THE IMPACT OF RADEC MODEL ON PRE-SERVICE ELEMENTARY TEACHERS' UNDERSTANDING OF FRACTIONS AND ITS CORRELATION TO SELF-REGULATED LEARNING

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Abstract. The low mathematical comprehension and poor self-regulated learning of pre-service elementary school teachers are behind this research. This study aims to determine the effect of implementing the RADEC model on increasing the conceptual understanding of prospective elementary school teachers on fractions and determine whether there is a correlation between the students' self-regulated learning in answering pre-learning questions and their mathematical comprehension. Quantitative research methods were carried out in this study, with the design of *the one-group pretest-postest.* The research was conducted at one of the universities in West Java, with research subjects of 88 students from an elementary school teacher education program. Tests and questionnaires are the primary research instruments in this study. The results showed an increase in students' mathematical comprehension after implementing the RADEC model, and there was a low correlation (r = 0.309) between self-regulated learning and mathematics conceptual understanding of fractions among the students.

Keywords: conceptual understanding, fraction, pre-service elementary teacher, RADEC model.

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INTRODUCTION

Fractions are critical subjects to master in elementary school mathematics (Hariyani et al., 2022; Rahayu et al., 2018). Academic achievement and student proficiency in fractional concepts are frequently correlated (Copur-Gencturk, 2021). The concepts of fractions serve as foundational elements for a wide range of mathematical materials in subsequent levels of study. These materials are, therefore, studied at the elementary through higher education levels. How well students understand fractional ideas majorly impacts how well they can deal with real-world problems and problems that might arise in the workplace. However, fractions are complex for elementary school students (Ndalichako, 2013; Yao et al., 2021). Students need help in learning conceptual understanding and procedural knowledge of fractions. According to the research of Moss and Case (1999), children frequently encounter difficulties in comprehending fractions due to teachers putting an excessive emphasis on fraction manipulation procedures rather than their conceptual meaning (Ndalichako, 2013). Another problem is that the pre-service teacher often has a misconception about fractions, which can be passed on to the student (Perry, 2023). This problem shows that teachers also encounter difficulties with fractions (Kang, 2022; Newton, 2008; Yao et al., 2021). Teachers and pre-service elementary school teachers need to improve their understanding and proficiency in fractions. Teachers and pre-service elementary school teachers may not fully understand the mathematical concepts, making mathematics lessons less useful (Yao et al., 2021) and causing a decline in student academic performance. Teachers and pre-service elementary teachers must possess a solid grasp of procedural and conceptual knowledge, as this knowledge directly impacts the quality of instruction and student outcomes (Copur-Gencturk, 2021; Yao et al., 2021). The teachers' knowledge of the subject matter is critical to assisting students in comprehending mathematical concepts. Teachers with a comprehensive understanding of the subject matter can deliver accurate explanations, effectively respond to inquiries, and foster a positive learning environment for their students.

The current state of research on the conceptual understanding of mathematics in fraction material is characterized by continual growth in the cognitive domain. However, few studies have investigated the connections between the cognitive and affective domains of the students.

Consequently, this study examines the relationship between students' conceptual understanding of fraction material and their level of self-regulated learning. Education in the 21st century emphasizes cultivating advanced cognitive abilities. Educators are responsible for providing students with essential proficiencies such as problem-solving, critical thinking, creative thinking, collaboration, effective communication, self-regulated learning, and metacognition (Sujana & Rachmatin, 2019). Therefore, in addition to understanding mathematical concepts, self-regulated learning is another aspect that needs special attention in learning mathematics. Self-regulated learning among students contains three key attributes: the implementation of self-regulated learning strategies by the students themselves, their readiness to respond to self-directed feedback regarding the effectiveness of their learning, and their interconnected motivational processes.

To attain desired academic results, self-regulated learners choose and implement self-regulated learning strategies through feedback regarding their learning efficacy and proficiency (Zimmerman, 1990). Learning independence in mathematics can shape a mathematical mindset and provide students with awareness of the benefits of mathematics (Isoda & Katagiri, 2012). Many students cannot learn independently, finish their assignments at the last minute, and copy their friends' work. These behaviours show that students need to be more highly autonomous in learning. The lack of students' self-regulated learning not only happens in elementary school but in secondary and higher education. It is often assumed that university students have already mastered these abilities. However, studies have revealed that many university students are unprepared for the obstacles they would confront. While natural maturation and lived experience may help learners improve their self-regulated learning abilities, research has shown that purposeful learning and assessment design can help them even more. Educators may better help students become autonomous and competent learners by introducing practices encouraging self-regulation in the learning environment (Russell et al., 2020).

