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Empowering Students' Problem-Solving Skills through the RADEC Model on Flood Topic

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Abstract: Education in the 21st century requires students to have various important skills, one of which is problem-solving skills. However, many students still experience difficulties solving problems and applying scientific knowledge to contextual situations. To support the development of problem-solving skills, teachers need to implement learning models that actively involve students. Effective learning provides opportunities for students to explore ideas, discuss, and build knowledge independently. Thus, this research aims to enhance students' problem-solving skills by applying the RADEC (Read, Answer, Discuss, Explain, and Create) model to the topic of flooding in science learning in elementary schools. This research uses a quantitative approach with a quasi-experimental method using a nonequivalent control group design. The research involved 30 fifth-grade students in the experimental class and 24 in the control class. Data collection was carried out using descriptive tests to measure students' problem-solving skills and observation sheets to document the implementation of the learning model. Data analysis included a normality test, a homogeneity test, independent sample t-test, and N-Gain analysis. The research results indicate that the application of the RADEC learning model falls into the very good category based on the observations. The average score of students' problem-solving skills in the experimental class increased from 59.63 in the pretest to 72.47 in the posttest, while in the control class it increased from 54.38 to 64.12. The results of the hypothesis test indicated a significant difference between the two groups ($p < 0.05$). In addition, the N-Gain analysis results show an increase in the medium category in the experimental class and a decrease in the low category in the control class. These findings indicate that the RADEC learning model effectively empowers students' problem-solving skills through contextual learning on flood-related topics.

Keywords: RADEC learning model, problem-solving skills, flood natural disaster, science learning, elementary school.

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■ INTRODUCTION

Education in the 21st century is expected to not only develop students' knowledge but also their skills, as these are important for facing complex real-life challenges (Yaakob & Wahab, 2022). With increasingly modern changes, education has become one of the keys to improving a person's quality of life (Vilbikienë, 2021). In this context, education in the current era demands policy adjustments to empower students with skills that meet societal needs and support personal welfare (Gougou & Palé, 2025). Education is not enough to focus solely on mastering material; it needs to be designed meaningfully to develop skills relevant to everyday life (Hatton & Fidler, 2025). One of the skills that needs to be developed is problem-solving skills. This skill is increasingly recognized as an important competency for interpreting information effectively, making sound decisions, and addressing a range of problems in academic and professional environments (X. Zhou et al., 2024). Problem-solving skills are an individual's ability to develop the right solution to a problem based on their knowledge and experience (Yorulmaz et al., 2021). In the context of science education, this skill is very important because it helps students understand natural phenomena and apply scientific knowledge to solve everyday problems (Choudhar et al., 2022). Therefore, developing students' problem-solving skills is one of the main goals of modern education (Kuboni, 2021).

Elementary school is the first step in formal education for children; during this phase, they are in a crucial and sensitive developmental period (Aeni et al., 2025). So, problem-solving skills play a very important role, as they are the foundation for students' cognitive development and study habits (Tokuhama-Espinosa et al., 2023). At this stage, students begin to learn to understand problems, organize information, and build simple reasoning. Providing opportunities to practice problem-solving skills from an early age will help students become more independent learners and better prepared to face increasingly complex problems in the future (Charles & Silver, 1988). Apart from that, this skill helps students connect knowledge to real-world situations, making learning more meaningful (Koskinen & Pitkäniemi, 2022).

One of the objectives of Learning Sciences in elementary schools, as outlined in the Badan Standar Nasional Pendidikan standards (Kumala, 2016), is for students to develop process skills for investigating the natural environment, making decisions, and solving problems. Through this process, it is hoped that students will develop critical thinking skills and be able to solve various problems encountered in everyday life. However, several studies indicate that students' problem-solving skills in Indonesia remain relatively low. This is also reflected in the results of the Program for International Student Assessment (PISA), which show that Indonesian students' achievement in science remains below the international average (Fatimah et al., 2025).

Furthermore, research conducted by Ramadhani (2021), titled "Improving Science Learning Problem Solving Ability about the Water Cycle through the Problem Based Learning Model," revealed that class VB students at SDN Dukuhan Kerten, Surakarta, experienced difficulties in solving science problems. Based on the results of observations and interviews, it was found that: 1) Students tend to be passive during learning, not daring to ask questions or express opinions. 2) The learning model used by teachers during online learning does not provide opportunities for students to carry out investigations independently or in groups. 3) The dominant learning method used is the assignment method. Moreover, 4) Students are not used to dealing with contextual problems related to everyday life, so material such as the water cycle is considered difficult. This condition was reinforced by the pretest results, which showed that only 26.92% (7 of 26 students) met the Minimum Completeness Criteria (KKM e" 75), while 73.08% (19 of 26 students) had not yet met it. If this situation is left unchecked, it could negatively affect science learning outcomes in the future. Another study by Aprasela & Silvester (2025), titled "Analysis of the Problem Solving Abilities of Class V Students of SD Negeri 03 Bengkayang in Science and Technology Subjects," also reported similar results. Based on the test results, 24.2% of the 33 students had high problem-solving abilities, 27.3% had medium, and 48.5% had low. This shows that the majority of students still have difficulty understanding and solving word problems that require analytical thinking and problem-solving skills.

