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# The summary of flipped classroom learning activities assisted by merdeka mengajar platform in improving students' numeracy skills in solving fraction problems

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**Abstract**

Technology has transformed the way students learn in the 21st century. The emphasis is no longer solely on memorization but on developing critical, creative, collaborative, and communicative thinking skills, enabling students to solve real-world problems. However, despite this emphasis on 21st-century skills, students' numeracy skills still require significant improvement. The flipped classroom model is an alternative learning model that has shown promise in enhancing students' activity and numeracy skills in solving mathematical problems, specifically in the area of comparing and ordering fractions. This approach involves reversing the traditional classroom dynamic, with students learning at home through pre-recorded videos and engaging in interactive activities in the classroom, such as problem-solving exercises and discussions. To achieve the desired learning objectives, the development of effective learning materials is critical. Several techniques for comparing and ordering fractions are available in textbooks and on the internet, but the flipped classroom model, assisted by the Merdeka Mengajar platform, has combined graph area shading and other innovative techniques to deliver the material. The use of these techniques is expected to improve students' numeracy skills significantly, enabling them to solve fraction problems with greater ease and accuracy. By embracing technology and innovative teaching methodologies, educators can prepare students with the necessary skills to thrive in the rapidly evolving landscape of the 21st century.

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## 1. Introduction

Technology development has influenced learning activities, including teaching fractions in mathematics. Fractions, as one of the parts of mathematics, are prepared from elementary school to higher levels. Some students consider fractions as a difficult subject, which may be caused by several factors such as: (a) students have difficulty understanding the problem and writing down what is known from the problem, (b) students are unable to explain the procedures used in solving the problem, (c) students are unable to grasp the explanations of the problem and understand the information provided by the problem instructions [2]. Fractional numbers can be denoted as $\frac{a}{b}$, where a is the numerator, b is the denominator, and a and b are integers with $b \neq 0$. The form $\frac{a}{b}$ can also be interpreted as a: b.

There are different types of fractions, including proper, mixed, decimal, and percentage fractions. To order fractions, we need to compare one fraction with another. If the denominators are the same, the comparison is easy. However, if the denominators differ, we must make them the same first. One technique that can be applied is Graph Area Shading.

The graph theory is widely used in helping to solve problems in life. Graphs are defined as a set of vertices together with edges that represent certain relationships. By shading the elements of the graph, both edges and the surface of the plane, this technique is called Graph Area Shading [3].

Mathematics is utilized in solving everyday life problems. Many daily activities of the community involve the comparison of fractions, such as making cakes, calculating distance and time in traveling to a place, and so on.

The rapid development of technology has an impact on the development of education, especially in learning activities. Mathematics, considered difficult by students, requires a suitable learning model that matches the material and the characteristics of students and the conditions and facilities available.

The flipped classroom learning model is an alternative learning method that is appropriate for fostering and improving students' activity, speed of material absorption, and numerical skills in solving mathematical problems. The flipped classroom is part of blended learning, combining online and face-to-face learning [16]. Learning material taught in face-to-face meetings is distributed to students virtually before the actual meeting day. Students can learn the material through their smartphones, laptops, etc., at home or anywhere they can access it [12]. This encourages students to develop independent attitudes and critical thinking skills in learning the material before it is further deepened in school.

According to [9], the design of a flipped classroom includes the following elements: (1) context, (2) driver, (3) flip, (4) outcomes, (5) components, (6) resources, and (7) evaluation. In the design of the flipped classroom, there are interconnections between elements. The numbering of each component is not interpreted as a mandatory sequence. The context (internal) and drivers (external) components are important for deciding whether flipping is feasible. Analyzing internal and external situation elements occurs simultaneously with the desired outcomes. As shown in the design process diagram, interconnection is fundamental, especially after the decision to flip. Examining context may occur simultaneously with the primary knowledge outcomes of the study.