The RADEC (Read-Answer-Discuss-Explain-Create) approach was adopted to address the abovementioned issue. The RADEC model is a learning approach that emphasizes student-centered activities. The RADEC paradigm may help students gain learning freedom and conceptual understanding. Students independently investigate material from numerous sources such as books, print media, and the internet at the Read stage. Students are also given pre-learning questions to answer. Students autonomously answer pre-learning questions provided in the form of LKM (student worksheet) at the Answer stage, allowing them to discover where they are having difficulties. The Read and Answer stage is critical for better comprehension of the topic. Students review the outcomes of their prior work in groups during the discussion stage. The outcomes of the group discussion were presented at the Explain stage. Students are encouraged to come up with unique ideas during the Create stage. Educators' roles in the RADEC model are facilitators, offering help as required, promoting student participation in discussions and presentations, ensuring that students' explanations are carried out scientifically, and stimulating students to produce new ideas (Sopandi et al., 2021). Students may increase their capacity to study independently and better grasp their studies by following the RADEC procedures. They learn to take charge of their learning by asking questions, conversing with others, and linking their learning to other topics.

From the abovementioned, the research questions of this research are :

1. Does the implementation of the RADEC learning model have a significant effect on students' understanding of the concept of fractions?
2. Is there a significant relationship between learning independence scores and students' understanding of fraction material?

Hence, the main objective of this study is to examine the impact of implementing the RADEC model on the mathematical understanding of pre-service elementary school teachers. Additionally, it intends to investigate the correlation between self-directed learning in addressing pre-learning questions and the mathematical understanding of pre-service elementary school teachers after implementing the RADEC model on fraction material.

METHOD

The population of this study was students in elementary school teacher education programs at one of the universities in West Java, and the sample of the participants of this study was 88 students from the third semester. The RADEC model was implemented during lectures with fraction materials.

This research is quantitative, using the One Group Pretest-Post test design; this design uses a quasi-experimental research design and does not use a control class. Experimental research looks for causal relationships between independent variables and dependent variables. The diagram of the design of *The One Group Pretest-Post test* is as follows (Gall et al., 2014):

O1 X O2

Information:
X = Treatment
O1 = Pretest
O2 = Postes

Research instruments in the form of tests and questionnaires. As an expert, the supervisor evaluates the construct and content validity and reliability of the questions and statements in the created questionnaire. The test is conducted to analyze students' understanding of fraction material. Tests are carried out before learning and after learning with the RADEC model. The questionnaire instrument is given to students to analyze their self-regulated learning skills in answering pre-learning questions.

The pre-test and post-test questions are designed according to the course learning outcomes and meet the conceptual mathematical understanding indicators (Hendriana et al., 2017) as follows:

1. Define concepts verbally and in writing,
2. Identify and create examples and non-examples,
3. Using models, diagrams, and symbols to represent a concept,
4. Transforming one form of representation into another form of representation,
5. Get to know various meanings and interpretations of concepts,
6. Identify the properties of a concept and recognize a condition that determines a concept,
7. Compare and contrast a concept.

Meanwhile, the indicators of self-regulated learning questionnaires in answering pre-learning questions were adapted from (Hendriana et al., 2017) and adjusted to the RADEC model, namely:

1. Initiative in answering pre-learning questions,
2. Setting learning targets/goals,
3. Utilize and find relevant resources in answering pre-learning questions,
4. Evaluate learning processes and outcomes.

Data processing is a way or procedure of collecting data to be processed in-depth, followed by summarising the information obtained. The data processing of descriptive and hypothetical research questions was done with SPSS software.

RESULTS

Data Analysis of the Fraction Conceptual Understanding of the Students.

An analysis was performed using the SPSS application to determine whether the RADEC model affected the students' conceptual understanding of fractions.