Based on findings from various studies, it can be concluded that students' problem-solving abilities in science learning in elementary schools remain relatively low. One of the factors contributing to this condition is the learning process, which remains dominated by teacher-centered instruction (Kirana et al., 2025). Learning carried out by teachers is still limited to providing rote material, so students receive it without linking it to other abilities that should be mastered (Widodo & Darmawan, 2019). Most teachers serve as the primary source of information, while students tend to play a passive role in the learning process (Çakýroðlu & Öztürk, 2020). Learning practices like this limit students' opportunities to actively participate in discussions, explore ideas, and engage in scientific reasoning (Sun & Firzan, 2024). As a result, students often focus on memorizing information rather than understanding concepts and applying them to solve problems. This situation makes it difficult for students to develop high-level thinking abilities, including problem-solving abilities (Suseelan et al., 2022). According to Pólya (1988), a situation considered a problem by one person may not be a problem for another, because each individual has different abilities in finding solutions (Santos et al., 2024). Problem-solving skills in this research refer to the stages proposed by Pólya (1988), which include four main steps, namely understanding the problem, planning a solution, implementing the plan, and reviewing the results. In the first stage, students identify what they know and what is being asked. In the second stage, students determine the strategy to be used. Next, in the third stage, students apply the chosen strategy. In the final stage, students evaluate the results and processes carried out. This stage is important for training students to think systematically, logically, and reflectively in solving problems. To practice these skills requires learning that presents contextual problems. One relevant example is flooding, as it is closely tied to students' daily lives and influenced by human activities and environmental conditions (Wang & Sebastian, 2021). In learning, the topic of flooding is used to practice problem-solving skills, in which students are directed to understand the problem by identifying the causes of flooding, planning solutions through various alternative actions, implementing plans conceptually, and assessing the effectiveness of the resulting solutions (Ziga-Abortta, 2025).

In teaching and learning activities, the factor that determines the quality of education is the application of sophisticated, modern methods, strategies, and educational approaches (Aeni, 2019). To support the development of problem-solving skills, teachers need to implement learning models that actively involve students. Effective learning provides opportunities for students to explore ideas, discuss, and build knowledge independently (Melaku et al., 2025). Moreover, it is not only results-oriented but also process-oriented, with students actively involved in building knowledge through meaningful learning experiences (Bollaert, 2025). Therefore, an effective learning strategy is needed to empower students' problem-solving skills. This is in line with the view that problem solving involves not only procedural abilities but also high-level thinking abilities, such as developing strategies, building problem representations, and adapting knowledge to the situation at hand (Eichenlaub & Redish, 2018). The RADEC (Read, Answer, Discuss, Explain, and Create) model provides opportunities for students to be actively involved in the learning process through the stages of reading, answering, discussing, explaining, and creating, so that it can support the development of conceptual knowledge and reflective thinking skills (Sturm & Bohndick, 2021). Thus, the application of the RADEC model is expected to improve students' problem-solving skills systematically and meaningfully, especially on flood-related topics that are contextual to everyday life. This is supported by the fact that children acquire knowledge from the family, community, and school environments through formal education, placing them in a strategic position to integrate these various sources of knowledge (Fanini et al., 2007). The RADEC model encourages active student involvement through structured learning stages, aligning each stage with the problem-solving process: students understand problems through reading and answering activities, plan solutions through discussion, and apply and evaluate solutions at the explaining and creating stages (Sopandi, 2017). Learning that involves cooperation among students can foster communication, build a sense of togetherness within the group, and help students achieve common goals (Sari & Yüce, 2020). This is in line with the application of the RADEC model, especially at the Discuss and Explain stages, which encourage students to discuss, exchange ideas, and put forward ideas. Through this process, students are trained to identify problems, formulate strategies to solve them, and evaluate the results, thereby optimally developing their problem-solving skills.

However, research that specifically examines problem-solving skills in science learning in elementary schools still shows mixed findings. Several previous studies focused on the application of learning models, such as Inquiry Learning, which is effective in developing students' problem-solving skills (Divrik et al., 2020). Apart from that, research by Agus et al. (2025) also examines the effectiveness of models such as Project-Based Learning and the use of interactive media in improving students' problem-solving abilities in science learning. Meanwhile, the RADEC model as a learning innovation has been proven to be able to support the development of high-level thinking skills in elementary school students (Sopandi, 2017); however, studies that specifically link the stages in this model with problem-solving skills, especially in the context of science learning in elementary schools, are still limited. Therefore, research is needed that not only tests the effectiveness of the learning model but also examines the stages of learning in greater depth. This research aims to enhance students' problem-solving abilities by applying the RADEC learning model to flood science instruction in elementary schools. The novelty of this research lies in integrating Pólya's (1988) problem-solving stages into the structure of the RADEC model, particularly the Create stage. In the general implementation of RADEC, the Create stage is more oriented towards activities to produce products or works as a form of expression of student understanding. However, in this research, the Create stage is reconstructed as a cognitive process that explicitly incorporates Pólya's problem-solving stages: understanding the problem, planning a solution, implementing the plan, and reviewing the results. Theoretically, various studies show that problem-solving skills require a structured, explicit framework for thinking in learning. For example, research by Zhou et al. (2019) shows that developing effective problem-solving skills requires the systematic integration of high-level cognitive processes into learning design. In addition, studies by Lee et al. (2018) confirm that students often experience difficulties in problem solving due to a lack of structured problem representation and solving strategies in the learning process. Other findings from Imants et al. (2020) also show that learning designs that explicitly integrate problem-solving stages can improve students' higher-order thinking abilities.

Based on these findings, the integration of the Pólya stage into the Create stage of the RADEC model in this research resulted in a conceptual shift, namely from a stage that was originally product-oriented to a stage that emphasized a systematic problem-solving process. Thus, the theoretical contribution of this research lies not only in the application of the RADEC model in the science learning context, but also in strengthening the RADEC conceptual framework by incorporating an explicit problem-solving framework. This implies that the RADEC model can be developed not only as an active learning model but also as a pedagogical framework that directly facilitates the development of students' problem-solving skills. Based on the introduction provided, the problem formulation for this research can be described as follows: 'Is the RADEC learning model able to empower the problem-solving skills of grade 5 students in science subjects with flood natural disaster material?' From the problem formulation, there are 3 research questions asked, namely:

a. How is the implementation of the RADEC learning model in empowering class 5 students' problem-solving skills on flood natural disaster material?
b. How are students' problem-solving skills before and after learning in classes that use the RADEC learning model and classes that use the conventional learning model?
c. Is there a significant difference in students' problem-solving skills between classes that use the conventional learning model and classes that use the RADEC model after being given the treatment?

