratio of the *Meru* roof's.

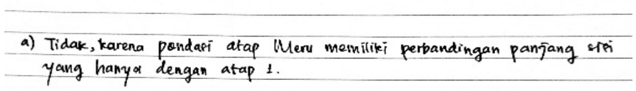
Define

In this section, students can mention the facts that limit the problem, namely by conveying that to determine if two shapes are congruent, then the ratio of the lengths of their corresponding sides is the same. Here are the student answers.

Based on the results of the researcher's interviews with students, students said that the answer to part a means that in determining that two figures are congruent, the ratio of the lengths of the corresponding sides must be the same. The comparison of the length of the side of the Meru roof foundation with roof 1 is the same, namely 2/1, while the ratio of the length of the side of the Meru roof foundation with roof 2 is not the same.

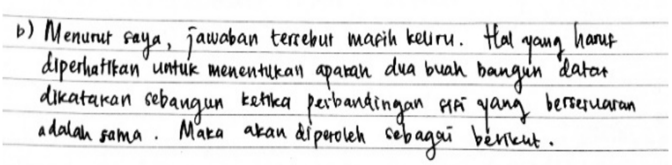
Enumerate

In this section, (S) can mention the choices of ways and reasonable answers, namely by explaining the concept of "corresponding side". The following is the result of the answer (S)


a) Tidak, karena pondasi atap Meru memiliki perbandingan panjang sisi yang hanya dengan atap 1.

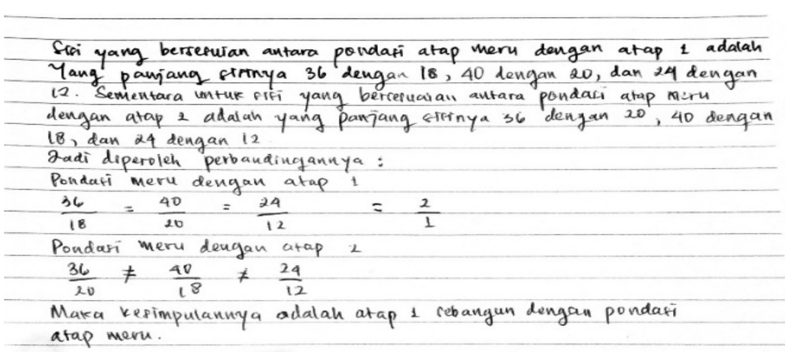
Translation
a) No, because the Meru roof foundation has the same side length ratio only with the roof 1 .

Fig. 4: Student's Answers in the define section


b) Menurut saya, jawaban tersebut masih keliru. Hal yang harus diperhatikan untuk menentukan apakah dua buah bangun datar dikatakan sebangun ketika perbandingan sisi yang bersesuaian adalah sama. Maka akan diperoleh sebagai berikut.

Translation
a) I think that answer is still wrong. What must be considered to determine whether two figures are similar is to look at the ratio of the corresponding sides. Then it will be obtained as follows:

Fig. 5: Student's Answers in the Enumerate Section


Sisi yang bersesuaian antara pondasi atap meru dengan atap 1 adalah yang panjang sisinya 36 dengan 18, 40 dengan 20, dan 24 dengan 12. Sementara untuk sisi yang bersesuaian antara pondasi atap meru dengan atap 2 adalah yang panjang sisinya 36 dengan 20, 40 dengan 18, dan 24 dengan 12

Jadi diperoleh perbandingannya :

Pondasi meru dengan atap 1

$$\frac{36}{18} = \frac{40}{20} = \frac{24}{12} = \frac{2}{1}$$

Pondasi meru dengan atap 2

$$\frac{36}{20} \neq \frac{40}{18} \neq \frac{24}{12}$$

Maka kesimpulannya adalah atap 1 sebangun dengan pondasi atap meru.

Translation

The side that corresponds between the foundation of the roof of Meru and the roof of 1 is

The side lengths are 36 with 18, 40 with 20, and 24 with 12. Meanwhile, the corresponding sides between the Meru roof foundation and the 2nd roof are those whose side lengths are 36 with 20, 40 with 18, and 24 with 12.

So the comparison:

Meru foundation with roof 1

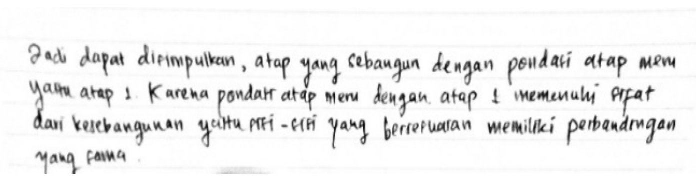
$$\frac{36}{18} = \frac{40}{20} = \frac{24}{12} = \frac{2}{1}$$

Meru foundation with 2 roofs

$$\frac{36}{20} \neq \frac{40}{18} \neq \frac{24}{12}$$

So the conclusion is that roof 1 is similar with the Meru roof foundation.

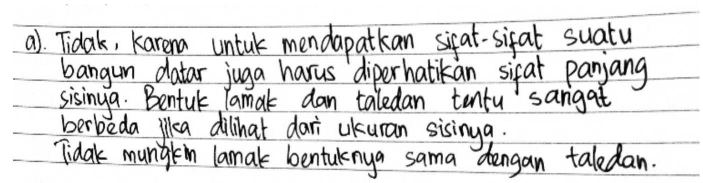
Fig. 6: tudent's Answers in the Analyze and List section



Translation

So it can be concluded, that the roof that is similar with the foundation of the Meru roof is roof 1. Because the foundation of the Meru roof and the 1st roof meets the properties of similarity, that is, the corresponding sides have the same ratio.