1. Normality Test
   H_0 = Normal distributed data ($\alpha \geq 0.05$)
   H_1 = Data is not normally distributed ($\alpha<0.05$)

Table 1. Tests of Normality

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest_Pecahan	.091	88	.067	.953	88	.003
Posttest_Pecahan	.131	88	.001	.955	88	.004
a. Lilliefors Significance Correction						

The fractional pre-test data is normally distributed because the sig value ≥ 0.05. Post-test fractional data is not normally distributed because the sig value < 0.05. Based on the results of the normality test, it was found that one of the data was not normally distributed, so the average difference test uses the Wilcoxon Test.

2. Average Difference Test
   H_0 = No significant mean difference (α ≥ 0.05)
   H_1 = There is a significant mean difference (α < 0.05)

Table 2. Test Statistics

Test Statistics	
	Posttest_Fraction - Pretest_Fraction
Z	-7.916[b]
Asymp. Sig. (2-tailed)	.000
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks.	

Based on the results of the Wilcoxon Test, a significance value of 0.000 < 0.05 was found so that H_0 was rejected, meaning that there were significant mean differences in the student's mathematical understanding of fractions.

Questionnaire Results and Correlation Between Student Self-Regulated Learning in Answering Pre-learning Questions with Student Mathematical Conceptual Understanding

For the questionnaire, we first analize the results of the student self-regulated learning questionnaire when answering pre-learning questions. The discussion will continue calculating the correlation between self-regulated learning and students' mathematics conceptual understanding of fractions.

1. Results of Student Self-Regulated Learning Questionnaire in Answering Pre-Learning Questions.

The student self-regulated learning questionnaire was distributed after the Read and Answer stage and before implementing the RADEC model learning. The aim is to see students self-regulated learning by answering pre-learning questions before lectures. The results of processing student self-regulated learning questionnaire data are as follows:

Table 3. Percentage of Questionnaire Results Seen from Self-regulated Learning Indicators

No	Statement	SS
1.	Indicator: Initiative in Answering Pre-learning Questions	77%
2.	Indicator: Setting Targets / Goals in Answering Pre-learning Questions	83%
3.	Indicator: Utilizing and Finding Relevant Resources in Answering Pre-learning Questions	84%
4.	Indicator: Evaluating Learning Processes and Outcomes	83%

Viewed from the indicators of self-regulated Learning, each indicator already has an acceptable value. As a result of the self-regulated learning of each student, more than half of students already have adequate self-regulated learning.

Table 4. Percentage of Student Learning Independence

Category	**F**	**Presented**
HI	19	22%
I	28	32%
L	35	40%
VL	6	7%
Sum	88	100%

Note:
H = High Independent
I = Independent
L = Low Independence
VL = Very Low Independence

2. Correlation Between Student Self-Regulated Learning with Student Mathematical Understanding

The correlation between self-regulated learning and students' mathematical understanding of fraction material was calculated. The first step is to test the normality of both data. The result of the normality test is that one of the data was not normally distributed. Therefore, the Spearman correlation test was carried out using the SPSS application.

H_0 = No significant relationship ($\alpha \geq 0.05$)
H_1 = There is a significant difference in relationship ($\alpha < 0.05$)

Table 5. Correlation Calculation Results

Correlations

			Questionnaire	Posttest
Spearman's rho	Questionnaire	Correlation Coefficient	1.000	.309**
		Sig. (2-tailed)	.	.003
		N	88	88
	Post-test	Correlation Coefficient	.309**	1.000
		Sig. (2-tailed)	.003	.
		N	88	88

**. Correlation is significant at the 0.01 level (2-tailed).

Based on the correlation test results, there is a significance value of 0.03 < 0.05, so it can be said that there is a correlation between student self-regulated learning in answering pre-learning questions and students' mathematical understanding of fraction of r = 0.309 (low correlation).

DISCUSSION

The RADEC learning model is a learning model that adapted to the demands of education in Indonesia. The steps of the RADEC model—reading, answering, discussing, explaining, and creating—have been shown to foster conceptual understanding, student critical thinking, and student creative thinking (Abidin et al., 2022; Nugraha & Prabawanto, 2021; Suryana et al., 2021). The RADEC learning model can also improve students' reading skills (Anita et al., 2022). Moreover, the result of the learning as follows:

Read

Students are given a worksheet with pre-learning questions at this stage. This worksheet is adapted to the RADEC learning model's stages. Students are expected to read various sources regarding fractional material, both from textbooks and web sources. This stage encourages students to prepare themselves before lectures (Suryana et al., 2021). The Read stage may also motivate students to engage in reading activities. According to the findings of surveys, interviews, and observations during class, most students seek and study learning resources in the form of printed and online materials. This finding is consistent with the 84% response rate on the questionnaire indicator: Utilizing and Finding Relevant Resources in Answering Pre-learning Questions. Some students claimed they sought learning videos online if they did not comprehend a subject.