The flipped classroom learning model requires technology to deliver its material [17]. The flipped classroom implementation utilizes technology with internet network facilities so that students can independently listen to tutorials, watch videos, or download materials and learning resources provided by teachers at home. On the other hand, flipped classroom learning utilizes and emphasizes time to make learning more effective and encourage students to improve their knowledge.

Platform Merdeka Mengajar is one of the platforms provided by the Ministry of Education and Culture that can be utilized in the flipped classroom learning model [19]. The Ministry has curated the learning materials and tools in the platform and has received feedback from peers, intending to make the learning process effective and efficient.

The requirements for mathematics learning in the 21st century emphasize the ability to collaborate and communicate, think critically, connect knowledge with the real world, and master information technology [8]. The learning process must enable students to develop creativity, needs, abilities, and independence in advancing science to acquire the necessary skills. 21st-century learning targets learning that encourages students to be active, creative, and enjoyable. This condition will create meaningful learning [1]. This can be achieved if students have good numeracy skills.

Mathematics learning using the flipped classroom model is expected to cultivate and improve students' numeracy skills. Numeracy skills involve using various numbers and symbols related to mathematics to solve problems, analyze information presented in tables, diagrams, etc., and interpret the analysis results of information presented to predict and make decisions [7]. Numeracy skills are related to problem-solving in daily life [13]. To master numeracy skills, appropriate learning materials are required for the material being studied.

Learning materials are crucial for improving students' numeracy skills. Teachers must design learning materials that can support successful learning. Several studies have been conducted on developing learning materials, including [14], which found that flipped classroom-based learning materials effectively improve students' mathematical reasoning skills. A study by (10) produced good learning materials with valid, practical, and effective criteria.

The learning materials developed in the flipped classroom model include Lesson Planning, Materials, Student Worksheets containing tasks, instructions, and step-by-step instructions, and Learning Outcome Test Sheets that have pre-and post-tests to measure students' abilities.

## 2. Research Methods

This study employs the Research and Development (R&D) approach. The stages of developing the learning tool refer to Plomp and Nieveen's (2007) framework, which consists of 1) the Preliminary research stage, which includes needs and context analysis, literature review, and the development of a conceptual or theoretical framework; 2) Prototyping phase, which involves interactive design and repetition/iteration as the most important research activity for improvement; and 3) Assessment phase, also known as semi-summative, which evaluates whether the intervention meets the specified criteria.

These stages can be linked to using the ADDIE model, which includes analysis, design, development, implementation, and evaluation [6]. The researcher uses the preliminary research and prototyping phases of Plomp & Nieveen's framework, aligning with ADDIE's five development stages.

The design stages of the learning tool include 1) the analysis stage, consisting of initial and final analysis, student analysis, concept and task analysis, and formulation of learning objectives; 2) the design stage, which involves designing assessment criteria, selecting the model to be implemented in the learning activities, designing the components of the learning tool such as lesson plans, student worksheets, instructional materials, and test sheets; 3) development stage, which is the stage of realizing the product design and aims to produce the learning tool product.

The next stage is 4) the implementation stage, where the developed learning tool is tested to determine its feasibility. The test is conducted using a one-group pretest-posttest design. Before the learning process, students are given a pretest. Student and teacher response questionnaires are also filled out; 5) the evaluation stage, where the researcher revises the learning tool based on feedback obtained during the implementation stage.

## 3. Results

### 3.1. Syntax Learning of Flipped Classroom Model

The framework of the flipped classroom model aims to determine whether the application of the flipped classroom model can improve students' numeracy skills in solving fraction problems. Understanding the issues that arise is the first step in the framework. The next step is to design and develop strategies to find solutions to problems by conducting literature studies and literature reviews. Next, recommend the learning model that will be applied according to the characteristics and abilities of the students and the availability of supporting infrastructure. The next step is to determine the education platform that supports the implementation of the selected learning model. After that, designing and developing the product, testing the product in the implementation of learning, and revising the product based on suggestions and feedback. Finally, the research report on implementing the flipped classroom model with the help of the Merdeka Mengajar platform.