Fig. 7: Student's Answers in the Self-Correct section



Translation

a) No, because in order to obtain the properties of a flat shape, one must also pay attention to the side length properties. The form of lamak and taledan are certainly very different when viewed from the size of the sides. It is impossible for lamak to have the same form as a taledan.

Fig. 8: Student's Answers in the Define section

At the time of the interview between (S) and (R), students said the concept was important so as not to make mistakes in doing the questions. If two plane figures are said to be congruent, then the ratios of their corresponding sides must be the same.

Analyze and List

In this section students can analyze the methods that have been chosen to determine the answers to the problems given. Students can also mention the right reasons for the method and answers chosen. Students use the concept of the corresponding sides. The following are student answer.

Based on the results of interviews (R) with (S), students initially mentioned that the foundation of the Meru roof with roof 2 has a pair of corresponding sides. Then (R) was reminded again about the concept of angle-side-angle that was said (S), and then (S) could realize his mistake, that the foundation of the roof of Meru with roof 2 can't actually find the corresponding sides.

Self-Correct

In this section, students re-check the answer process thoroughly by placing emphasis at the end of the answer as follows:

Based on the findings of the test and interview data analysis, students' critical thinking skills for the six indicators in solving controversial problems with the nuances of *Jejaitan* Bali are as follows.

Identify

In this identify indicator, the research subject (S) asked the researcher (R) during the interview.

- S Mom, it's about determining the properties of rectangles and squares, isn't it, Mom?
- R : yes, right
- S : But why the answer to find a rectangle is a square Ma'am?

According to the excerpt of the conversation, students can mention the main problem by finding the keyword questions, namely "the nature of rectangles and squares," but the steps taken are to find rectangles.

Define

Students can mention the facts that limit the problem in this section, namely by conveying to know the properties of rectangles and squares, as well as the side length properties of the known shapes. Here is one of the student's answers.

Based on the results of interviews (R) with (S), students also said that to their knowledge a rectangle is not the same as a square.

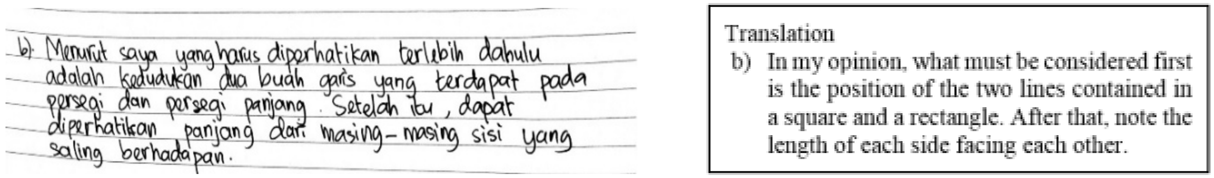
Enumerate

In this section, (S) can discuss the various options and reasonable answers, specifically by explaining the concept of "the position of two lines". Here are the answers (S).

Based on the results of interviews between (R) and (S) it was found that, students said that the concept of "the position of two lines" needed to be considered. If in two lines that are opposite each other, a rectangle and a square must fulfill one of the positions of the lines.

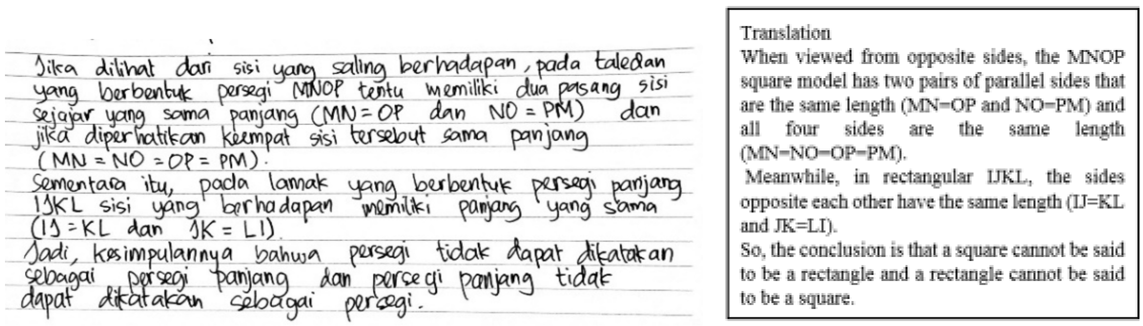
Analyze dan List

Students analyze the methods used to determine the answers to the problems given, state the correct reasons for the methods


b) Menurut saya yang harus diperhatikan terlebih dahulu adalah kedudukan dua buah garis yang terdapat pada persegi dan persegi panjang. Setelah itu, dapat diperhatikan panjang dari masing-masing sisi yang saling berhadapan.

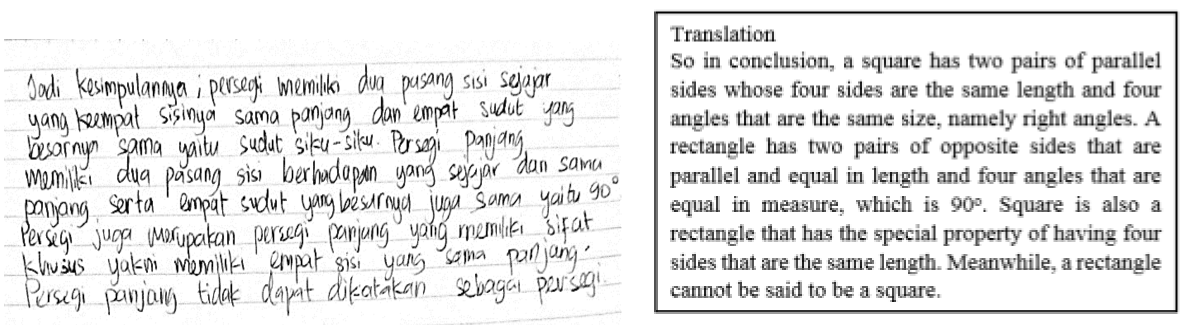
Translation
b) In my opinion, what must be considered first is the position of the two lines contained in a square and a rectangle. After that, note the length of each side facing each other.