Answer

During the Answer stage, students write answers to the questions in the student worksheet. During this stage, students must respond to pre-learning questions in section A of the student worksheet. Students are strongly encouraged to respond to pre-learning questions based on their capacities. The questions on the student worksheet are adjusted to the indicators of mathematical conceptual understanding, which are as follows: define concepts verbally and in writing, identify and create examples and non-examples, use models, diagrams, and symbols to represent a concept, transform one form of representation into another form of representation, learn various meanings and interpretations of concepts, identify the properties of a concept, and recognize a condition that determines a concept, and compare and contrast a concept (Hendriana et al., 2017). The questions also test students' problem-solving, critical thinking, and creative thinking knowledge. Even though they were told not to, some students worked with their classmates to answer the pre-learning question. As a result, the percentage for Indicator: Initiative in Answering Pre-learning Questions is 77%.

At this stage, students construct their knowledge of fractions, make representations of mathematical generalizations, and solve problems given to pre-learning questions. Based on observations during lectures and the results of student worksheets, it can be concluded that students have answered most of the pre-learning questions. However, students are less careful when reading questions, so the answers given are incorrect. Students also encounter difficulties in terms of:

1. Use models, diagrams, and symbols to represent a concept.
   Students still find it challenging to represent a problem in images or other forms of representation. The students must be able to describe a mathematical issue, especially those related to everyday life, in visual images; this is because, in elementary education, it is vital to consider the child's ability to learn through direct experience, pictures, and symbols.

Question: Add the fractions below to get the sum! Can you create a model that represents the addition?

$$\frac{1}{3}+\frac{4}{3}=$$

Answer: (Sample of the answer)

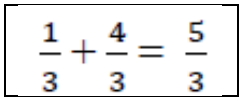

Figure 1. One of the answers of the student.

From Figure 1 above, students cannot visually represent adding fractions.

2. Transform one form of representation into another form of representation.
Students misinterpret one of the questions to transform from a fractional form into a number line. Students use a calculator or convert it into decimal form to see the value of the fraction before placing it on the number line.

Question: Write the values $\frac{3}{7}$ and $\frac{2}{6}$ on a number line!

Answer: (Sample of the answer)

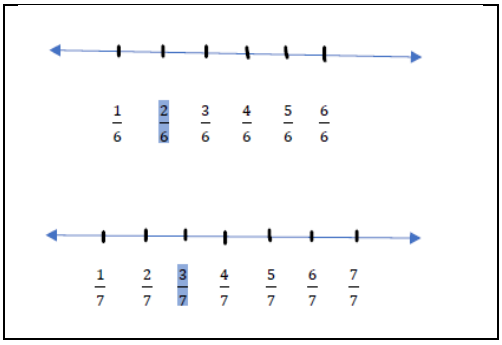

Figure 2. Misconception of the answers of the student.

In Figure 2, students draw fractions in two number lines; students should draw the value of both fractions in a number line.

3. Identify the properties of a concept and recognize a condition that determines an idea.
In showing the closed properties of adding fractions, students conduct an inductive process by giving examples and drawing conclusions. Students have not been able to generalize the closed property of fractions.

Question: Justify the closedness properties of adding rational numbers!

Answer: (Sample of the answer)

Example: 23 + 32 = 46+ 96 = 136 You will always receive one whenever you add, remove, or multiply an integer. This is called the closed feature. Since adding to this reasonable number gives us an integer, we can say that the above process is closed.

Figure 3. Students can not generalize the properties.

In Figure 3, students give examples to prove the closed properties of addition, and students have not done the deductive proofs.