The stages of activities in flipped classroom learning, in general, according to [11, 18], are:

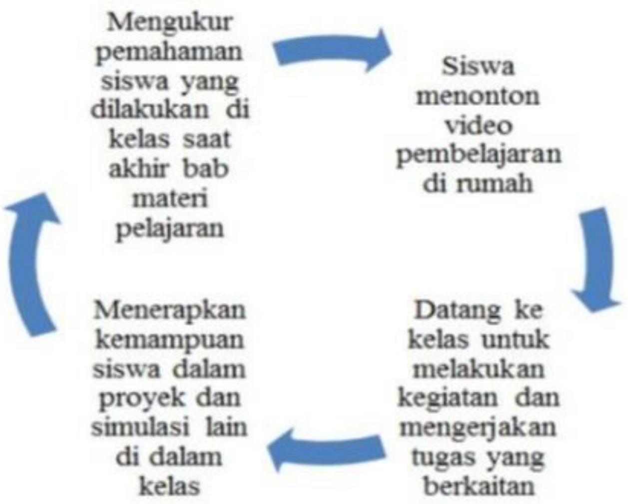


**Fig 1:** Syntax of Flipped Classroom Learning Model

The material in the learning is about comparing and ordering fractions. When are students asked which fraction is greater? Which fraction is smaller? They still need help answering. Many techniques have been applied by teachers related to the material. One of the techniques used in ordering fractions is the Area Shading Technique. Its syntax shows that the larger the shaded area, the greater the value of the fraction. Conversely, the smaller the shaded area, the smaller the value of the fraction. This is effective if the denominators of the compared fractions are the same. However, if the denominators are different, it can be unclear. For example.


**Fig 2:** Fraction bar graphs $\frac{2}{3}$, $\frac{3}{6}$ and $\frac{5}{6}$

There is no problem in the comparison of fractions $\frac{3}{6}$ and $\frac{5}{6}$, there is no problem, but in the comparison of fractions $\frac{2}{3}$ and $\frac{5}{6}$, each student gives a different answer because the partitions obtained are not the same width. Thus, the shaded area does not accurately represent the fraction area.

In the flipped classroom learning model, Graph Area Shading is used in delivering the material. The advantage of this technique is that bar graphs can be expanded using any image.

The simplest graph is a path graph where the number of nodes is n, and the number of edges is n-1. Meanwhile, a cycle graph is a graph where the number of nodes and edges are also n. Example:

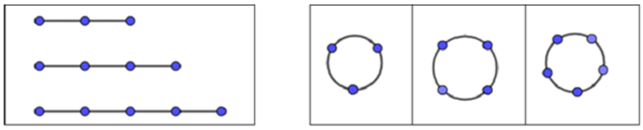

**Fig 3:** Path 3, 4, 5 and Cycle 3, 4, 5

Comparison and ordering of fractions in this material include comparisons of common fractions with the same denominator, fractions with the same numerator, mixed fractions with common fractions, fractions with decimals and percentages, ordering of fractions, and problem-solving related to comparison and ordering of fractions in everyday life. Several examples of graphs that can be used to compare and order fractions are:

**a. Example of fraction comparison $\frac{3}{10}$ and $\frac{3}{13}$**

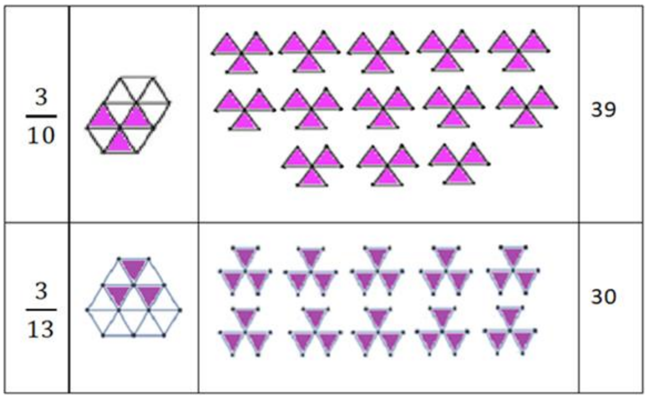


**Fig 4:** Fractional Triangular Stair Graph $\frac{3}{10}$ and $\frac{3}{13}$

The above illustration uses a triangular ladder graph. The first step is to draw a graph to represent the first fraction. Then we do the same for the second fraction. Next, shade several areas equal to the numerator of each fraction. Since $\frac{3}{10}$ and $\frac{3}{13}$ fractions have three as the numerator, we shade three parts in the first fraction and three in the second. Redraw the three shaded parts and the three shaded parts on the second row according to the denominators of each fraction, considering the overlapping positions of the two denominators. Then manually calculate the total area shaded for each fraction and compare the entire shaded area. Based on the graph of the shaded area above, it appears that fractions with smaller denominators have larger fraction values than those with larger numerators and denominators. Therefore, the fraction $\frac{3}{10} \geq \frac{3}{13}$.

### b. Examples of fraction comparison─s 18, $\frac{2}{8}$ and $\frac{3}{8}$

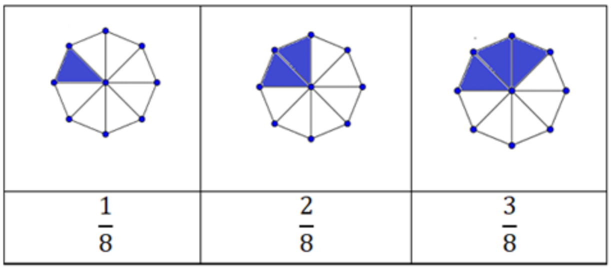


**Fig 5:** Fraction wheel chart graph─s 18, $\frac{2}{8}$ and $\frac{3}{8}$

In this comparison, a wheel graph is used. This graph is formed by connecting a universal node to all cycle nodes. A wheel graph with n nodes will have 2(n-1) edges. The first step is drawing a wheel graph representing the first fraction. Then we do the same for the second and third fractions. Next, shade several regions according to the numerator in each fraction. Fractions $\frac{1}{8}$, $\frac{2}{8}$, and $\frac{3}{8}$ have 1, 2, and 3 as their numerators, respectively, so we shade 1 region in the first fraction, 2 regions in the second fraction, and 3 regions in the third fraction. The shaded area graph above shows that fractions with larger numerators have larger shaded areas, indicating that their values are also larger and vice versa.

### c. Contoh perbandingan pecahan $\frac{6}{24}$ dan $\frac{4}{22}$

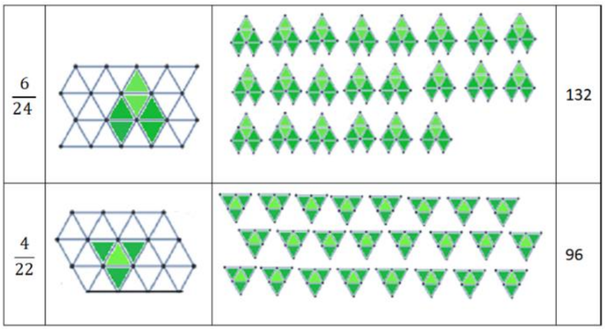


**Fig 6:** Triangular ladder graphs $\frac{6}{24}$ and $\frac{4}{22}$

The comparison, in this case, uses a triangular ladder graph. The first step is drawing a triangular ladder graph representing the first fraction. Then, draw the same graph for the second fraction. Next, shade several regions according to the numerator of each fraction. Fractions $\frac{6}{24}$ and $\frac{4}{22}$ have 6 and 4 as their numerators, respectively, so we color six regions in the first fraction and four in the second. Redraw the six shaded regions and four shaded regions in the second row according to the denominators of each fraction, considering the crossing positions of the two denominators. Then manually calculate the total shaded area for each fraction and compare the full shaded areas. If the entire shaded area is larger by one fraction, it is considered the larger fraction. So, $\frac{6}{24} > \frac{4}{22}$.