From these research questions, the hypothesis in this study was formulated as follows:

H_0 : There is no significant difference between the problem-solving skills of students who learn using the RADEC learning model and students who learn using conventional learning models on flood material in class 5 of elementary school.

H_1 : There is a significant difference between the problem-solving skills of students who learn using the RADEC learning model and students who learn using conventional learning models on flood material in class 5 of elementary school.

■ METHOD

Participants

This research involved participants consisting of the population and sample. The population is all individuals who are the target of a generalization in research results. In educational research, populations can include students, teachers, and educational institutions with specific characteristics. Meanwhile, the sample is part of the population chosen to represent these characteristics in the research process.

In this research, the population comprised all fifth-grade students in state elementary schools in Argapura District, Majalengka Regency, West Java, Indonesia. The sample is part of the population selected through specific procedures to obtain representative data and to support the validity of the research results. In the context of quasi-experimental research, sample selection is an important aspect because it influences the research's ability to explain cause-and-effect relationships more convincingly (Gopalan et al., 2020). The sampling technique in this research is purposive sampling, namely the deliberate selection of subjects based on criteria relevant to the research objectives. The use of this technique in quasi-experimental research is based on the limitations of applying full randomization in an educational context, so researchers need to select groups that have relatively equivalent characteristics to increase the internal validity of the research (Ballance, 2024).

The sample selection criteria include: (1) the school has relatively the same characteristics as an A accreditation, (2) students have never received learning using the RADEC model, (3) students' initial academic abilities are relatively comparable based on pretest results (this criterion was proposed to strengthen the relevance of the research). This consideration is important to ensure that differences in the results are attributable to the treatment given, rather than to differences in students' initial characteristics. Based on these criteria, the research sample consisted of 30 Class V students at SDN Sadasari I as the experimental class and 24 Class V students at SDN Sadasari III as the control class. The two groups showed relatively balanced initial demographic and academic characteristics, as demonstrated by pretest results that were not significantly different. This equality is an important basis for quasi-experimental research to increase internal validity and support a more accurate interpretation of results.

Research Design and Procedures

This research uses a quantitative approach with quasi-experimental methods. The research design used was a nonequivalent control group design, which involved two groups: an experimental group and a control group (Apriliani et al., 2025). Both groups were given an initial test (pretest) to assess students' problem-solving abilities on flood mitigation. Next, the experimental group received treatment through RADEC-based instruction (Read, Answer, Discuss, Explain, and Create), while the control group received conventional instruction. After the learning process was complete, both groups were given a final test (posttest) to determine the improvement in students' problem-solving skills. The research design can be described as follows:

Table 1. Research design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Information:
O_1 = experimental class pretest
O_2 = experimental class posttest
O_3 = control class pretest
O_4 = control class posttest
X = learning using the RADEC model

The research procedure was carried out in several systematically designed stages. In the initial stage, students were given an initial test (pretest) to determine initial problem-solving abilities in flood natural disaster material. This test consisted of essay questions that assessed students' ability to understand problems, plan solutions, implement strategies, and produce results. The pretest lasted 50 minutes. Furthermore, learning activities were conducted in two groups: the experimental class, which used the RADEC learning model, and the control class, which used conventional methods, including lectures, question-and-answer sessions, and assignments. Learning in both classes was carried out in 2 meetings, each lasting 2 x 35 minutes. In the experimental class, learning was conducted using the RADEC model stages: Reading, Answering, Discussing, Explaining, and Creating. In the Read and Answer stage, students were given teaching materials in the form of reading texts about floods, distributed one day before learning. Students were asked to read the material independently at home and then answer 7 initial comprehension questions about the causes, impacts, and mitigation efforts of floods. In the Discussion stage, students were divided into 5 small groups. Each group discussed the answers from the activity at home. The discussion activity lasted for 20-25 minutes with a guidance teacher. At the Explanation stage, group representatives discussed the results of the discussion in front of the class for 5-7 minutes per group. Other students were allowed to provide responses or questions, so that two-way interaction occurred. The teacher acted as a facilitator, directing the broadcast and preventing inappropriate content from being aired.

The create stage was not only directed at product production but also serves as a cognitive process that aligns with Pólya's problem-solving stages. At this stage, students were asked to create work related to flood mitigation efforts, such as a poster on keeping gutters clean, a board inviting them to dispose of rubbish in the right place, a design for separate rubbish bins, a song about flood prevention, or a poem about the dangers of flooding. This activity not only trains students' creativity but also encourages them to think systematically when solving contextual problems. The integration of the Pólya stages can be seen as students begin to understand flood problems through reading activities, discussions, and the identification of the causes and impacts of flooding in the surrounding environment. At this stage, students were trained to determine important information related to the given problem. Next, during the completion planning stage, students discussed how to determine the type of work they will create and why they are choosing it. Students also prepared the steps for creating a work, which include determining the purpose, tools, and materials, as well as the message they want to convey. This process showed that students do not immediately create a product, but first systematically design a completion strategy. The stage of implementing the plan is seen when students begin to realize the results of group discussions in the form of work. In this process, students apply ideas, divide group tasks, and adjust the manufacturing steps to the previously prepared plans. The re-examination stage was carried out through evaluation activities of the work before it is presented. Students rechecked the suitability of the work's content for the topic of flood mitigation, the accuracy of the information, and the clarity of the message they want to convey.