Fig. 9: Student's Answers in the Enumerate section


Jika dilihat dari sisi yang saling berhadapan, pada taledan yang berbentuk persegi MNOP tentu memiliki dua pasang sisi sejajar yang sama panjang (MN = OP dan NO = PM) dan jika diperhatikan keempat sisi tersebut sama panjang (MN = NO = OP = PM).
Sementara itu, pada lamak yang berbentuk persegi panjang IJKL sisi yang berhadapan memiliki panjang yang sama (IJ = KL dan JK = LI).
Jadi, kesimpulannya bahwa persegi tidak dapat dikatakan sebagai persegi panjang dan persegi panjang tidak dapat dikatakan sebagai persegi.

Translation
When viewed from opposite sides, the MNOP square model has two pairs of parallel sides that are the same length (MN=OP and NO=PM) and all four sides are the same length (MN=NO=OP=PM).
Meanwhile, in rectangular IJKL, the sides opposite each other have the same length (IJ=KL and JK=LI).
So, the conclusion is that a square cannot be said to be a rectangle and a rectangle cannot be said to be a square.

Fig. 10: Student's Answers in the Analyze dan List section


Jadi kesimpulannya, persegi memiliki dua pasang sisi sejajar yang keempat sisinya sama panjang dan empat sudut yang besarnya sama yaitu sudut siku-siku. Persegi panjang memiliki dua pasang sisi berhadapan yang sejajar dan sama panjang serta empat sudut yang besarnya juga sama yaitu 90°. Persegi juga merupakan persegi panjang yang memiliki sifat khusus yakni memiliki empat sisi yang sama panjang. Persegi panjang tidak dapat dikatakan sebagai persegi.

Translation
So in conclusion, a square has two pairs of parallel sides whose four sides are the same length and four angles that are the same size, namely right angles. A rectangle has two pairs of opposite sides that are parallel and equal in length and four angles that are equal in measure, which is 90°. Square is also a rectangle that has the special property of having four sides that are the same length. Meanwhile, a rectangle cannot be said to be a square.

Fig. 11: Student's Answers in the Self-Correct section

and answers chosen, and use the positions of the parallel and opposite sides in rectangles and squares. Here are the answers

Based on the results of the interview (S) with (R), students said that the reason for saying that the opposite sides of a square and a rectangle are parallel to each other is that if the lines that are opposite each other are extended, they will never intersect. Students are also given guiding questions that cause students to realize that a rectangle can be said to be a square under the special condition that all four sides are the same length.

Self-Correct

In this section, students thoroughly re-check the answer process by emphasizing the end of the answer as follows.

Discussion

This study aims to investigate the effect of an ethnomathematically controversial problem-based multimodal approach on improving students' critical thinking skills. The results of the ANOVA test showed that students had better performance than students who were taught using traditional teaching approaches. Students' critical thinking skills can emerge when given a problem in which there is a cognitive conflict and two controversial results. Significantly, (Mueller & Yankelewitz, 2014), noted that controversial issues effectively involve students in the learning process and improve students' critical thinking skills because they raise the desire to recognize contradictions and conduct in-depth exploration of a matter. Previous research agrees that problem-based learning environments can overcome problems in traditional teaching (Gokkurt et al., 2012; Nugroho et al., 2018).

T-test results also imply that students who are taught using digital mathematics learning with this approach have significantly higher critical thinking skills. One possible reason is that teachers create a learning environment using a multimodal approach. The results of this study support previous relevant research on the application of learning using a multimodal approach (Al Fajri, 2018; O'Halloran et al., 2011; Pan & Zhang, 2020), the approach is able to accommodate all student learning styles and as the right solution for realizing effective learning in the era of digitalization. To further assist students with visual learning styles, researchers used media in the form of worksheets featuring ethnomathematical material of the sacred buildings *Meru* and *Jejaitan* Bali. Students with auditory learning styles are well facilitated through media in the form of contextual learning videos, while students with kinesthetic learning styles are facilitated through geogebra simulation media, where students are asked to design the roofs of *Meru* and *Jejaitan* Bali referring to the similarity concept. The digital mathematics media are made to be interconnected and facilitate the construction of the same concept, so that if applied simultaneously the three media are able to properly facilitate students with global learning styles and analytic learning styles (Lailiyah et al., 2020; Pathuddin et al., 2021; Rudhito & Prasety, 2016).

Tukey's test was also conducted to test students' initial abilities in terms of learning outcomes. According to research (Syafri, 2019), students' initial mathematical abilities can influence their critical thinking levels. As a result, each category possesses varying degrees of critical thinking ability. This study adds a fresh perspective to the use of a multimodal approach in digital mathematics learning by presenting ethnomathematics in an effort to make formal mathematics more meaningful to students and to ensure that learning does not feel dry because the designed learning is based on mathematical values that are relevant to students' daily lives (Lisnani et al., 2020; Prahmana et al., 2021; Pathuddin et al., 2021). This study complements the shortcomings of previous research conducted by researchers Pasek Suryawan (Suryawan & Juniantari, 2021; Suryawan & Sariyasa, 2018) related to the application of ethnomathematics in mathematics learning, where the advantages of this study accommodate students' initial geometric abilities, so the results are unequivocal. The success of this research stems from the design of digital learning with controversial issues that accommodate all student learning styles and use students' initial abilities related to students' experiences of mathematical content contained in the sacred building culture of *Meru* and *Jejaitan* Bali.

