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Mathematical Representation Ability in the Implementation of Ethno-Flipped Classroom Model Assisted by Interactive Media Based on Self-Efficacy

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Abstract

This study aims to (1) determine the effectiveness of the Ethno-Flipped Classroom model assisted by interactive media on students' mathematical representation abilities, and (2) describe the mathematical representation abilities of students who have high, medium and low self-efficacy. This study was mixed-methods with sequential explanatory design. Retrieval of quantitative data using a mathematical representation ability test, while collecting qualitative data using self-efficacy questionnaires and interview guidelines. The population in this study were students of class VIII SMP N 2 Susukan, Banjarnegara Regency. The samples of this study were 25 students from the experimental class and 26 students from the control class. The results showed that (1) Ethno-Flipped Classroom assisted by interactive media was effective on mathematical representation abilities, (2) subjects with high self-efficacy were able to fulfill all indicators of mathematical representation abilities, namely verbal, symbolic and visual representations, (3) subjects with medium self-efficacy can fulfill indicators of verbal and symbolic representation, (4) subjects with low self-efficacy only fulfill indicators of verbal representation.

1. Introduction

Mathematics is a branch of science, an important part of education because with it the development of science and technology can develop (Ulya et al., 2019). Ramdani (2006) strengthens his opinion that mathematics is a deductive science, structured about patterns and relationships, language of symbols, as well as queens and services of science. Therefore, mathematics has a very important role for the development of a nation's civilization.

One of the objectives of mathematics in the 2013 curriculum as contained in the annex to regulation of the minister of education and culture Number 58 of 2014 concerning the 2013 Curriculum for Junior High Schools in the Mathematics Subject Guidelines section is to understand mathematical concepts which are competencies in explaining interrelationships between concepts and using concepts and algorithms flexibly, accurately, efficient, and precise in solving problems. As for one of the indicators of achieving mathematical competency in tables, graphs, diagrams, drawings, sketches, mathematical models, or other methods (Permendikbud, 2014: 325-326). In line with this, the National Council of Teachers of Mathematics (NCTM) in its Principles and Standards for School Mathematics states that there are five standard processes for learning mathematics that students must master, namely: solving mathematical problems; mathematical reasoning and proof; mathematical communication; mathematical connections; and mathematical representations. Therefore this study will specialize in the ability of mathematical representation. NCTM (2000) explains that representation is needed by students to understand

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mathematical concepts and the relationships between mathematical concepts. Representation enables students to communicate mathematical approaches, arguments, and understandings to themselves and to others. Representation also allows students to recognize connections between related concepts and apply mathematics to realistic problems through modeling. In line with this Chapman (2010:289)suggests that the role of representation in learning mathematics is a way of thinking, a way of recording and a way of communicating mathematically.

The Organization for Economic Cooperation and Development (OECD) in 2019 released a chart of Indonesia's 2018 PISA results for the mathematics category decreased compared to the PISA results in 2015. The 2018 PISA results for the mathematics category, Indonesia is ranked 73rd or 7th from the bottom with an average score 379. This shows that students' mathematical literacy skills in Indonesia are still very low. Besides being able to measure students' literacy skills, PISA questions can also be used to measure students' mathematical representation abilities. This is because the indicator in literacy ability is representation (Santia, 2018). This is corroborated by the results of the 2015 Trends in International Mathematics and Science Study (TIMSS) survey which explained that Indonesian students were weak in all aspects of mathematical content (representing mathematical ideas or concepts in the matter of numbers, geometry, data presentation, knowledge, application, and thinking).

Lunenburg (2011) explains that in addition to representational abilities, students' confidence in their ability to express ideas also contributes to one's success in solving a problem. A person's belief in coordinating and directing his ability to change and deal with situations is called self-efficacy. Students with high self-efficacy tend to be more diligent in trying to complete learning tasks than students with low self-efficacy (Santrock, 2009: 216).

