Increasing Elementary Teachers' Engineering-Oriented Learning Through the RADEC Training Model

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Abstract. PPPPTKIPA's competency training for elementary school teachers through the massively open online training program (DIDAMBA) aims to increase teachers' knowledge and skills in managing learning, which trains students' engineering skills in implementing their creative ideas in problem-solving. The RADEC syntax (Read-Answer-Discuss-Explain-Create learning model) was used to train teachers in engineering-oriented learning, with the Create syntax combined with engineering stages (Proposal-Plan-Decision-Implementation-Evaluation). This training was attended by 14 elementary school teachers from border regions with limited learning infrastructure participating in DIDAMBA, which was conducted online using the LMS (Learning Management System) platform for material delivery, communication (instructors-participants, participants), and evaluations. Based on observations made during the activity and participant evaluations, it was determined that the training successfully motivated and enhanced elementary school teachers in border areas regarding managing STEM-based classes. The participants were generally pleased with the training program, except for the duration, which was deemed insufficient to conduct learning simulations.

Keywords: Elementary school teachers training, RADEC learning model, engineering-oriented learning, engineering skills.

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INTRODUCTION

The instructional models used by primary school instructors have progressed. Every teacher in the country has the opportunity to improve their pedagogical abilities by taking part in professional development opportunities made available through a program run by the Ministry of Education and Culture. Teachers in elementary schools can take advantage of this program to gain knowledge about contemporary educational approaches that can be implemented into the standard curriculum. However, following the training, the educators admitted that they struggled to apply the learning paradigm in their classrooms. According to Friani et al. [1], specific learning syntaxes were not utilized to the full extent that they were capable of being in teaching and learning inquiries. According to the study by Nurlaily and her colleagues, teachers have a tough time in developing and implementing learning strategies because they struggle to understand each learning syntax included in the learning model [2]. To accomplish what you set out to do with the learning model training, you will need to deal with this problem and find a solution. According to the TNA (Training Need Analysis) conducted by the PPPTKIPA, teachers require training phases to enable students to actively connect and experience the learning model being taught [3]. Bringing attention to the problems with school-based learning aligns with TNA's mission, which backs the idea that teachers need more training [4].

A departure from the traditional challenges of implementing classroom learning in Indonesia due to the country's peculiar characteristics has been signaled by the launch of the RADEC learning model, an alternative learning model first presented at an international conference in Kuala Lumpur, Malaysia. The RADEC model was the first alternative learning approach presented at a crucial academic meeting. In this respect, the RADEC learning model represents a significant advance in defining a standard Indonesian learning model suitable for the conditions that prevail in Indonesian education. Students in Indonesian elementary schools are subjected to considerable academic pressure because the school curriculum requires them to acquire a significant amount of content. Elementary school pupils in Indonesia are faced with a number of substantial obstacles, two of the most important of which are the school and the national examinations [5]. Therefore, it is necessary to design the RADEC learning model to improve the low quality of the process and the learning results for students. The RADEC learning model is effective, with students showing gains in areas such as reading, independence in learning, the ability to produce work, collaboration, and access to the tools necessary to acquire 21st-century skills [6]. Therefore, the current research is carried out to implement the syntax of the RADEC learning model into the PPPPTKIPA elementary school teacher training stages in order to develop elementary school teachers' STEM-required engineering-based learning skills.

METHOD

Based on the preliminary research findings in Table 1, training was conducted for the development of engineering-oriented learning in improving engineering skills in the STEM approach by adopting the RADEC learning model syntax in DIDAMBA training at PPPPTKIPA. In summary, the preliminary research findings can be seen in Table 1.

Tabel 1. Problem Identification and Resolution

Problems	Solution
The low performance of teachers is attributable to the implementation of training results associated with learning models.	The syntax of the RADEC learning model is used as a step in teacher training method.
Students in STEM have a low ability to engineer in terms of putting their creative ideas into action when solving problems.	Primary school teachers are being trained in the use of engineering-oriented learning.

As a paradigm, the National Teacher Teaching Center of PPPPTKIPA employs the RADEC learning model's stages to guide its approach to training educators. These stages are incorporated into the training design for the engineering-focused RADEC learning model. Within the Create Phase of the RADEC learning model, the orientation is known as the engineering-learning phase. The objective of adapting engineering learning during the Create Phase is for teachers to develop training goods in the form of learning implementation plans and learning instruments that will be applied in their respective classrooms. The RADEC learning model was selected because it demonstrated that it could be used successfully in Indonesia as a replacement learning model to improve the overall results of student learning [5]. The training activities completed with the engineering-focused RADEC learning model are outlined in Figure 1.