Learning design begins with the *Meru* construction process which is familiar to students. Furthermore, by using a controversial problem-based multimodal approach, researchers created lessons that can improve students' critical thinking skills, and the learning content is nuanced in the ethnomathematical nuances of *Meru* and *Jejaitan*. *Meru* Bali was chosen because it contains many mathematical concepts, particularly the hat of congruence, and has been passed down from generation to generation as a local wisdom in Bali. Meanwhile, *lamak* and *taledan*, as *Jejaitan* Bali, are manufactured in standard rectangular and square. The implication is that students' confidence in learning is growing, which is assisting them in interpreting mathematics

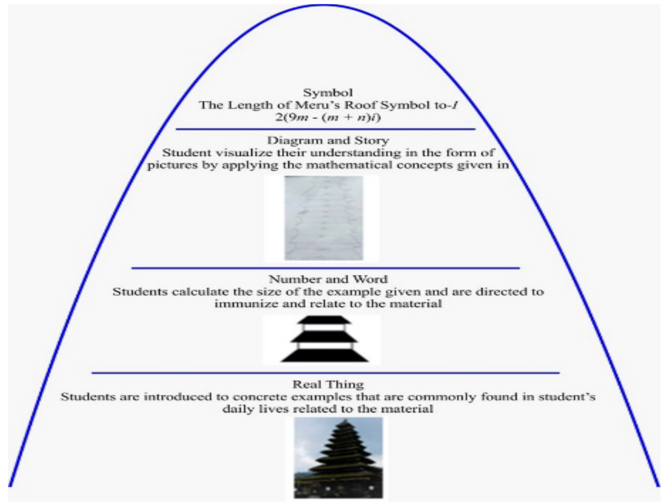


Fig. 12. Example of a multimodal learning sketch based on Meru Bali's ethnomathematics

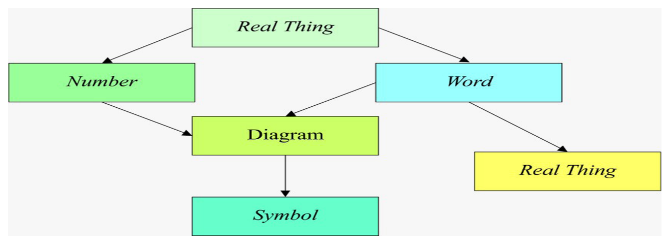


Fig. 17: Stages of the Ethnomathematical Meru Bali-Based Multimodal Approach

on the geometry topic under study. This is supported by an explanation of the six stages of implementing a multimodal approach, namely real things, numbers, words, diagrams, stories, and symbols. (Al Fajri, 2018). Digital learning with multimodal approach ethnomathematics nuances sacred building *Meru* Bali have a significant influences on student's conceptual understanding reffering to the six stages of strategy whose relationship is illustrated as shown in figure 17.

The first strategy is the real thing, which is called the stage of introducing the material or concept to students. The teacher gives an example in the form of the *Meru* Bali as ethno-mathematics with local wisdom. Students calculate the length of the rectangle that forms the *Meru* building's roof in the number stage. Furthermore, students are directed to communicate various materials contained in mathematics learning, particularly on the topic of geometry. The teacher also instructs students to visualize or create pictures in the form of diagrams based on the data and numbers provided in order to strengthen students' understanding of the concept of similarity, Story is the fifth stage where students hone their logical thinking skills by practicing their reasoning from the questions given. Through this stage, mathematics can become a science that can be applied in various fields of life (Apsari et al., 2020).

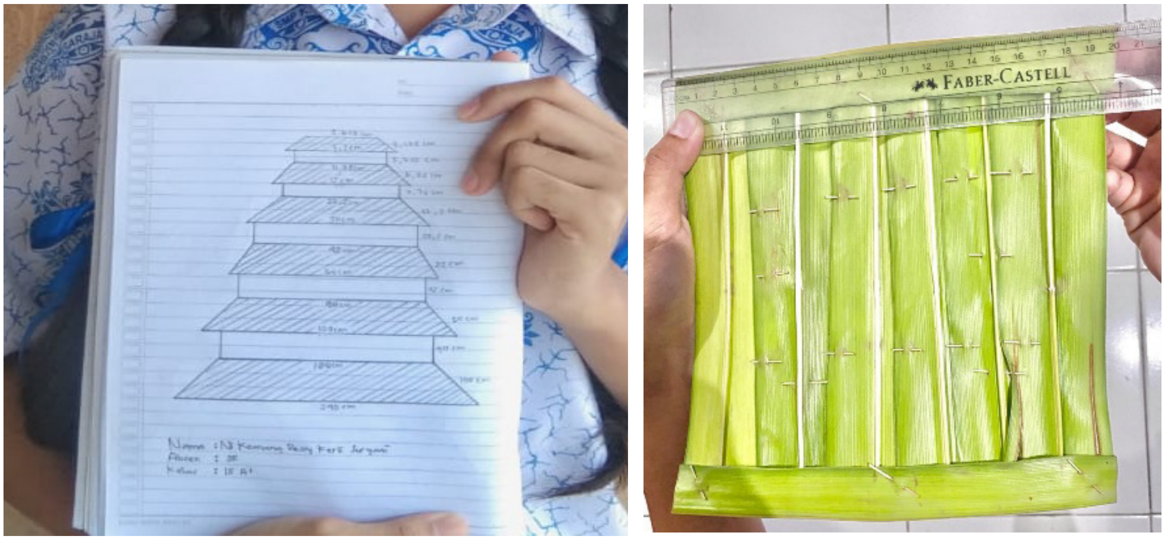


Figure 18: One of the Results of the *Meru* Roof Design by Students and Activities to Identify Plane Using Balinese *Jejaitan*

In the story stage, a critical thinking process is identified into six stages, namely a) identify, b) define, c) enumerate, d) analyze, e) list, and f) self-correct. (Peter, 2012) The results of the analysis of students' answers in completing this demonstrate that the process of analysis and student lists occur simultaneously. Research is also involved in the process of merging parts of critical thinking. Cheng and Wan (2017), Fani et al. (2018), and Murtafiah et al. (2018).