The problem that the researchers found during the observation at Public Middle School (*SMP Negeri*) 2 Susukan, Banjarnegara Regency, was the low ability of the mathematical representation of class VIII students at SMP Negeri 2 Susukan, Banjarnegara Regency. This can be seen from the results of the Odd Mid Semester Assessment, most students answered the description questions without writing down how to find the final answer. Another problem is when students find questions that they consider difficult, many students complain that they cannot do them. This shows that students' self-efficacy is still low. In addition, there are no innovative learning media that teachers use to attract students' attention and encourage students to be active during learning.

One learning model that is able to maximize student self-efficacy and representation abilities is flipped classroom learning (Ulya et al., 2019). Flipped classroom learning is flipped learning, where students are given the task of learning a subject matter that can be supported by learning videos, textbooks and so on, so that in classroom learning students already have stock of material and can form discussion groups to solve questions. questions and deepen the material they have. The syntax of the flipped classroom learning model according to Bishop & Verleger (2013) are as follows a) phase 0 (students learn independently), b) phase 1 (come to class to carry out teaching and learning activities and do related assignments), c) phase 2 (apply students' abilities in projects and other simulations in class), d) phase 3 (measuring student understanding carried out in class at the end of the subject matter). In this case the flipped classroom model acts as a channel that bridges students to explore their abilities in overcoming the problems given. Therefore, it is hoped that the flipped classroom model can improve students' mathematical representation abilities.

Students' difficulties in understanding mathematical problems are also caused by the absence of problems that are close to tradition, culture, and students' real experiences. Culture and tradition-based mathematics or known as ethnomathematics. In providing contextual problems, one that can be used is to link learning with culture in society. Therefore, ethnomathematics can be used in learning. Learning that uses cultural patterns is a good strategy to use to create a learning environment, provide learning experiences by integrating culture as part of the learning process. A form of culture-based learning is ethnomathematics (Zaenuri et al, 2019).

Ramadhani et al. (2022) recommends the Ethno-Flipped Classroom model as a mixed-based mathematics learning model that uses technology in the learning process, but also presents meaningful mathematics learning through cultural integration using an ethnomathematics context. The application of the Ethno-Flipped Classroom model can be used as a solution in implementing mathematics learning in the New Normal period (Ramadhani et al., 2022).

Interactive media in learning is one of the efforts to increase the interaction between teachers and students and the interaction of students and the learning environment. The function of learning media is as a teaching aid, namely to support the use of teaching methods used by teachers (Istiqlal, 2017: 48). Therefore, with the help of interactive learning media it is hoped that it can stimulate students to respond positively to the learning material presented.

Based on the background that has been described, the objectives of this study are, (1) to determine the effectiveness of the Ethno-Flipped Classroom model assisted by interactive media on students' mathematical representation abilities, and (2) to describe the mathematical representation abilities of students who have high self-efficacy, medium and low.

2. Methods

This research was mixed method research. The research design used was a sequential explanatory design using a Posttest-Only Design with Nonequivalent Groups. Sequential explanatory, namely collecting and analyzing quantitative data then collecting and analyzing qualitative data to help explain or elaborate on quantitative results (Creswell, 2015:1106). The combination of quantitative data with qualitative data is usually based on the results obtained previously from the first stage.

Table 1. Posttest-Only design research design with Nonequivalent Groups

Group	**Treatment**	***Posttest***
Experiment Class	X	O_1
Control Class	Y	O_2

Information:

X	:	learning with models Ethno-Flipped Classroom assisted by interactive media
Y	:	learning with the Problem Based Learning model
O_1, O_2	:	posttest results of mathematical representation abilities

The research was conducted at Susukan 2 Public Middle School, Banjarnegara Regency. The population in this study were all students of class VIII. The sample of this research is class VIII F as the control class and class VIII E as the experimental class. Learning in the experimental class is carried out with a model Ethno-Flipped Classroom assisted by interactive media, while learning in the control class uses the Problem Based Learning (PBL) model. Sampling in this study using simple random sampling technique.