Discuss

During the Discuss stage, students exchange ideas and solutions related to their responses to pre-learning questions. Discussion activities are conducted in small groups. Students who have attained a high level of proficiency in the subject matter engage in sharing information to assist their peers who may be struggling to comprehend the content. The lecturers facilitate the group discussion activity. The lecturer systematically monitors each group's progress, documenting the groups who have achieved proficiency in the concept and the specific areas of the pre-learning questions that remain unclear to the students. For the difficulties that students encounter in the Answer stage, there is an improvement to the solution of this problem in the Discuss stage:

1. Use models, diagrams, and symbols to represent a concept.
   Many students still find it challenging to represent a problem in images or other forms of representation.
   Question: Add the fractions below to get the sum! Can you create a model that represents the addition?

   $$\frac{1}{3}+\frac{4}{3}=$$

   Answer:

   $$\frac{1}{3}+\frac{4}{3}=\frac{1+4}{3}=\frac{5}{3}$$

Figure 4. Students struggle to represent the addition in images.

During the discussion stage, most of the group's work outcomes did not exhibit any notable alterations (Figure 4). The majority still failed to deliver what was expected as a visual representation.

2. Transform one form of representation into another form of representation.
   A few groups of students still use a calculator to convert fractions into decimals to see the value of the fraction before placing it on the number line.
   Question: Write the values $\frac{3}{7}$ and $\frac{2}{6}$ on a number line!

   Answer: (Sample of the answer)

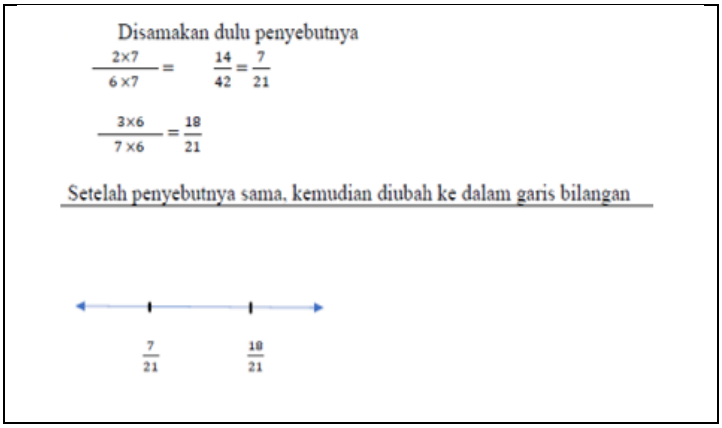

Figure 5. One of the answers of a group.

There was a significant change in students' answers after group discussions on this issue.

3. Identify the properties of a concept and recognize a condition that determines an idea.
   In showing the closed properties of adding fractions, the student groups still conduct an inductive process by giving examples and drawing conclusions. None of the groups has been able to generalize the closed property of fractions.
   Question: Justify the closedness of the operation of adding rational numbers.!

   Answer: (Sample of the answer)

> Example $\frac{3}{4}+\frac{1}{4}=\frac{4}{4}=1$
> Closed property occurs when integers are added, subtracted, or multiplied; the outcome is always an integer. The above process is closed since it undergoes an additional operation, resulting in an integer.

Figure 6. Improvement on the example from Figure 3.

There has been no progress in comprehending the closed features of rational numbers addition in this problem.

Explain

During this stage, the students present the results of the group discussions they participated in earlier to the class. While the other groups listen, ask questions, and give feedback or critique of the answers presented by the presenter group. Students are expected to participate more actively throughout this stage of the process. The role of the lecturer is similar to that of a facilitator; lecturers observe student presentations, check the mathematical concepts, and give any necessary feedback. At this point, the lecturer will only review the mathematics concepts students have not yet grasped. The Explain stage ensures that lectures are interactive; this stage is designed so that students may engage not only with their classmates but also with the educational materials and their lecturers.

After the Explain phase, the answers of the groups became:

1. Use models, diagrams, and symbols to represent a concept.
   The presented groups answer the question with pictorial representation.

   Question: Add the fractions below to get the sum! Can you create a model that represents the addition?

$$\frac{1}{3}+\frac{4}{3}=$$

Answer:

$$\frac{1}{3}+\frac{4}{3}=\frac{1+4}{3}=\frac{5}{3}$$

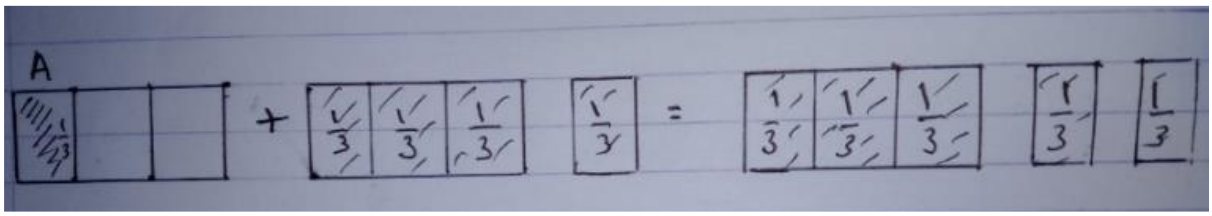

Figure 7. The answer group of students on the explain stage.