Specific characteristics are possessed by the training implementation that uses the RADEC learning model-oriented engineering. The implementation of training based on the engineering-oriented RADEC learning model phases is depicted in the flowchart shown in Figure 1, and the application of engineering learning in the "Create" stage of teacher training is illustrated in the flowchart displayed in Figure 2. The training is unique by the participation of primary school teachers from border's dictrict. The participants in this study are teachers at elementary schools who have been working as educators for a period of time longer than five years. The participants include male and female teachers, certified and uncertified teachers, and teachers currently working at the school. Because the program's primary focus is on enhancing the instructors' professional capabilities, it is expected that they will have some prior conceptual familiarity with the training materials that are being provided.

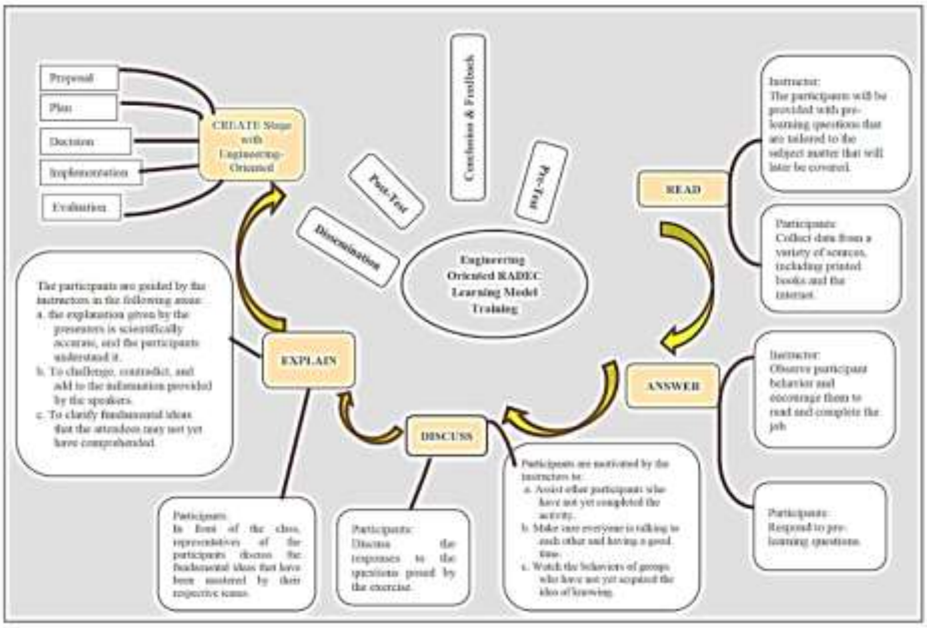

Figure 1. Diagrammatic representation of the processes involved in the implementation of training based on the engineering-focused RADEC learning model

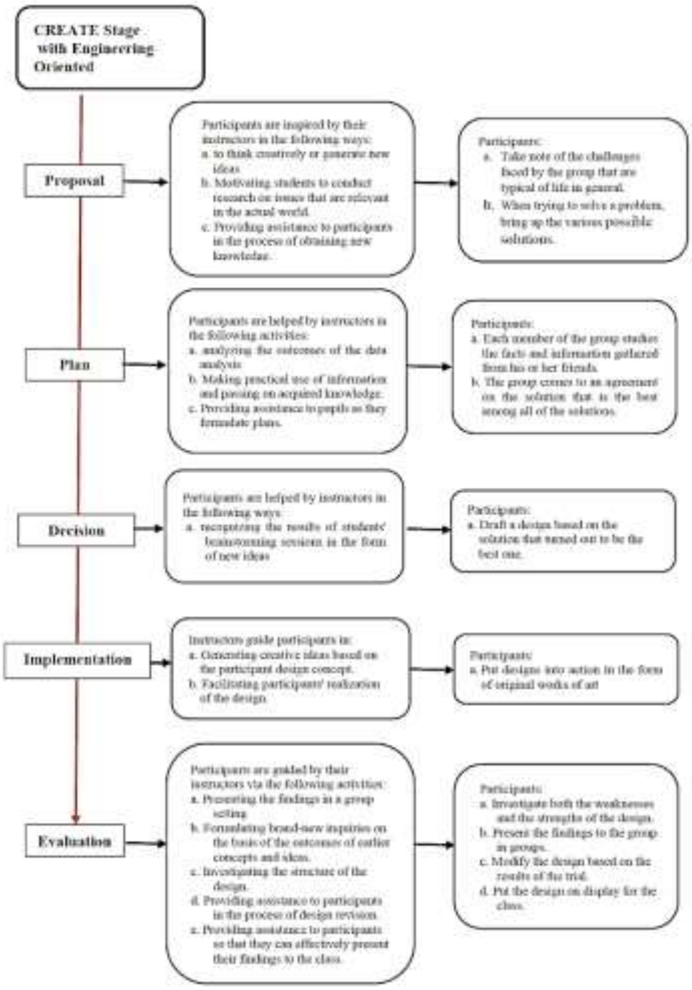

Figure 2. A flowchart illustrating the incorporation of engineering education into the "Create" stage of the teacher preparation process