Thus, the Create stage in this research not only produced the final product but also developed the ability to understand problems, plan solutions, implement strategies, and evaluate solution outcomes, in line with Pólya's problem-solving stages. This showed that reconstructing the Create stage in the RADEC model can support the development of students' problem-solving skills through contextual, meaningful activities. After the entire learning series was completed, students were given a final test (posttest) with forms and indicators equivalent to the pretest to assess improvement in students' problem-solving skills. The posttest lasted 50 minutes.

Instrument

The research instruments used consisted of test and non-test instruments. The test instrument, consisting of essay questions, was used to measure students' problem-solving skills on the topic of flooding. Instrument preparation refers to the problem-solving stages according to Pólya (1988), which include understanding the problem, planning a solution, implementing the plan, and checking again. The use of these stages is supported by research indicating that the assessment of problem-solving skills should be conducted systematically by measuring students' thinking processes, not just their final answers (Docktor et al., 2016). Apart from that, the use of essay questions is considered capable of providing a more in-depth picture of students' reasoning, analysis, and evaluation abilities in solving contextual problems (Ghazawi & Simpson, 2025).

The test instrument consisted of 10 essay questions prepared based on Pólya's four problem-solving indicators: understanding the problem, planning a solution, implementing the plan, and reevaluating the results. The distribution of questions on each indicator was adjusted to the characteristics of the ability being measured. Understanding of the problem is measured with 4 questions, while planning a solution, implementing the plan, and checking again are each measured with 2 questions. The number of questions on the understanding the problem indicator was increased because the ability to understand the problem is the main basis of the problem-solving process and requires identifying the information, causes, and impacts of the problem in greater depth. An example question is: "If you were the head of an RT and your neighborhood often experienced flooding, what activities would you do to encourage residents to keep the environment clean?" This question measures students' ability to understand problems (identify causes), plan solutions, carry out reasoning, and evaluate the solutions provided.

The assessment of student answers used an analytical rubric adapted from international research on assessing problem-solving skills

(Docktor et al., 2016). Each student's answer was assessed using a scoring rubric on a scale of 0-4. In the understanding-of-the-problem indicator, a score is given based on students' ability to identify the facts, causes, and impacts of flooding in a relevant and precise manner. In the planning solution indicator, a score was assigned based on the logic and feasibility of the student's proposed solution plan. In the plan implementation indicator, assessment was based on the accuracy and effectiveness of the actions students develop. Meanwhile, in the rechecking indicator, a score was assigned based on the student's ability to evaluate solutions that are supported by strong, logical reasoning.

A score of 0 was given if the student did not provide an answer or the answer was inappropriate. In contrast, a score of 4 is given if the student's answer was complete, correct, relevant, and met all the criteria for the indicators being assessed. The complete assessment rubric is presented in Table 2.

Table 2. Assessment rubric

Problem-Solving Indicator	Score	Criteria
Understanding the Problem	0	No answer or blank answer
	1	Describe irrelevant facts/causes/impacts
	2	Describes facts/causes/impacts inaccurately
	3	Describes most of the facts/causes/impacts correctly
	4	Describes all facts/causes/impacts completely, precisely, and relevantly
Planning a Solution	0	No answer or blank answer
	1	Providing plan suggestions that are not relevant to the flood problem
	2	Suggesting plans that are illogical or difficult to actually implement
	3	Provides logical but incomplete plan suggestions
	4	Providing suggestions for a solution plan that is logical, complete, and very feasible
Implementing the Plan	0	No answer or blank answer
	1	Developing inappropriate or ineffective actions
	2	Develop correct but less effective actions
	3	Develop correct and quite effective actions
	4	Develop a very effective solution and appropriate action
Reevaluating Results	0	No answer or blank answer
	1	Evaluating is wrong
	2	Evaluate but only by answering sufficient/appropriate and inappropriate/not sufficient
	3	Evaluate the solution correctly, but the reasons are not strong enough
	4	Evaluate solutions with logical and strong reasons

Based on this rubric, the maximum score for each question is 4. With 10 questions, the overall maximum score is 40. Next, the raw score is converted to a scale of 0-100. Apart from test instruments, non-test instruments were also used in the form of observation sheets to observe student activities and the implementation of learning using the RADEC model. This observation sheet contained indicators such as students' activity in reading, answering, discussing, and explaining, as well as their involvement in work-creation activities. Before being used in research, the test instrument was first tested for validity and reliability. In this study, SPSS and Microsoft Excel were used to test the validity of the question items. The validity of a question can be assessed using the correlation coefficient at the 0.05 significance level. A question is valid if r count > r table, but if r count < r table, then the question is invalid (Coleman et al., 2021). Based on sig. 0.05 with 20 respondents, the r table value was 0.468. The validity of the 10 test items based on the calculated r and r table values was analyzed in the following table:

Table 3. Validity test results

Question Number	r count	r table	Information
1	0.725	0.468	Valid
2	0.651	0.468	Valid
3	0.657	0.468	Valid
4	0.634	0.468	Valid
5	0.549	0.468	Valid
6	0.702	0.468	Valid
7	0.622	0.468	Valid
8	0.515	0.468	Valid
9	0.757	0.468	Valid
10	0.805	0.468	Valid

Based on the test questions, the validity test results are shown in the table above. The table shows that all numbers are valid. Therefore, the questions can be used for research.

Next, a reliability test was conducted using Cronbach's alpha to assess the instrument's internal consistency. If the alpha coefficient is greater than 0.90, the instrument has very high reliability, or is considered perfect. An alpha value in the range of 0.70-0.90 indicates that the instrument has high reliability. If the alpha value is between 0.50 and 0.70, the instrument is included in the moderate or medium reliability category; conversely, if the alpha value is < 0.50, the instrument has low reliability (Coleman et al., 2021). The test results show a Cronbach's alpha of 0.87, which falls in the high reliability category, so the instrument is deemed suitable for use in research.