Quantitative data collection used mathematical representation ability test questions, while for qualitative research using questionnaires self-efficacy. The validity of the two data was then tested using a triangulation technique, namely conducting interviews to confirm the work results of the research subjects.

Quantitative data analysis was divided into initial data analysis and final data analysis. The initial data analysis used the Shapiro-Wilk normality test, the homogeneity test with the Levene test, and the similarity test of the two means with the independent t-test. The final data analysis used the normality test, the homogeneity test as a prerequisite test and then continued with the average achievement test, the proportion test, the two average difference test. After analyzing the quantitative data, it was then followed by qualitative data analysis using a student interest questionnaire through the Google form and student answer sheets.

3. Results & Discussions

This section contains a description of the results of quantitative and qualitative research. Quantitative research was conducted using a mathematical representation ability test instrument. Students work on contextual questions, each of which contains indicators of mathematical representation. This research was conducted using a self-efficacy questionnaire. Before being used in the experimental class and control class, the test instruments were tested first using validity, reliability, question discrimination, and difficulty levels.

3.1. Students' Mathematical Representation Ability in the Implementation of the Ethno-Flipped Classroom Model Assisted by Interactive Media Achieves Mastery

Based on the results of the analysis, the results of the test scores for students' mathematical representation ability in the implementation of the Ethno-Flipped Classroom model assisted by interactive media are normally distributed and homogeneous. Then proceed with the average test and proportion test. It was found that the ability of students' mathematical representation in the matter of Linear Equation System of Two Variables in the implementation of the Ethno-Flipped Classroom model assisted by interactive media was completed both individually and classically. On the mathematical representation ability test, the average score of the experimental class was 78.1 with the lowest value being 50 and the highest value being 100. The average test results were obtained $t_{count} = 4.66 > t_{table} = 1.174$ so it can be concluded that the average score of the experimental class meet the mastery learning criteria complete that is 65. Then for the proportion test the result is $z_{count} = 1.9629 > z_{table} = 1.64.$ These results indicate that the proportion of students who achieve minimum completeness criteria in the Ethno-Flipped Classroom model assisted by interactive media has reached classical mastery. Based on the results of the mathematical representation ability test on the Ethno-Flipped Classroom model assisted by interactive media, there were 23 out of 25 students or 92% who had completed the minimum completeness criteria. Based on the results of the average test and proportion test, it can be said that the implementation of the Ethno-Flipped Classroom model assisted by interactive media can help students achieve learning mastery. These results are in line with Alsalamah's research (2022) which found that classes taught using the Flipped Classroom model with ethnomathematics nuances achieved classical mastery.

3.2. Students' Mathematical Representation Ability in the Implementation of the Ethno-Flipped Classroom Model Aided by Interactive Media is Better Than the PBL Model

In the Ethno-Flipped Classroom learning model assisted by interactive media, 23 students completed it while 17 students completed the PBL learning model. Based on these data, it can be said that the proportion of students who complete the Ethno-Flipped Classroom model assisted by interactive media is higher than the PBL model. The results of the average similarity test obtained $t_{count} = 1.79089 > t_{table} = 1.676$ so that it can be said that the average mathematical representation ability of students in the class with the Ethno-Flipped Classroom learning model assisted by interactive media is better than the average students' mathematical representation ability in class with the PBL learning model. The average for the experimental class was 78.1 while the average for the control class was 70.48.

This is obtained because the syntax in the Ethno-Flipped Classroom model can encourage students to be more active in class. The Ethno-Flipped Classroom model is a reverse learning model, what is usually done in class is now done at home, what is usually done as homework is now completed in class. The Ethno-Flipped Classroom learning model assisted by interactive media utilizes the role of technology where students are given learning videos that must be watched during pre-class activities and use time in class to work together to solve problems and develop concepts. So that in practice it encourages students to learn actively in building and discovering the concepts of their knowledge. In addition, the Ethno-Flipped Classroom learning model assisted by interactive media also has a positive impact on students because it trains students to be responsible for learning, trains student independence, so that students do not only depend on the information provided by the teacher, and trains students' confidence in their ability to understand and solve problems. That belief is what is meant by self-efficacy. This is in line with research conducted by Kiptiyah (2021) that implementing the Flipped Classroom model with ethnomathematics nuances is effective in increasing mathematical literacy skills. and train students' confidence in their ability to understand and solve problems.