According to research (Murtafiah et al., 2018), students made a conceptual error in the analysis and list sections when the special qualities of a rectangle arise when two pairs of opposite sides are the same length on *Jejaitan* Bali and name the corresponding sides on *Meru*'s roof. Analysis is a relationship with assumptions, classifying and distinguishing (Dekker, 2020; Din, 2020; Reynders et al., 2020). Based on the data analysis, students know that a square is a plane with four equal-length sides, but they are perplexed when asked whether a rectangle is a square in *Jejaitan* Bali, and students know how to find the corresponding sides that must meet the requirements of one of the angles side angle. In the enumerate sections, analysis and list can be seen that there is an argumentation process for students so that they find reinforcement from previously accepted concepts. (Mueller & Yankelewitz, 2014; Setiana et al., 2021). The findings in this study are the process of combining critical thinking stages in solving controversial problems. Students expressing opinions also require argumentation and re-checking (Altun, S. D. G., & Konyalioglu, 2019; Goldberg & Savenije, 2018; Kello, 2016; Simic-Muller et al., 2015).

Students are guided through the symbol stage to recognize and comprehend the manipulation of mathematical symbols in the geometry similarity material. This condition is required to direct and increase students' competency in comprehending and developing diverse mathematical formulas based on their own knowledge and understanding through the use of learning media that are compatible with their learning style. Meanwhile, *Meru* and *Jejaitan* Bali add new nuances to make digital mathematics learning with a multimodal approach more meaningful.

Based on the above description, the limitations of using digital learning with a multimodal approach can be addressed by providing a touch of meaningful content through the ethnomathematical nuances of *Meru* and *Jejaitan* Bali's. This is shown in the apperception section, students are introduced and reminded again with the form of *Meru* and *Jejaitan* Bali as shown in Figure 1. The teacher defines *Meru* and *Jejaitan* and how they relate to learning material. The learning objectives that students must achieve through the context of *Meru* and *Jejaitan* Bali on various media are then described. The teacher explains the similarity rules found in *Meru* so that the *Meru* building appears proportional and balanced, while the teacher explains the standard forms of *taledan* and *lamak*, which are examples of *Jejaitan* Bali. Students are also invited to design the *Meru*'s roof using the concept of similarity and analyze the characteristics of plane with *Jejaitan* Bali, which is used as an evaluation material to determine students' understanding of the similarity material. Figure 18 shows one of the outcomes of the *Meru* roof and *jejahitan taledan* design created by students. It can be seen that students grasped the concept of similarity and were able to apply it to the *Meru* concept and also the concept of two dimensional shapes in real life.

Conclusion

An ethnomathematics controversial problem-based multimodal approach provides a new nuance in meaningful mathematics learning in the era of digitalization.

This approach and the integration of controversial issues, as well as ethnomathematical synergies in the sacred buildings of Meru and Jejahitan Bali, are an effective combination to improve students' critical thinking skills, especially in the topic of geometry. Controversial issues arise at the story stage in the multimodal approach. The content of mathematics contained in the sacred building of Meru and Jejahitan Bali which is packaged in controversial issues is used as content in the implementation of a multimodal approach to facilitate each student's learning style, such as digital text material containing ethnomathematical content of the sacred buildings of Meru and Jejahitan Bali, which is beneficial to students who learn visually. Likewise, students with auditory learning styles are well facilitated through media in the form of contextual learning videos with ethnomathematical nuances of the sacred buildings of Meru and Jejahitan Bali. Meanwhile, students with kinesthetic learning styles benefit from GeoGebra simulation media, in which students are asked to design Meru's roof and identify the properties of Jejahitan Bali's plane to refer to the concept of similarity. Worksheets, videos, and GeoGebra simulations are all examples of digital mathematics media that have been designed to be interconnected and facilitate the construction of the same concept so that when used together, the three media can help students with both global and analytical learning styles.

The ethnomathematics synergy of Meru and Jejahitan Bali, as well as a multimodal approach and integration of difficult subjects, are beneficial combinations to increase students' critical thinking skills, but only on the topic of geometry. From the several perspectives that exist, ethnomathematics only included one religious edifice and two Jejaitan Bali. From the five known student learning styles, this study recently facilitated three new student learning styles: visual, auditory, and kinesthetic. For global student learning styles and analytics, using media that is tailored to the student's learning style has not had a significant impact. According to the researchers, teachers, readers, and other academics are expected to follow up on the study's findings to help address the restrictions.

Limitations

A multimodal approach is an approach that is expected to be able to facilitate the diversity of student learning styles, however, in this study, we were limited to only being able to facilitate three of the 5 student learning styles, namely auditory, visual, and kinesthetic. Furthermore, we realized that there are difficulties in finding controversial problems according to mathematical topics and not all topics in mathematics can be combined with ethnomathematical nuances, therefore in our research, we combine learning with ethnomathematical controversial problems in the field of geometry. We hope that our research can be developed on other mathematical topics by using relevant controversial issues and using cultural nuances so that mathematics learning becomes more meaningful.

Acknowledgments

The authors thank the principal, teachers, and students of Singaraja junior high school, traditional Balinese architects (Undagi Bali), *Serati* related to Balinese *Jejaitan*, and all parties who have contributed to this research.