### d. The comparison of fractions 0.5 and $\frac{5}{8}$

Convert the decimal to a common fraction and then compare. $0{,}5 = \frac{50}{100}$, Simplify into a proper fraction and then compare $\frac{50:25}{100:25} = \frac{2}{4}$

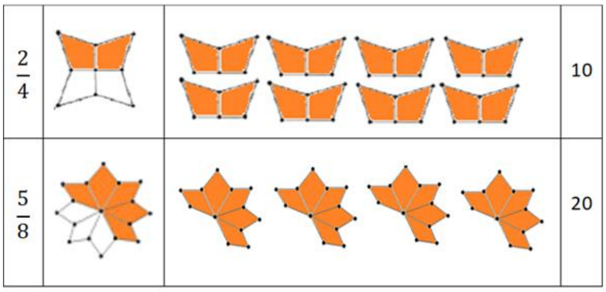


**Fig 7:** Jahangir's Fraction Graphs $\frac{2}{4}$ and $\frac{5}{8}$

This graph is a Jahangir graph. Using the GAS technique, the first step is to draw a Jahangir graph to represent the first fraction. Then we do the same for the second fraction. Next, shade several regions equal to the numerator in each fraction. Fractions 2/(4 ) and 5/8 have 2 and 5 as their numerators, respectively, so we shade two regions in the first fraction and five in the second. Redraw the shaded areas for 2 and 5 in the second row, equal to the denominators of each fraction, considering the intersecting positions of the two denominators. Then manually calculate the total area of the shaded regions for each fraction and compare the entire shaded area. If the whole shaded area for one fraction is larger, it is considered larger. Thus, $\frac{2}{4} < \frac{5}{8}$.

### e. Example of fraction comparison $2\frac{3}{8}$ and $3\frac{2}{7}$

The larger whole number has a greater value by considering the whole number in mixed fractions being compared. The number 3 has a greater value compared to the number 2, so $2\frac{3}{8} < 3\frac{2}{7}$

If the whole numbers in both fractions being compared are the same, then we need to compare the fractions themselves. For example, $2\frac{3}{8}$ and $2\frac{2}{7}$

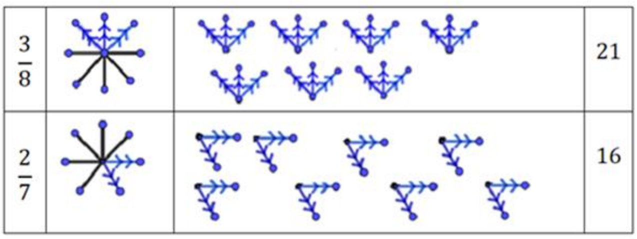


**Fig 8:** Star Fraction Graph $\frac{3}{8}$ and $\frac{2}{7}$

The comparison uses a star graph. With the GAS technique, we draw a star graph to represent the first fraction followed by a second star representing the second fraction. Then we shade/color some edges based on their respective numerators. Since the fractions $\frac{3}{8}$ and $-27$ have 3 and 2 as their numerators, respectively, we have 3 and 2 edges shaded. Redraw the graph with three shaded edges and two shaded edges on the second row, aligning them with the denominators of each fraction and considering the crossing positions of the two denominators. Finally, manually calculate the total number of shaded edges from each fraction and compare the results. Since the number of shaded edges from the second fraction is larger, then $2\frac{3}{8} > 2\frac{2}{7}$

**f. Arranging fraction**

To sort fractions, decimals, and percentages, the steps to be followed are as follows: Convert decimal and percentage fractions into common fractions, then simplify those fractions, next, make the denominators equal by finding the least common multiple (LCM) of the denominators. Finally, sort the fractions from smallest to largest or from largest to smallest.