In this study the Ethno-Flipped Classroom learning model assisted by interactive media provides problems related to local culture around students, namely batik, dawet, and tourist attractions in Gumelem Wetan Village, Susukan District, Banjarnegara Regency, Central Java. So as to develop students' reasoning with the problems given and be more active in the learning process. The activity was preceded by a pre-class phase, namely a preparatory activity in which students studied material on a system of two-variable linear equations in textbooks and learning videos followed by writing summaries related to the material that had been studied. At the time of learning in class, students discussed how to complete student worksheets with ethnomathematics nuances.

Interactive media is used as a game media during learning and as an evaluation medium when learning ends. The application of games has a positive influence on student stimulus development, improves student representation abilities and provides a pleasant atmosphere for students (Marlina et al., 2014). Interactive media in the form of online math games can help create interesting activities in learning so that learning becomes fun and effective (Andriani et al., 2021).

Package books and learning videos given in pre-class activities to students are used as guides in the learning process, while the ethnomathematics nuanced worksheets given at each meeting in in-class activities (core) aim to help students explore problems related to the material of a system of two-variable linear equations and help students reason gradually. The student worksheets with ethnomathematics nuances that was developed encourages students to be active in the learning that is carried out. This is because the problems presented are related to the culture that exists around students so that students can explore information according to the cognitive structure in compiling and associating new information with what has been previously obtained which is useful in solving problems in order to develop students' reasoning abilities. The learning process is also more meaningful because it relates to the life that is around students. This is also in accordance with the law of readiness which explains that students will be more successful if students are ready to carry out learning activities, because previously students were required to watch videos and study textbooks.

3.3. Student Self-Efficacy Classification

Student grouping is based on three categories of student self-efficacy namely self-efficacy low, medium and high. Based on the results of the analysis on the self-efficacy questionnaire, the student grouping data was obtained as shown in Table 2.

Table 2. Student Self-Efficacy Criteria Data

Self-Efficacy Criteria	The number of students	Percentage
Low Self-Efficacy (SER)	5	20%
Medium Self-Efficacy (SES)	15	60%
High Self-Efficacy (SET)	5	20%

For each criterion, 2 SER students, 2 SES students, and 2 SET students were taken so that there were 6 students as research subjects. The determination of the 6 research subjects is shown in Table 3 as follows.

Table 3. Research Subjects Based on Students' Self-Efficacy Criteria

Criteria *Self-Efficacy*	Student Code	SE score	Test Score	Mention
Low	E-7	70	55	RE-7
	E-17	75	67.5	RE-17
Medium	E-18	93	80	SE-18
	E-16	87	80	SE-16
High	E-20	114	100	TE-20
	E-5	107	95	TE-5

A summary of the ability of mathematical representation based on students' self-efficacy can be seen in Table 4.

3.4. Description of Mathematical Representation Ability in View of Self-Efficacy

3.4.1. Mathematical Representation Ability in View of High Self-Efficacy

Based on the self-efficacy questionnaire analysis, there are 5 students who fall into the high self-efficacy category. The researcher then chose 2 out of 5 students who had high self-efficacy as a sample to analyze their mathematical representation skills. The two subjects were able to solve all questions of mathematical representation ability well. The results show that subjects who have high self-efficacy are able to fulfill all indicators of mathematical representation ability.

Subjects with high self-efficacy are able to fulfill indicators of verbal representation, namely the subject is able to write down interpretations of a representation. Being able here means that the student can write down interpretations based on the representations he has made and can explain them well. Thus, subjects in the high self-efficacy group are able to write down the interpretation of a representation. The subject is also able to compose a story in accordance with a representation presented, by making out what is known and what is asked and writing down the steps for solving mathematical problems in words or written text properly.