Data Analysis

Research data were analyzed using SPSS. Data analysis began with a normality test using the Shapiro-Wilk test to determine whether the data are normally distributed. If the significance value was greater than 0.05, the data were normally distributed; if it was smaller than 0.05, the data were not normally distributed.

Next, Levene's test was conducted to assess the equality of variances between the experimental and control classes. If the data are normally distributed and homogeneous, then hypothesis testing was carried out using the Independent Samples t-Test to determine differences in problem-solving skills between the two groups. However, if the data were not normally distributed, the Mann-Whitney Test was used as a nonparametric test.

Additionally, an N-Gain test was conducted to assess improvements in students' problem-solving skills following implementation of the RADEC learning model. The N-Gain value was calculated from the pretest and posttest scores and categorized as low, medium, or high levels of improvement. This analysis assessed the effectiveness of implementing the RADEC model in empowering students' problem-solving skills in flood-mitigation learning.

■ RESULT AND DISCUSSION

The results of the research entitled "Empowering Students' Problem-Solving Skills through RADEC Model on Flood Topic" will be presented and explained in line with the research questions derived from the research problem formulation. In this section, research data will be presented, including data from the implementation of the RADEC learning model via observation sheets, pretest and posttest scores for problem-solving skills in both the experimental and control classes, and differences in students' improvement in problem-solving skills.

How is the Implementation of the RADEC Learning Model in Empowering Class 5 Students' Problem-Solving Skills on Flood Natural Disaster Material?

The RADEC learning model was applied specifically in the experimental class. During the learning process, direct observations were carried out by observers using an instrument in the form of an observation sheet, which includes five syntaxes, namely Read, Answer, Discuss, Explain, and Create, with a total of 2 meetings. This observation sheet is designed to monitor two important aspects: teacher performance and student activities. As an initial step to map students' basic abilities, a pretest was administered to 30 students before they received treatment. Then, to assess students' problem-solving skills following implementation of the RADEC learning model, a posttest was administered to 30 students. The following table presents the scores obtained and the results of data analysis related to the implementation of the RADEC learning model during the research process.

Table 4. Observation results of RADEC learning model implementation

Syntax	Maximum Score	Obtained Score
Read	12	12
Answer	6	6
Discuss	12	12
Explain	12	8
Create	6	6
Total	48	44

The calculation data in Table 4 show a score of 44 out of a maximum of 48, with an implementation level of 91.66%, which is in the very good category. These results show that learning using the RADEC model can be carried out systematically at each stage, namely Read, Answer, Discuss, Explain, and Create, so that students are actively involved throughout the learning process.

In the Read stage, students read teaching materials and answer pre-learning questions given the day before learning takes place. This activity aims to build students' prior knowledge before participating in class. Reading activities before learning align with constructivist theory, which emphasizes that new knowledge is built on students' prior knowledge (Priyamvada, 2018). Activation of prior knowledge helps students better understand the material and increases cognitive engagement during learning (Dong et al., 2020).

At the Answer stage, students work independently on pre-learning questions based on the reading they have studied. This activity helps students identify important information and develop initial thinking skills for problem-solving. This process aligns with cognitive learning theory, which posits that independent information processing can strengthen students' conceptual understanding (Raišienÿe et al., 2021).

The Discuss stage is conducted through group discussions to explore solutions to flooding problems. Group discussions encourage students to exchange opinions, provide reasons, and evaluate answers with peers. This activity aligns with Vygotsky's (1978) social constructivist view, which emphasizes that social interaction plays an important role in helping students build understanding and develop problem-solving abilities (Dong et al., 2020).

In the Explain stage, students present the results of the group discussion to the class, while the teacher reinforces students' answers. Presentation activities help students develop communication skills and strengthen their understanding of concepts by explaining what they have learned. However, there are still several obstacles, such as students' presentations being less clear and students' attention not being at its best when other groups present the results of their discussions. This indicates that students' communication skills and attentiveness to learning still need improvement.

The final stage is Create, where students create works based on the results of group discussions, such as posters for keeping gutters clean, signs for disposing of rubbish in their proper place, segregated rubbish bins, songs about flood prevention, or poems about the dangers of flooding. At this stage, students are involved in designing ideas, determining tools and materials, and preparing steps to create work collaboratively. These activities support meaningful learning because students connect science concepts with real experiences in the surrounding environment (Raišienÿe et al., 2021).

Overall, the application of the RADEC model fosters active and meaningful learning through student involvement in reading, thinking, discussing, explaining, and creating solutions to contextual problems. This process shows that learning not only focuses on mastering concepts but also helps students build problem-solving skills through cognitive activities and social interactions.

How Are Students' Problem-Solving Skills Before and After Learning in Classes That use the RADEC Learning Model and Classes that use the Conventional Learning Model?

Students' problem-solving skills were measured using pretest and posttest assessments in both the experimental and control classes. The experimental class was taught using the RADEC learning model, while the control class used conventional learning methods. The descriptive statistics for the experimental class are presented in Table 5.

Based on Table 5, the average score of students in the experimental class increased from 59.63 at the pretest to 72.47 at the posttest. These results indicate that the RADEC learning model positively influences students' problem-solving skills. The systematic learning stages in the RADEC model help students become more active in building conceptual understanding and applying their knowledge to solve contextual problems related to flood material. These findings are in line with research that states that problem-solving skills develop more effectively when students are actively involved in identifying, analyzing, and producing solutions to real problems (Santos-Trigo, 2024).