Examples of fractions 0,6; $\frac{2}{8}$; 80%. The steps to be taken are as follows:

Convert the fractions to common fractions: $\frac{6}{10}$; $\frac{2}{8}$ ; $\frac{80}{100}$

Simplify the fractions: $\frac{6}{10}$ ; $\frac{2}{8}$ ; $\frac{8}{10} = \frac{3}{5}$ ; $\frac{1}{4}$ ; $\frac{4}{5}$

Make the denominators equal by finding the least common multiple (LCM) of 5 and 4, resulting in $\frac{12}{20}$; $\frac{5}{20}$ ; $\frac{16}{20}$

Finally, arrange the fractions in ascending order: $\frac{2}{8}$; 0,6; 80%.

### 3.2. The Flipped Classroom Learning Model Framework for Enhancing Students' Numeracy Skills in Solving Fraction Problems

The flipped classroom learning model is implemented for 2 sessions. In preparing the facilities and infrastructure, the teacher ensures that all students have devices that can be used to access materials, such as smartphones, laptops, computers, and others. The teacher also provides that the internet connection is smooth at the students' location and school.

**1) Meeting Activity 1**

**Table 1:** Activities for the first meeting

| Stage | Learning Activity |
|---|---|
| Pre-face-to-face meeting at school | 1. Provision of learning materials before a face-to-face meeting. Students can access the materials through smartphones, laptops, or other devices.<br>2. Students are asked to carefully read and take notes on important information from the provided materials in their math notebooks. |
| Students come to class to engage in activities and complete related tasks, | 1. Pre-lesson activities such as anticipation, orientation, motivation, and presentation of learning objectives are conducted.<br>2. Collection of important notes from the video material presented.<br>3. Learning is focused on deepening the material through question and answer sessions, class discussions, video presentations using LCD, and providing examples of problems related to the material.<br>4. Formation of groups consisting of 4 to 5 students with varying abilities.<br>5. Group discussions to solve issues given using Worksheets. Each group member is assigned responsibilities.<br>6. In solving the problems, students create visualizations of fractions using recycled cardboard.<br>7. Creation of area shading graph.<br>8. Manual calculations are performed.<br>9. During this activity, the teacher moves around, facilitates, and ensures the smooth progress of the activity, and that group members are able to convey their ideas. |
| Implementing students' abilities in projects and other simulations in the classroom | 1. The results of their work are then presented.<br>2. Other groups of students can ask questions to the presenting group and analyze the problem-solving approach from their presentation.<br>3. Reinforcement, drawing conclusions, and follow-up actions |
| Measuring students' understanding. | Random questions related to the material are given |

**Fig 9:** Activities of learning before face-to-face class

**Fig 10:** Activities of the first meeting of learning

### 2) Activities for the second meeting

**Table 2:** Activities for the second learning session

| Stage | Learning activities |
|---|---|
| During the activities before face-to-face at school | 1. Presentation of learning material<br>2. Material is given virtually |
| Students come to class to engage in activities and work on related tasks, | 1. Implementation of pre-assessment, orientation, motivation, and learning objectives.<br>2. Learning focuses on deepening the material through questioning, class discussions, and video presentations via LCD and providing examples of problems related to the material.<br>3. Formation of groups consisting of 4 to 5 students with varying abilities.<br>4. Group discussions to solve issues are given through Worksheets. |
| Applying students' abilities in projects and other simulations in the classroom | 1. Creating simple visualizations using recycled bottle caps and fabric.<br>2. Performing calculations using the concepts of comparison and ordering of fractions manually.<br>3. The teacher facilitates and ensures that the activity runs smoothly and group members can convey their ideas and collaborate.<br>4. Group presentations of their work.<br>5. Other students analyze the group presentations.<br>6. Classroom discussion related to the group presentations.<br>7. Reinforcement, conclusion, and follow-up actions |
| Measuring students' understanding at the end of the learning material | The written test is conducted |

**Fig 11:** Activities for the second learning session

**Fig 12:** Presentation of work results

In group discussion activities, teachers can assess students' participation and attitude. Students' abilities are assessed through written tests at the end of the material presented. Assessment of students' creativity and skills is done through performance/product assessment.