Table 4. Mathematical Representational Ability of Research Subjects Based on Self-Efficacy.

Question Number	High		Medium		Low		Representation Indicator
	TE-5	TE-20	SE-16	SE-18	RE-17	RE-7	
1	✓	✓	-	-	-	✓	verbal
2	✓	✓	✓	✓	✓	✓	
3	✓	✓	✓	✓	-	-	
4	✓	✓	✓	✓	✓	✓	
1	✓	✓	✓	-	-	✓	symbolic
2a	✓	✓	✓	✓	-	-	
2b	✓	✓	✓	✓	-	-	
2c	✓	✓	✓	✓	-	✓	
3a	✓	✓	✓	✓	-	-	
3c	✓	✓	✓	✓	-	-	
3d	✓	✓	✓	✓	-	-	
4	✓	✓	✓	✓	-	-	
1	✓	✓	-	-	-	-	Visual
3	✓	✓	✓	✓	-	-	

Note:
✓ : meet the indicators
- : does not meet the indicators

In the symbolic representation indicator, namely solving problems with mathematical expressions, subjects in the high self-efficacy group have the ability to solve problems with mathematical expressions. Being able here means that the subject can do calculations well and can explain his work smoothly at the time of the interview. Thus, subjects in the high self-efficacy group are able to solve problems involving mathematical expressions.

In terms of visual representation indicators to explain and facilitate completion, subjects in the high self-efficacy group tend to be able to make graphs and pictures that match the questions. Tend to be able here means that the subject can draw correctly but there is still something incomplete or a little wrong in giving information on pictures or graphs. Incomplete here means that the student only draws graphs without writing down coordinates. Slightly wrong here means that mistakes can still be tolerated, the answer is in question number 3b. Subjects provide descriptions of images in the form of sizes that have been calculated in number 3c, they should provide information in the form of variables. Therefore,

Based on the description above, information is obtained that research subjects with high self-efficacy groups can fulfill the representation ability indicators very well. This is in line with what Bandura (1997) said, that individuals with high self-efficacy can solve problems persistently and correctly. Subsequent similar studies were conducted by Nadia et al. with the results of the study namely students with high self-efficacy can use all indicators of mathematical representation to the maximum compared to students with medium and low self-efficacy (Najiha Nadia et al., 2017).

3.4.2. Mathematical Representation Ability Viewed from Medium Self-Efficacy

Based on the self-efficacy questionnaire analysis, there were 15 students who were included in the medium self-efficacy category. The researcher then chose 2 out of 15 students who had medium self-efficacy as a sample to analyze their mathematical representation abilities. Subject SE-16 was able to solve mathematical representation ability questions quite well even though in question number 1 the verbal and visual representation indicators were still not fulfilled and in question number 2 the verbal representation indicators were also not fulfilled. However, in question number other verbal and visual indicators can be fulfilled. Likewise, subject SE-18 was able to solve all mathematical representation ability questions quite well even though, in question number 1, the verbal, symbolic, and visual representation indicators were still not met.

Subjects with medium self-efficacy tend to have verbal representation skills, namely the subject is able to write down interpretations of a representation and write steps to solve problems in words or written text. Subject SE-16 was able to fulfill some of the questions that contained verbal representations, namely only questions 3 and 4. Whereas Subject SE-18 was able to work on questions that contained verbal representations, namely on questions number 2, 3, and 4.

On the symbolic representation indicator, namely solving problems with mathematical expressions, subjects in the self-efficacy group have the ability to solve problems with mathematical expressions. Being able here means that the subject can do calculations well and can explain his work smoothly at the time of the interview. Subject SE-16 can fulfill all questions that contain indicators of symbolic representation. Meanwhile, subject SE-18 was able to work on all indicators of symbolic representation questions except for question number 1. Thus, subjects in the medium self-efficacy group tended to be able to solve problems involving mathematical expressions.