Table 5. Descriptive statistics of pretest and posttest scores in the experimental class

Test	N	Lowest Score	Highest Score	Mean	Std. Dev
Pretest	30	25	81	59.63	12.71
Posttest	30	50	96	72.47	12.54

However, the presentation of the data above focuses solely on aggregate descriptive statistics and therefore cannot provide an in-depth account of students' ability development. Therefore, further analysis was carried out using indicators of problem-solving skills aligned with Pólya's (1988) stages: understanding the problem, planning a solution, implementing the plan, and checking the results. An analysis was conducted to assess students' development of ability for each indicator after implementing the RADEC learning model for flood material. The development of students' problem-solving abilities for each indicator was analyzed using the mean difference and the paired-samples t-test to compare average pretest and posttest scores. The mean difference value is used to determine the magnitude of the increase in students' abilities after implementing the RADEC learning model. The higher the mean difference, the greater the development of students' problem-solving abilities on this indicator. The average difference between the pretest and posttest is widely used in educational research to evaluate changes in students' abilities after receiving a learning treatment (Delucchi, 2014).

In addition, the paired-samples t-test was used to determine the significance of the difference between pretest and posttest scores for each indicator of problem-solving ability. This test was conducted because the data were collected from the same subject before and after the learning treatment. If the significance value (Sig.) < 0.05, the difference between the pretest and posttest scores is considered significant, indicating that the application of the learning model influences the development of students' abilities on the measured indicators. The paired-samples t-test is widely used in educational experimental research to evaluate changes in students' abilities following the learning process (Kim & Willson, 2010). The increase in the average score from pretest to posttest indicates that the learning process influences students' development of ability in the measured aspects. Mean difference analysis helps researchers identify which indicators have changed the most, while the paired-sample t-test is used to determine whether the increase is statistically significant. Thus, the two analyzes complement each other in explaining the development of students' problem-solving abilities after implementing the RADEC learning model. The results of the analysis of students' problem-solving abilities based on the Polya indicators are presented in Table 6.

Table 6. Analysis results based on each stage of problem-solving skill indicators

Problem-Solving Indicator	Pretest Mean	Posttest Mean	Mean Difference	Sig. < 0.05 (Paired Sample T-test)
Understanding the problem	10.6	12.3	1.7	0.004
Planning completion	5.06	6.23	1,17	0.000
Implementing the plan	4.2	5.2	1	0.000
Check again	3.73	4.86	1.3	0.002

Based on the analysis of the average difference for each problem-solving skill indicator, all indicators showed improvement after implementing the RADEC learning model. However, the level of development for each indicator varies. All indicators also show a p-value < 0.05 in the paired-samples t-test, so the increase is declared statistically significant.

The problem understanding indicator had the highest mean difference of 1.7, with a significance value of 0.004. These results show that the problem-understanding aspect is the indicator that has experienced the greatest development compared to the others. This increase shows that students are increasingly able to identify important information, determine the core of the problem, and understand the context of the problem better after following learning using the RADEC model. The Read and Answer stages in the RADEC model help students build an initial understanding of the material before engaging in further problem-solving processes.

The research also explained that the ability to understand problems is the primary basis for the success of the problem-solving process, as students need to understand the problem situation before determining a solution strategy (Santos-Trigo, 2024).

Next, the indicators were checked again, yielding a mean difference of 1.3 and a significance of 0.002. These results show that students are beginning to make progress in reflecting on and re-examining their answers. Although this indicator remains challenging for some students, this improvement shows that the RADEC model can help them develop evaluative and metacognitive abilities during the Create stage. Previous research indicates that reflective learning activities can improve students' metacognitive abilities to evaluate the processes and outcomes of problem solving (Clark et al., 2024).

In the solution planning indicator, the mean difference was 1.17, with a significance of 0.000. These results show that students are developing in their ability to determine problem-solving strategies more systematically. Discussion activities in the RADEC model help students exchange ideas and develop more appropriate solution steps through social interaction and group collaboration. This is in line with social constructivism, which emphasizes the importance of interaction in building students' knowledge (Priyamvada, 2018).

Meanwhile, the plan implementation indicator had the lowest mean difference, namely 1.0, with a significance value of 0.000. Nevertheless, these results show the development of students' ability to apply solution strategies in a coherent and systematic manner. An increase in this indicator shows that students are starting to apply the concepts they have understood to the problem-solving process. This research explained that implementing a problem-solving strategy requires more complex cognitive abilities because students must integrate conceptual understanding and procedural knowledge simultaneously (Phuong, 2020).

Overall, the research results show that the problem-understanding indicator is the aspect that has experienced the greatest development following the implementation of the RADEC learning model. In contrast, the plan-implementation indicator is the aspect with the lowest development. However, all indicators have increased significantly, indicating that the RADEC learning model can help students develop problem-solving skills at each stage of Pólya's model. The pretest and posttest results of the control class are presented in Table 7.

Table 7 shows that the average score of students in the control class increased from 54.38 in the pretest to 64.12 in the posttest. Although there was an improvement in students' scores, the increase was lower than that of the experimental class. The research results show that the RADEC learning model is more effective at improving students' problem-solving skills than conventional learning. Even though the experimental class and control class both experienced an increase in posttest scores, the increase in the experimental class was higher than the control class. These results show that the learning stages in the RADEC model provide broader opportunities for students to actively build knowledge through reading, discussing, explaining, and creating solutions.

Table 7. Descriptive statistics of pretest and posttest scores in the control class

Test	N	Lowest Score	Highest Score	Mean	Std. Dev
Pretest	24	16	83	54.38	15.37
Posttest	24	37	85	64.12	11.80

The superiority of the RADEC learning model is evident in its student-centered characteristics. In conventional learning, teacher explanations tend to dominate, so students' active involvement in building understanding remains limited. In contrast, the RADEC model encourages students to be actively involved in every stage of learning. The Read stage helps students explore information independently before learning begins. In contrast, the Discussion and Explanation stages allow students to share ideas and communicate the results of their thinking. Active learning activities are known to increase students' cognitive engagement and help students build a deeper understanding of concepts (Tithi et al., 2026).