2. Transform one form of representation into another form of representation.
   The presented group has the correct answer for the problems of transforming one representation into another. They use the least common multiple as a way to answer the issues.
   Question: Write the values $\frac{3}{7}$ and $\frac{2}{6}$ on a number line!

   Answer:

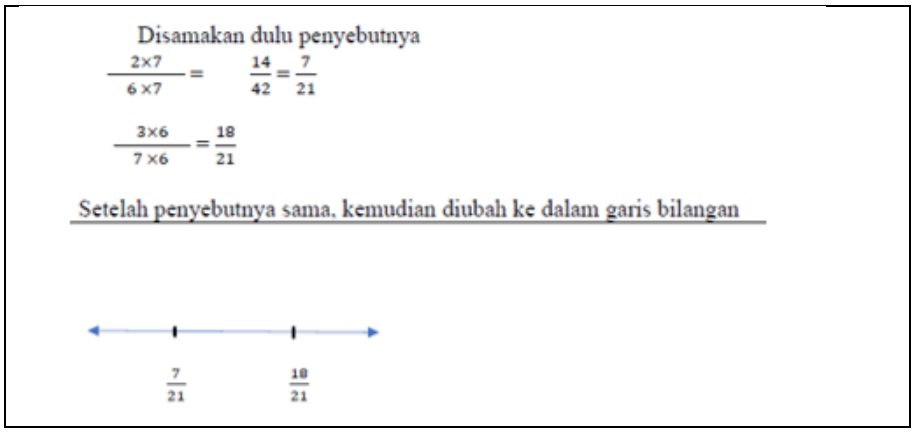

Figure 8. The answer group of students on the Explain stage in the number line problems.

3. Identify the properties of a concept and recognize a condition that determines an idea.
   No groups of students can justify the closedness properties of the addition of rational numbers. The lecturer then explains the concept.
   Question: Justify the closedness properties of adding rational numbers.!

   Answer (Group A):
   One of the group answers after the Explain phase is

> Misalkan $\frac{a}{b}$ dan $\frac{c}{d}$, dengan b≠0 d≠0 adalah bilangan rasional, maka berlaku $\frac{a}{b}+\frac{c}{d}=\frac{ab+cd}{bd}$
> karena b≠0 d≠0, maka bd ≠ 0.
> Oleh karena itu haruslah $\frac{ab+cd}{bd}$ merupakan bilangan rasional.
> Sehingga dapat ditunjukkan bahwa penjumlahan bilangan rasional bersifat tertutup

Figure 9. The answer group of students on the Explain stage after the lecturer's explanation.

Create

Creative thinking is one of the abilities that students must possess (Pratama et al., 2019). Students have to think about what they will create since the Answer phase. Pre-learning questions require students to be able to think creatively. Students can work alone or with their groups to create new things. Lecturers can inspire students with examples if they struggle to develop new, original ideas. Students can realize their ideas independently or with their groups. The purpose of this stage is to prepare students for the challenges they face in real life. In addition, this stage hones student collaboration and communication skills. The Create stages of this research encourage students to make a learning media related to fractions.

CONCLUSION

Fractions are an essential topic in elementary school mathematics, as they serve as foundational elements for a wide range of mathematical materials in subsequent levels of study. However, many students struggle with understanding and grasping the conceptual meaning of fractions. This difficulty can be attributed to teachers' excessive emphasis on procedural knowledge rather than conceptual understanding. The RADEC (Read-Answer-Discuss-Explain-

Create) model is a student-centered learning approach that can help address these challenges. Based on the results of data analysis, it was found that the influences of the RADEC learning model increase the understanding of mathematical concepts in fractional material. By implementing the RADEC model, students can gain self-regulated learning and improve their conceptual understanding of fractions. In addition, self-regulated learning plays a significant role in mathematics education. Additional investigation can focus on applying fraction learning skills by prospective elementary school teachers in elementary school settings.

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