In terms of visual representation indicators to explain and facilitate completion, subjects SE-16 and SE-18 in the medium self-efficacy group were not able to make graphs and pictures that match the questions. Subjects SE-16 and SE-18 had not been able to draw graphs correctly in question number 1 and in question number 3 they were slightly mistaken in providing information on the pictures. Slightly wrong here means that mistakes can still be tolerated, the answer is in question number 3b. Subjects provide descriptions of images in the form of sizes that have been calculated in number 3c, they should provide information in the form of variables. Thus, subjects in the medium self-efficacy group tend not to be able to make graphs and pictures to explain and facilitate completion.

Based on the description above, information was obtained that most of the students in the experimental class were included in the medium self-efficacy group. Research subjects in the medium self-efficacy group were able to fulfill indicators of verbal and symbolic representation fairly well, but not as well as the high self-efficacy group. Subjects in the medium self-efficacy group could not fulfill the visual representation indicators. So that it can be concluded, research subjects with medium self-efficacy groups can only fulfill some of the indicators of mathematical representation, namely verbal and symbolic representations.

3.4.3. Mathematical Representation Ability in View of Low Self-Efficacy

Based on the self-efficacy questionnaire analysis, there are 5 students who fall into the low self-efficacy category. The researcher then chose 2 out of 5 students who had low self-efficacy as a sample to analyze their mathematical representation skills. As a result, the low self-efficacy group is generally not able to solve mathematical representation ability questions well.

Subjects with low self-efficacy have different verbal representation abilities. Subject RE-17 was able to fulfill some of the questions that contained verbal representations, namely only questions number 2 and 4. Whereas Subject RE-7 was able to work on questions that contained verbal representations, namely on questions number 1, 2, and 4. So it can be concluded that the low self-efficacy group tends to be able to fulfill verbal indicators.

On the symbolic representation indicator, namely solving problems with mathematical expressions, subjects in the low self-efficacy group do not have the ability to solve problems with mathematical expressions. The subject could not perform calculations correctly and was not fluent in explaining his work at the time of the interview. Subject RE-17 could not work on all the questions that contained indicators of symbolic representation. Meanwhile, subject RE-7 was able to work on questions containing indicators of symbolic representation only on questions number 1 and 2c. Thus, subjects in the low self-efficacy group tend not to be able to solve problems involving mathematical expressions.

In terms of visual representation indicators to explain and facilitate completion, the low self-efficacy group has not been able to make graphs and pictures that match the questions. Subjects RE-17 and RE-7 had not been able to draw graphs correctly in question number 1 and in question number 3 they were wrong in providing information on the pictures. Thus, subjects in the low self-efficacy group have not been able to fulfill the visual representation indicators.

Based on the description above, information was obtained that the research subjects in the low self-efficacy group did not perform well in fulfilling the mathematical representation ability indicators. This is in accordance with what was said by Bandura (1997), that students with low levels of self-efficacy are still unsure of their abilities so that there are still students who do not understand the concept of the material because they feel they do not understand or are unable. Research subjects with low self-efficacy groups can only fulfill verbal representation indicators.

4. Conclusion

Based on the results of the research and discussion, the following conclusions are obtained: Ethno-Flipped Classroom assisted by interactive media is effective on mathematical representation abilities as indicated by the following criteria: (1) students' mathematical representation abilities in Ethno-Flipped Classroom learning assisted by interactive media obtain an average average 78.1 more than the minimum completeness criteria, namely 65 (2) the proportion of students who achieve the minimum completeness criteria is more than 75%; (3) students' mathematical representation abilities in Ethno-Flipped Classroom learning assisted by interactive media are more than students' mathematical representation abilities in PBL learning. The description of the subject's mathematical representation ability in terms of self-efficacy obtained the following results: (a) subjects with high self-efficacy were able to fulfill all indicators of mathematical representation ability, in this study namely verbal, symbolic and visual representations, (b) subjects with medium self-efficacy only fulfilled some of the indicators of mathematical representation ability, in this study namely representation verbal and symbolic. (c) subjects with low self-efficacy only fulfill some of the indicators of mathematical representation ability, in this study, namely verbal representation.

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