The results of this research are consistent with studies indicating that active learning positively influences students' critical thinking and problem-solving abilities. Learning that involves discussion, collaboration, and active student participation can significantly improve high-level thinking abilities and conceptual understanding (Bogaart & Ginkel, 2026). Apart from that, other research indicates that problem-solving skills develop more effectively when students engage in reflective activities and collaborative problem-solving (Becker et al., 2021). Compared with other active learning models, the RADEC model has several distinct advantages. The Problem-Based Learning (PBL) model, for example, places greater emphasis on contextual problem-solving. At the same time, the RADEC model not only emphasizes problem-solving but also integrates literacy activities through the Read stage. This stage helps students build initial knowledge before entering the discussion and problem-solving process. Reading activities in learning are known to strengthen conceptual understanding and support the development of students' higher-order thinking abilities (Pambudi, 2022). In contrast to Discovery Learning, which often requires more time to discover concepts, the RADEC model features more structured learning stages, so students receive clearer guidance throughout the learning process. The Explain and Create stages help students communicate their understanding and apply concepts creatively in problem-solving situations. A structured active learning environment is known to increase cognitive engagement and student learning outcomes more effectively (Chi & Wylie, 2014).

According to constructivist learning theory, the effectiveness of the RADEC model stems from students actively building knowledge through their learning experiences. Constructivism explains that knowledge cannot be transferred directly from teachers to students but is actively built through interaction with the environment and learning experiences (Priyamvada, 2018). In RADEC learning, students have the opportunity to read, discuss, explain ideas, and create solutions independently, making the learning process more meaningful. Apart from constructivism, the results of this research are also in line with cognitive learning theory, which emphasizes that learning occurs through the processing of information within students' cognitive structures. Learning will be more effective if students actively connect new knowledge with previous knowledge (Koskinen & Pitkäniemi, 2022). The learning stages in the RADEC model help students organize information, enabling more effective development of conceptual understanding and problem-solving abilities.

Overall, the results of this research strengthen previous findings that the constructivism-based active learning model improves students' problem-solving skills more effectively than conventional learning. The RADEC model demonstrates excellence in integrating literacy activities, collaborative discussions, reflection, and creative problem-solving into a structured learning process, helping students develop higher-level thinking skills and more effective problem-solving.

Is There a Significant Difference in Students' Problem-Solving Skills Between Classes that use The Conventional Learning Model and Classes that use the RADEC Model After Being Given the Treatment?

Before conducting hypothesis testing, prerequisite tests were performed to ensure that the data met the assumptions required for parametric statistical analysis. The results of the normality and homogeneity tests indicated that the data were normally distributed and homogeneous. Therefore, hypothesis testing using the Independent Samples t-Test could be conducted.

Table 8. Independent samples t-test results

Class	Mean	Mean Difference	Sig. (2-tailed)
Experimental	72.47	8.342	0.016
Control	64.12		

Based on Table 8, a significant difference was observed in the posttest scores of students' problem-solving skills between the experimental and control classes. These results indicate that the application of the RADEC learning model has a greater influence on problem-solving skills than learning in the control class. Below are also presented the results of calculating the effect size using the Cohen's d formula so that the impact of the intervention can be seen:

Table 9. Effect size result

M_1	M_2	Std. Dev 1	Std. Dev 2	M_1-M_2	Pooled SD	Cohen's d
72.47	64.12	12.547	11.804	8.342	12.18	0.6848

Based on the results of the effect size calculation using Cohen's d, a value of 0.6848 was obtained. This value is in the medium category because it is in the range 0.5 d" d < 0.8. The medium category indicates that the RADEC learning model has a significant and quite effective influence on students' problem-solving skills. This means that the RADEC model can produce a clearly visible increase in capability, even though the effect is not yet in the high category. The interpretation of the effect size category follows Cohen's criteria, which classify values of 0.2 as low, 0.5 as medium, and 0.8 as high (Brydges, 2019).

These results show that the stages in the RADEC model (Read, Answer, Discuss, Explain, and Create) encourage students to be more active in understanding problems, discussing them, and systematically compiling solutions, thereby helping students' problem-solving skills develop. This finding is in line with research that states that problem-solving-based learning and active student involvement can significantly improve high-level thinking skills (Sionicio & Barbacena, 2021).

To strengthen these findings, visual analysis was conducted using pretest and posttest scatter diagrams for both classes. Scatter diagrams are used to visualize the trend in individual students' increasing problem-solving skills by comparing the distribution of scores before and after learning. In the diagram, data points above the diagonal indicate an increase in problem-solving skills, while points near the diagonal indicate a relatively small increase. Below is a scatter diagram for the experimental class:

Meanwhile, in the control class scatter diagram, the data points tend to cluster near the diagonal. This indicates that the increase in students' problem-solving skills in the control