### 3.3 Tindak lanjut pengembangan perangkat pembelajaran

The first stage of developing a learning device using the ADDIE model is analysis. The analysis is done to identify the main problems in mathematics learning and what is needed. The analysis includes initial and final analysis, student analysis, concept analysis, and task formulation for understanding objectives. All the information obtained serves as a basis for determining the learning model and designing the learning device. Document study, unstructured interviews, observation, and task identification are conducted at this stage.

The next stage design. In the design stage, the initial design of the mathematics learning device is created. The steps taken at this stage are: 1) designing the assessment criteria; 2) selecting the model to be implemented in the learning activities. The selected model has flipped classroom, which aligns with the learning activities' objectives, concepts, characteristics, and tasks. The format is selected based on didactic, constructive, and technical requirements and compatibility with the chosen model for easy implementation. 3) designing the components of the learning device, such as the lesson plan/module, student worksheets, teaching materials, and assessment sheets, as an initial outline

The development stage is the third stage in developing this flipped classroom model learning device. This stage is the realization of the product design and aims to produce a learning device product. The steps taken in this stage are an expert appraisal and revision.

After creating the learning device design, the next activity is validation or feasibility testing. Validation is obtained from the validation instrument that has been prepared. Experts carry out validation. The experts' suggestions on the draft I design are used as considerations for preparing draft II. The results of drafting draft II are used for limited trials.

The fourth stage is implementation. In this stage, the developed instructional design is put into practice. A pilot test is conducted to determine the feasibility of the developed instructional materials. The pilot test is performed with sixth-grade students from SDN Curahmalang II Sumobito Jombang. The design used for the pilot test is a one-group pretest-posttest design. Before the mathematics flipped classroom instruction, students are given a pretest. After the flipped classroom instruction, students are given a post-test to assess the effect of the flipped classroom on their numeracy skills in solving fraction problems.

During this stage, student and teacher questionnaires are also administered to gather feedback on the practicality of the developed instructional materials. The data from the tests and questionnaires are then analyzed.

The final stage is evaluation. In this stage, the researcher revises the instructional materials based on the feedback received during the development and implementation stages. This ensures that the mathematics flipped classroom instructional materials are aligned and can be implemented by other users or schools. The instructional design for the flipped classroom model is uploaded to the Merdeka Mengajar platform to receive feedback, comments, and suggestions from colleagues and other stakeholders to improve the developed materials further.

## 4. Discussion

In this article, we have discussed implementing the flipped classroom model in learning. One potential development in this research is the analysis of the application of the flipped classroom model in teaching, along with the use of the Graph Area Shading (GAS) technique for comparing and ordering fractions. With the GAS technique, elementary school students will be able to compare fractions easily, in line with the opinion of [15]. Students can also choose the type of graph they want to use. Various graphs are presented in this study to teach students how to create their graphs, and the selected graphs do not have to be of the same size. What is interesting about this technique is when comparing the amount of shaded area for each fraction. So, the mathematical operations involved in this cognitive process are relatively easy. Students only need to perform mathematical calculations. This technique will enhance students' critical and creative thinking skills in solving problems related to comparing and ordering fractions, as students can choose and determine different graphs compared to other students. This will generate interest in students' learning activities. Therefore, using the GAS technique will improve higher-order thinking skills [4]. Students can also learn the material through their smartphones, laptops, etc., at home or anywhere they can access it [12].

The summary of this learning activity will enhance students' numeracy skills in solving fraction problems. Through the flipped classroom model, students can learn and apply the GAS technique in solving fraction problems not only in the classroom but also wherever they are.

## 5. Conclusion

Based on the results and discussion, it can be concluded that this study has described the syntax of flipped classroom learning assisted by the Merdeka Mengajar platform using the Graph Area Shading (GAS) technique, which has the advantages of being efficient, accurate, and highly engaging for students. Furthermore, this technique can enhance creativity and critical thinking skills when students can choose any graph and provide shading or colors according to the numerator of each fraction. Through flipped classroom learning, students can improve their numeracy skills in solving fraction problems wherever they are.

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