References

Abiam, P., Abonyi, O., Ugama, J., & Okafor, G. (2016). Effects of Ethnomathematics-based Instructional Approach on Primary School Pupils' Achievement in Geometry. *Journal of Scientific Research and Reports*,*9*(2),1–15. https://doi.org/10.9734/jsrr/2016/19079

Al Fajri, T. A. (2018). Pentingnya Penggunaan Pendekatan Multimodal Dalam Pembelajaran. *WASKITA: Jurnal Pendidikan Nilai dan Pembangunan Karakter*, *2*(1), 57–72. https://doi.org/10.21776/ub.waskita.2018.002.01.5

Al Fajri, T. A. (2018). Pentingnya Penggunaan Pendekatan Multimodal dalam Pembelajaran. *WASKITA: Jurnal Pendidikan Nilai Dan Pembangunan Karakter*, *2*(1), 57–72. https://doi.org/10.21776/ub.waskita.2018.002.01.5

Almusharraf, N. M., & Khahro, S. H. (2020). Students' Satisfaction with Online Learning Experiences during the COVID-19 Pandemic. *International Journal of Emerging Technologies in Learning*, *15*, 246–267. https://doi.org/10.3991/ijet.v15i21.15647

Altun, S. D. G., & Konyalioglu, A. C. (2019). The influence of mistake-handling activities on mathematics education: An example of definitions. *European Journal of Educational Research*, *8*(2), 467–476. https://doi.org/https://doi.org/10.12973/eujer.8.2.467

Apsari, R. A., Putri, R. I. I., Sariyasa, Abels, M., & Prayitno, S. (2020). Geometry representation to develop algebraic thinking: A recommendation for a pattern investigation in pre-algebra class. *Journal on Mathematics Education*, *11*(1), 45–58. https://doi.org/10.22342/jme.11.1.9535.45-58

Bismala, L., & Manurung, Y. H. (2021). Student satisfaction in e-learning along the COVID-19 pandemic with importance performance analysis. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(3), 753. https://doi.org/10.11591/ijere.v10i3.21467

Bulte, A. M. ., Westbroek, H. B., Jong, O. de, & Pilot, A. (2006). A research approach to designing chemistry education using authentic practices as contexts. *International Journal of Science Education*, *28*(9), 1063–1086.

Cheng, M. H. M., & Wan, Z. H. (2017). Exploring the effects of classroom learning environment on critical thinking skills and disposition: A study of Hong Kong 12th graders in Liberal Studies. *Thinking Skills and Creativity*. https://doi.org/https: //doi.org/10.1016/j.tsc.2017.03.001

Current Trends in Ethnomathematics. (2016). *Revista Latinoamericana de Etnomatemática*, *9*(2), 4–11.

Dekker, T. J. (2020). Teaching critical thinking through engagement with multiplicity. *Thinking Skills and Creativity*. https://doi.org/https: //doi.org/10.1016/j.tsc.2020.100701

Di Pietro, G., Biagi, F., Costa, P., Karpiński, Z., & Mazza, J. (2020). The likely impact of COVID-19 on education: Reflections based on the existing literature and recent international datasets. In *Publications Office of the European Union, Luxembourg: Vol. EUR 30275* (Issue JRC121071). https://doi.org/10.2760/126686

Din, M. (2020). Evaluating university students' critical thinking ability as reflected in their critical reading skill: A study at bachelor level in Pakistan. *Thinking Skills and Creativity*. https://doi.org/https://doi.org/ 10.1016/j.tsc.2020.100627

Fani, E. T. R., Baiduri, B., & Rosyadi, A. A. P. (2018). Analysis Of Students' Critical Thinking and Independence of Learning Through Problem-Based Learning. *Mathematics Education Journal*. https://doi.org/https://doi.org/10.22219/mej.v2i2.6500

Farman, F., Arbain, A., & Hali, F. (2021). Learning Style Preferences Based on Class and Gender. *AL-ISHLAH: Jurnal Pendidikan*, *13*(1), 164–172. https://doi.org/10.35445/alishlah.v13i1.368

Gokkurt, B., Dundar, S., Soylu, Y., & Akgun, L. (2012). The Effects of Learning Together Technique Which is based on Cooperative Learning on Students' Achieevement in Mathematics Class. *Procedia - Social and Behavioral Sciences*, *46*, 3431–3434. https://doi.org/10.1016/j.sbspro.2012.06.079

Goldberg, T., & Savenije, G. M. (2018). *Teaching Controversial Historical Issues. In The Wiley International Handbook of History Teaching and Learning*. 503–526. https://doi.org/https://doi.org/10.1002/978111910081 2.ch19

Gülburnu, M., & Yildirim, K. (2021). Development and implementation of mathematics attitudes scale for the primary and secondary students. *Pegem Egitim ve Ogretim Dergisi*, *11*(4), 177–184. https://doi.org/10.47750/pegegog.11.04.17

Ishartono, N., Nurcahyo, A., Waluyo, M., Prayitno, H. J., & Hanifah, M. (2022). Integrating GeoGebra into the flipped learning approach to improve students' self-regulated learning during the covid-19 pandemic. *Journal on Mathematics Education*, *13*(1), 69–86. https://doi.org/10.22342/jme.v13i1.pp69-86

Jannah Akmal, Miftahul, & Santaria, R. (2020). Mutu Pendidikan Era Revolusi 4.0 di Tengah Covid-19.[The Quality of Education in the Revolutionary Era 4.0 in the Middle of Covid-19].*Journal of Teaching and Learning Research*, *2*(2), 1–12. http://ejournal.iainpalopo.ac.id/index.php/JTLR/article/view/1415