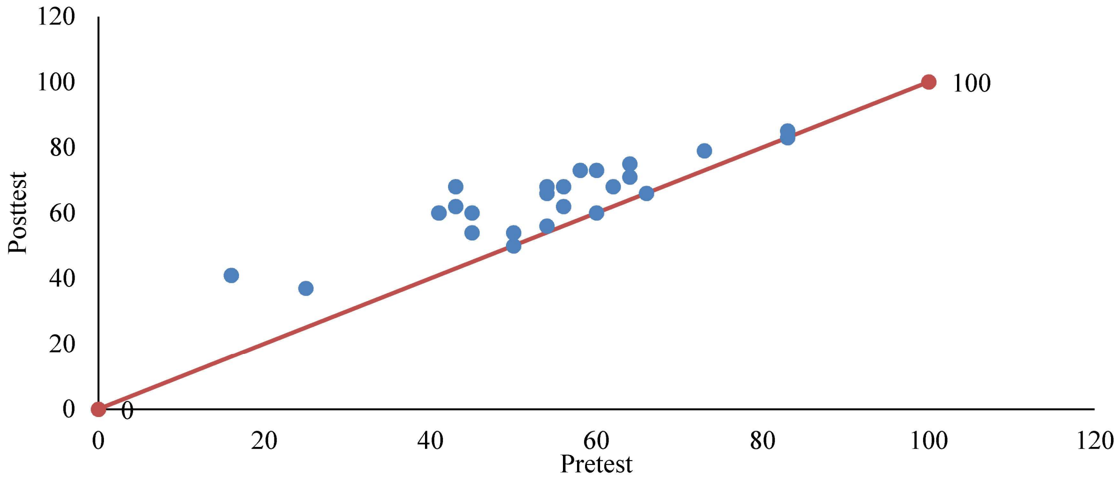

Figure 1. Scatter diagram control class

class remains relatively lower than in the experimental class. Although several students experienced an increase in their posttest scores, the overall increase did not appear significant. Thus, the scatter diagram results strengthen the findings of the independent-samples t-test that the RADEC learning model is more effective at improving students' problem-solving skills than learning in the control class.

To determine the level of improvement in students' problem-solving skills, an N-Gain analysis was conducted. The results of the N-Gain analysis are presented in Table 10.

Table 10. N-Gain results

Learning Model	N	N-Gain	Category
RADEC	30	0.32	Moderate
Conventional	24	0.19	Low

Based on Table 10, the experimental class that applied the RADEC learning model obtained an N-Gain score of 0.32, which falls into the moderate category. Meanwhile, the control class obtained an N-Gain score of 0.19, which is categorized as low. This indicates that the improvement in students' problem-solving skills in the experimental class was greater than that in the control class.

These findings suggest that the RADEC learning model is more effective at improving students' problem-solving skills than conventional learning. The structured learning stages encourage students to actively construct knowledge, collaborate with peers, and apply their understanding to real-life problems. This learning approach also helps students develop critical and analytical thinking skills, which are essential for solving environmental problems such as floods.

The findings of this study suggest that the RADEC learning model can serve as an effective alternative learning strategy for improving students' problem-solving skills in elementary school science. By engaging students in active learning activities, the RADEC model can support the development of higher-order thinking skills and encourage students to become more active and independent learners (Nurafifah et al., 2024).

In addition to the N-Gain analysis in the experimental and control classes, this research included a qualitative analysis of students' essay responses. Analysis was conducted on students in the high- and low-N-Gain categories to examine differences in students' thinking processes when solving problems after implementing the RADEC learning model.

Students with a high N-Gain of 0.78 show an increase in problem-solving abilities, which are in the high category. On the other hand, students with an N-Gain of 0 indicate no increase in problem-solving abilities after learning. These differences are used to see how students' thinking processes change before and after implementing the RADEC model.

In students with high N-Gain, there is visible development of the thinking process at each stage of Pólya problem-solving. Before learning, students tend to write answers immediately without identifying the important information in the questions. However, after implementing the RADEC model, students were able to write down the information they knew and asked about more completely, determine a solution strategy, and explain the solution steps coherently.

Apart from that, students in the high N-Gain category also show better reflective abilities. In the posttest, students begin to re-examine their solutions by writing conclusions or checking the results. This shows that learning using the RADEC model helps students develop systematic and metacognitive thinking skills in the problem-solving process.

Meanwhile, for students with low N-Gain, changes in thinking processes were not observed to the same extent. Some students still have difficulty determining a solution strategy and are less careful when carrying out the solution steps. Some students have also not rechecked their answers, so procedural and calculation errors persist.

The results of this analysis show that the increase in quantitative scores aligns with changes in students' problem-solving processes. Thus, the application of the RADEC model not only influences the final results in the form of scores, but also helps students develop stages of problem-solving thinking more systematically.

CONCLUSION

This research shows that the RADEC learning model improves elementary school students' problem-solving skills in flood-related material. The results showed that the average posttest score for the experimental class was higher than the control class. Apart from that, improvements in problem-solving skills are evident across all Pólya stage indicators: understanding the problem, planning a solution, implementing the plan, and checking answers. The indicator of understanding the problem is the aspect that has experienced the greatest improvement based on the results of the mean difference analysis. These results show that the learning stages in the RADEC model can help students be more active in understanding concepts and solving problems during the learning process.

This research suggests that a student-centered learning model can support the development of problem-solving skills in science among elementary school students. Reading, discussion, and conveying ideas activities in the RADEC model help students become more actively involved in the learning process, making learning more meaningful. However, the results of this study should be interpreted with caution, as the research was conducted with a limited sample size and used purposive sampling, so the findings cannot be widely generalized. In addition, the research data used in this study focuses on the results of problem-solving skills tests, so it cannot provide an in-depth picture of students' thinking processes during learning. Therefore, it is recommended that further research use a larger sample size, employ more diverse sampling techniques, and include qualitative data, such as observations or analyses of student work, to obtain a more comprehensive understanding of the RADEC learning model's application.

DECLARATION ON THE USE OF GENERATIVE AI IN THE WRITING PROCESS

During the process of writing this manuscript, the author used ChatGPT on a limited basis to help clarify less coherent sentences, improve academic writing and editorials, and paraphrase certain parts to make them more systematic and easier to understand. This tool is not used to produce research data or analyze research results. The entire contents of the manuscript have been reviewed, adjusted, and re-edited by the author, so responsibility for the content and accuracy of the article lies entirely with the author.

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