This methodology for the execution of training was carried out across a total of six primary sessions. During the first session, trainees explored information through assignments in the "Read" phase while being guided by pre-learning questions about engineering-oriented learning, engineering applications in learning associated with the concept of science (temperature and heat), and engineering-oriented learning assessment. During the second session, trainees independently answered pre-learning questions during the "Answer" phase session. The teacher keeps track of the participants' progress and encourages them to read the assigned materials and complete the activities. During the "Discuss" segment of Session 3, the participants participate in group discussion activities. Participants meet in small groups to discuss the solutions to various puzzles or topics. Participants who have discovered the solution are encouraged by the instructors to assist their peers who are struggling with the activity to help them succeed. In addition to ensuring that participants can speak with one another, instructors monitor which groups have grasped the material and which have not to determine which groups have achieved the most success. During the "Explain" segment of Session 4, the participants' representatives will explain the fundamental ideas that their respective teams have mastered in front of the class. The instructor ensures that the participants comprehend the presenter's explanation and that it is accurate from a scientific point of view. The instructor encourages attendees to ask questions, dispute the presenter's issues, and add knowledge to what is already being presented. The instructor is responsible for elaborating on fundamental ideas about which the participants do not yet understand. During Session 5, participants will move through the "Create" portion of the engineering learning cycle in the following manner: a) "Proposal," in which participants examine concerns about temperature and heat in the group that develops in daily life where the participants offer a variety of potential answers to the issues at hand; b) "Plan," in which participants analyze data and information and agree on the best solution among all solutions proposed by the group. The Instructor inspire participants to spark ideas or creative thinking and motivate participants to explore new information in which the instructors are responsible for inspiring participants to spark ideas or creative thinking and encouraging participants to explore new information where participants are guided through the process of analyzing data findings, applying knowledge, and generating plans with the help of instructors; d) "Decision," in which participants create a design draft based on the most optimally agreed-upon solution to the problem of temperature and heat where participants are assisted by instructors in materializing the outcomes of brainstorming sessions in the form of novel ideas; e) "Implementation (Carrying out)," in which participants materialize the design of the design in the form of creative works on temperature and heat; f) "Evaluation," in which the participants conduct investigations about the shortcomings and advantages of the design, then present their findings in groups, and finally conduct trials to revise the design results that are presented in the classroom where the instructors guide the participants in making creative ideas that are based on the design concept and facilitate the participants in realizing the design. The Instructor encourage participants to do Refinement, in which the participants refine the design results that are presented in the classroom where the instructors guide the participants in making creative ideas and assists the participants in modifying the design of the project and presenting the findings in the classroom while also guiding the participants through the process of delivering the results in groups. In the sixth and final session, participants construct a follow-up plan to distribute engineering-oriented learning to their TWG co-workers (Teachers Working Group). The six primary training sessions for elementary school teachers that were conducted using the engineering-focused RADEC learning model were carried out in an online format. At the school, a single session took place, and it was the implementation session of science learning gadgets with engineering-oriented learning. Participants (teachers) were responsible for implementing the educational tool.

Understanding the relationship between engineering-oriented learning and RADEC learning models, and the development of learning tools with a science-based learning approach are all areas in which the activities can provide the instructor with additional knowledge and experience. It is planned that resources for an engineering-oriented learning model that the primary school teachers will acquire through training will be deployed so that kids' ability to produce can be created, organized, and measured. The length of time required for the RADEC engineering-oriented learning model training activities for elementary school teachers is adjusted according to the specificity of the training materials. During the entirety of the course, there were a total of 40 hours dedicated to meeting times. The temperature and heat materials from Class 5 Science were chosen to represent the specified scientific idea.

RESULTS

Table 1 presents the overarching findings of an analysis of teachers' knowledge of engineering-oriented learning obtained before and after the dissemination of the RADEC engineering-oriented learning model training for elementary school teachers in a large trial evaluated using N-Gain. The findings were obtained before and after the training was conducted.