Juniati, D., & Budayasa, I. K. (2017). Pengembangan Bahan Ajar Geometri Fraktal Berbasis Eksperimen Untuk Meningkatkan Kompetensi Mahasiswa. *Jurnal Cakrawala Pendidikan*, *36*(1), 24–33. https://doi.org/10.21831/cp.v36i1.11660

Junpeng, P., Marwiang, M., Chiajunthuk, S., Suwannatrai, P., Chanayota, K., Pongboriboon, K., Tang, K. N., & Wilson, M. (2020). Validation of a digital tool for diagnosing mathematical proficiency. *International Journal of Evaluation and Research in Education*, *9*(3), 665–674. https://doi.org/10.11591/ijere.v9i3.20503

Kello, K. I. (2016). Sensitive and controversial issues in the classroom: Teaching history in a divided society. *In Teachers and Teaching: Theory and Practice*. https://doi.org/https://doi.org/10.1080/13540602.2015 .1023027

Khoiriyah, N., Abdurrahman, A., & Wahyudi, I. (2018). Jurnal riset dan kajian pendidikan fisika. *Jurnal Riset Dan Kajian Pendidikan Fisika*, *5*(2), 53–62.

Lailiyah, S., Hayat, S., Urifah, S., & Setyawati, M. (2020). Levels Of Students' Mathematics Anxieties And The Impacts On Online Mathematics Learning. *Jurnal Cakrawala Pendidikan*, *39*(2), 107–119. https://doi.org/10.21831/cp.v39i2.28173

Lase, D. (2019). Jurnal sundermann. *Journal Sunderman*, *1*(1), 28–43. 10.1109/ITHET.2016.7760744

Lisnani, Zulkardi, Indra Putri, R. I., & Somakim. (2020). *Etnomatematika : Pengenalan Bangun Datar Melalui Konteks Museum Negeri Sumatera Selatan Balaputera Dewa*. *9* (September), 359–370.

Mardiana, D., & Umiarso. (2020). Merdeka Belajar di Tengah Pandemi COVID-19 : Studi di Sekolah Menengah Pertama di Indonesia*Journal of Educational Studies*] *13*(2), 78–91.

Meryansumayeka, Zulkardi, Putri, R. I. I., & Hiltrimartin, C. (2022). Designing geometrical learning activities assisted with ICT media for supporting students' higher order thinking skills. *Journal on Mathematics Education*, *13*(1), 135–148. https://doi.org/10.22342/jme.v13i1.pp135-148

Mowla, S., & Kolekar, S. V. (2020). Development and integration of E-learning services using rest APIs. *International Journal of Emerging Technologies in Learning*, *15*(4), 53–72. https://doi.org/10.3991/ijet.v15i04.11687

Mueller, M., & Yankelewitz, D. (2014). Fallacious argumentation in student reasoning: Are there benefits? *European Journal of Science and Mathematics Education*, *2*(1), 27–38. https://doi.org/10.30935/scimath/9398

Murtafiah, W., Sa'dijah, C., Candra, T. D., Susiswo, & As'ari, A. R. (2018). Exploring the explanation of pre-service teacher in mathematics teaching practice. *Journal on Mathematics Education*. https://doi.org/https://doi.org/10.22342/jme.9.2.5388.259-270

Naufal, M. A., Abdullah, A. H., Osman, S., Abu, M. S., Ihsan, H., & Rondiyah. (2021). Reviewing the Van Hiele model and the application of metacognition on geometric thinking. *International Journal of Evaluation and Research in Education*, *10*(2), 597–605. https://doi.org/10.11591/ijere.v10i2.21185

Nugroho, P. B., Nusantara, T., As'ari, A. R., Sisworo, Hidayanto, E., & Susiswo. (2018). Critical thinking disposition: Students skeptic in dealing with ill-logical mathematics problem. *International Journal of Instruction*, *11*(3), 635–648. https://doi.org/10.12973/iji.2018.11343a

Olsson, D. M. (2018). Replicated Randomized Complete Block Design. *Journal of Quality Technology*, *10*(1). https://doi.org/https://doi.org/10.1080/00224065.1978.11980811

Özgen, K. (2021). Checklist on question design for mathematical literacy. *Pegem Egitim ve Ogretim Dergisi*, *11*(1), 259–298. https://doi.org/10.14527/PEGEGOG.2021.008

Pan, X., & Zhang, Z. (2020). An empirical study of application of multimodal approach to teaching reading in EFL in senior high school. *International Journal of Emerging Technologies in Learning*, *15*(2), 98–111. https://doi.org/10.3991/ijet.v15i02.11267

Papageorgiou, V., & Lameras, P. (2017). Multimodal teaching and learning with the use of technology: Meanings, practices and discourses. *14th International Conference on Cognition and Exploratory Learning in the Digital Age, CELDA 2017, October*, 133–140.

Parwati, N. N., & Suharta, I. G. P. (2020). Effectiveness of the implementation of cognitive conflict strategy assisted by e-service learning to reduce students' mathematical misconceptions. *International Journal of Emerging Technologies in Learning*, *15*(11), 102–118. https://doi.org/10.3991/IJET.V15I11.11802

Pathuddin, H., Kamariah, & Ichsan Nawawi, M. (2021). Buginese ethnomathematics: Barongko cake explorations as mathematics learning resources. *Journal on Mathematics Education*, *12*(2), 295–312. https://doi.org/10.22342/jme.12.2.12695.295-312

Peter, E. E. (2012). Critical thinking: Essence for teaching mathematics and mathematics problem solving skills. *African Journal of Mathematics and Computer Science Research*. https://doi.org/https://doi.org/10.5897/ ajmcsr11.161

PhD Assoc.Egamberdieva L.N. (2022). *The Role and Significance Of The Use Of Multimedia*. 15–16.

Prahmana, R. C. I., Yunianto, W., Rosa, M., & Orey, D. C. (2021). Ethnomathematics: Pranatamangsa system and the birth-death ceremonial in yogyakarta. *Journal on Mathematics Education*, *12*(1), 93–112.

https://doi.org/10.22342/JME.12.1.11745.93-112

Pujawan, I. G. N., Suryawan, I. P. P., & Prabawati, D. A. A. (2020). The effect of van hiele learning model on students' spatial abilities. *International Journal of Instruction*, *13*(3), 461–474. https://doi.org/10.29333/iji.2020.13332a

Rachmawati, I. (2012). Eksplorasi Etnomatematika Masyarakat Sidoarjo. *MATHEdunesa*, *1*(1), 1–8.

Rahman, N. A., Rosli, R., Rambely, A. S., Siregar, N. C., Capraro, M. M., & Capraro, R. M. (2022). Secondary school teachers' perceptions of STEM pedagogical content knowledge. *Journal on Mathematics Education*, *13*(1), 119–134. https://doi.org/10.22342/jme.v13i1.pp119-134

Ramadoni, & Mustofa. (2022). *Enhancing Flipped Classroom with Peer Teaching to Promote Students ' Conceptual Understanding and Self- Efficacy in Calculus Courses*. *12*(3), 154–168. https://doi.org/10.47750/pegegog.12.03.17

Reynders, G., Lantz, J., Ruder, S. M., Stanford, C. L., & Cole, R. S. (2020). Rubrics to assess critical thinking and information processing in undergraduate STEM courses. *International Journal of STEM Education*. https://doi.org/https://doi.org/10.1186/ s40594-020-00208-5

Rudhito, M. A., & Prasety, D. A. B. (2016). Pengembangan Soal Matematika Model Timss Untuk Mendukung Pembelajaran Matematika SMP Kelas VII Kurikulum 2013. [Development of the Timss Model of Mathematics Problems to Support Mathematics Learning for Junior High School Class VII Curriculum 2013]. *Jurnal Cakrawala Pendidikan*, *1*(1), 88–97. https://doi.org/10.21831/cp.v1i1.8370

Sagitarini, R. (2018). *Kajian Etnomatematika Pada Undagi Bali dan Upaya Memperoleh Pengetahuannya*

Setiana, D. S., Purwoko, R. Y., & Sugiman. (2021). The application of mathematics learning model to stimulate mathematical critical thinking skills of senior high school students. *European Journal of Educational Research*, *10*(1), 509–523. https://doi.org/10.12973/EU-JER.10.1.509

Simic-Muller, K., Fernandes, A., & FeltonKoestler, M. D. (2015). "I just wouldn't want to get as deep into it": Preservice teachers' beliefs about the role of controversial topics in mathematics education. *Journal of Urban Mathematics Education*.

Sirate, S. F. S. (2015). Menggagas Integrasi Multikultur Pembelajaran Matematika : suatu telaah etnomatematika.[*Initiating* Multicultural Integration of Mathematics Learning: an ethnomathematical study.] *Auladuna*, *2*(2), 246–263.

Su, H. F. H., Ricci, F. A., & Mnatsakanian, M. (2016). Mathematical teaching strategies: Pathways to critical thinking and metacognition. *International Journal of Research in Education and Science*, *2*(1), 190–200. https://doi.org/10.21890/ijres.57796

Suarsana, I. M., & Mahayukti, G. A. (2013). Pengembangan E-Modul Berorientasi Pemecahan Masalah Untuk Meningkatkan Keterampilan Berpikir Kritis Mahasiswa. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, *2*(3), 193. https://doi.org/10.23887/janapati.v2i3.9800

Suarsana, I. M., Mahayukti, G. A., Sudarma, I. K., & Pujawan, A. A. G. S. (2019). The Effect of Interactive Mathematics Learning Media toward Mathematical Conceptual Understanding on Probability of Hearing-impaired Students. *Journal of Physics: Conference Series*, *1165*(1). https://doi.org/10.1088/1742-6596/1165/1/012021

Sudiarta, I. G. P., & Widana, I. W. (2019). Increasing mathematical proficiency and students character: Lesson from the implementation of blended learning in junior high school in Bali. *Journal of Physics: Conference Series, 1317, 012118*. https://doi.org/https://doi.org/10.1088/1742-6596/1317/1/012118

Suryawan, I. P. P., & Juniantari, M. (2021). *Undagi Bali Ethnomathematic Study and How to Acquire Its Knowledge*. *536*(Icsteir 2020), 384–390.

Suryawan, I. P. P., & Sariyasa. (2018). Integrating ethnomathematics into open-ended problem based teaching materials. *Journal of Physics: Conference Series*, *1040*(1). https://doi.org/10.1088/1742-6596/1040/1/012033

Syafri, F. S. (2019). Pengaruh kemampuan representasi siswa dalam pemecahan masalah matematika. *Jurnal Pendidikan Matematika*, *3*(May), 49–55.

Umbara, U., Wahyudin, & Prabawanto, S. (2021). Ethnomathematics Vs Ethomodeling: how does cigugur traditional community determines the direction of the wind to seek fortune based on month. *Journal of Physics: Conference Series*, *1776*(1), 012034. https://doi.org/10.1088/1742-6596/1776/1/012034

Umoh, M. (2020). Teaching and Learning with Technology Teaching and Learning. *Technology*, *7*(5), 296–300.

Utami, R. E., Nugroho, A., Andri Dwijayanti, I., & Sukarno, A. P. (2018). *Pengembangan E-Modul Berbasis Etnomatematika untuk Meningkatkan Kemampuan Pemecahan Masalah*. Universitas PGRI Semarang.