Table 1. Enhancement of engineering-focused learning knowledge

Participant	Pre-test	Post-test	N-Gain (%)
15	47	80	62.26
17	47	87	75.47
18	60	93	82.5
28	60	73	32.5
31	67	87	60.61
34	67	100	100
35	53	80	57.45
38	53	87	72.34
41	60	80	50
42	47	87	75.47
45	47	73	49.06
46	53	93	85.11
48	73	100	100
49	73	87	51.85
Average			68.19

An average of 68.19% falls into the high group based on the data recapitulation from the initial analysis of boosting participants' grasp of engineering-oriented learning. This increase in the high category indicates that the teacher's engineering knowledge is adequate but might be improved by participating in various professional development activities, particularly those focusing on learning implementation. As a result, ongoing training activities on developing engineering-oriented learning lesson plans are essential to guarantee that teachers generally understand engineering-oriented learning while constructing learning devices. Engineering-oriented learning activities can be included in the classroom learning process by teachers who thoroughly understand engineering. This method is consistent with Lally's opinion that solid engineering learning skills are required for instructors to carry out their roles as school educators. The essence of 21st Century Education Quality might be diminished by a lack of engineering learning skills [18]. Engineering-oriented learning, as an essential component of teaching and learning, is a vital professional capability for teachers in the twenty-first century [19]. While carrying out their responsibilities as teachers, teachers spend more time observing attitudes throughout the learning process. Teachers spend more than half of their professional time watching learners' attitudes during and after the learning process [20].

DISCUSSION

The following stages comprise the engineering-focused learning flow: proposal, planning, decision-making, implementation, and evaluation [16]. Teachers with solid engineering habits will be able to identify engineering attitudes in their students, collaborate effectively, think outside the box when solving problems, communicate assessment results clearly (via report cards, test scores, portfolios, or school conferences), and inspire their students to reach their full academic potential. Good engineering thinking habits can be found here. On the other hand, "engineering thinking habits" are utilized to characterize the cognitive processes involved in engineering learning. In the publication "Science for All Americans," the American Association for the Advancement of Science (AAAS) gave its stamp of approval to a particular way of thinking [21]. Engineering thinking habits are strongly connected to the 21st Century Skills and contain the values, attitudes, and thinking skills associated with engineering actions. The National Academy of Engineering recommends the following six ways of thinking for engineers: (1) thinking in systems, (2) solving issues, (3) visualizing, (4) improving, (5) creative problem-solving, and (6) registering [22]. Henry Petroski believes that the values, attitudes, and cognitive skills necessary for engineering begin to develop from a young age [23]. Petroski acknowledges that play involves learners in engineering activities. During play, children create their own toys, games, and artifacts by designing, inventing, and constructing them, giving them the freedom to choose what they use. Students' actions, such as using a garbage truck to move sand in a sandbox, constructing buildings out of unit blocks, switching gears while making snacks, or manipulating objects by pointing to a light source to create a particular form of a shadow, are all examples of engineering practice, as argued by Petroski. According to Petroski, the design process is integrated into the learners' imaginative capacities, choices, and the play activities they engage in with things [23]. Regrettably, traditional educational institutions rarely put these pursuits top of the list of things to do when there is limited time available. What is generally understood and even disregarded as "simple play" is frequently the start of engineering or repetitive thinking and needs to be encouraged in the early grades.

Students are equipped with technical knowledge, practical skills, and a sense of responsibility through an education in engineering, which is one of the aims of engineering education [24]. In order to reach this goal, schools will need to adjust to the rapid changes in science and technology, and they will need to teach students how to adapt to these changes so that they are prepared for them [25]. Instructional delegates observe the implementation of teaching and learning in elementary schools. Participants at the workshop on creating an engineering-oriented lesson plan put into action the learning implementation plan (RPP) they had created. This workshop was conducted by participants (teachers) in borders, and the outskirts all have elementary schools where students can learn science fundamentals in the fifth grade. They each have to teach lessons that last for thirty-five minutes. Post-lesson interviews with educators corroborate prior observations about engineering-oriented learning as a method that is both successful and easy to implement. One of the reasons is that educators are accustomed to delivering STEM-focused lessons utilizing a wide variety of learning strategies that are improvised following the stages of engineering-oriented learning but which are ultimately accomplished. Another reason is that the teachers are accustomed to teaching using engineering-oriented learning. It is envisaged that engineering-oriented learning can be one of the alternatives to learning ways that can be utilized in the classroom, alongside STEM approaches that have been suggested for use in the process of putting the curriculum for 2013 into action. Students are more satisfied with their education when they are directly involved in the application stage of engineering-oriented learning that is diverse with many learning methodologies that they are receiving. This way makes studying a pleasant experience for students. As a consequence, education and training are extremely important for educators. The success of engineering-oriented learning training ultimately influences how educators teach and assist learners' engineering thinking processes within the classroom [26].

CONCLUSION

Elementary school teachers in border's district were trained engineering oriented learning . The instruction was delivered in a manner that was consistent with the stages of the RADEC learning model. The findings of the calculations based on gain pre-test and post-tst for knowledge of engineering-focused learning is categorized high. There is a considerable difference in the improvement before and after training. Positive findings emerge from research examining educators' capabilities t

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