# Development of Primary School Teacher Training Through The Engineering-Oriented RADEC Learning Model

**Chaerun Anwar[1], Wahyu Sopandi[2], Udin Syaefudin Saud [3]**
[1] Indonesia University of Education
[1,2,3] PPPPTKIPA MoECRT of the Republic of Indonesia
[1]achaerun@gmail.com, [2]wsopandi@upi.edu, [3]usaud@upi.edu

**Abstract**

The goal of this study is to provide school teacher training that is based on the engineering-oriented RADEC learning model. The training program was created using development research techniques and processes that adhered to the ADDIE stages of analysis, design, development, implementation, and evaluation. We employed the CIPP evaluation paradigm for the assessment phase, including context, input, process, and product evaluation. This training program included 35 elementary school teachers from 12 provinces and 35 cities and districts in Indonesia, with primary school regions in city, district, and borders. There are two types of instruments used: test and non-test. The exam category includes essay and multiple-choice questions designed to assess engineering literacy knowledge. Non-test methods include questionnaires, observation, documentation, and interviews. Interview guidelines, observation sheets, training model validation sheets, training plans, training modules, trainee response questionnaires, test questions, and attitude evaluation sheets were also utilized to collect information and data. The development research data was assessed descriptively, qualitatively, and quantitatively. Through engineering-oriented RADEC learning models, development research has produced research products in the form of a set of primary school teacher training products, including program structure, activity schedule, syllabus, lesson plan, hand-out training materials, observation instruments, and questionnaire responses of training participants. All of these items have been validated by science education, curriculum, and assessment specialists, and the results are valid and credible. The results demonstrated that the engineering-oriented RADEC learning model training program could improve instructors' knowledge of engineering literacy concepts, knowledge based on regional peculiarities, engineering abilities, and RADEC-based lesson plans. There are also considerable variations between before and after the RADEC engineering-oriented learning model training for elementary school teachers.

***Keywords**:* The teacher training model, RADEC learning model, Engineering-oriented learning, Engineering skills

## Introduction

Primary school teachers' learning models have evolved. Through a training program offered by the Ministry of Education and Culture, each teacher has the option to participate in training to improve their teaching skills. This program provides an opportunity for primary school teachers to learn about innovative learning models incorporated into the curriculum. However, after the training, the teachers confessed that they had difficulty using the learning paradigm. Friani et al. claimed that some learning syntaxes were not used to their full potential in teaching and learning probes [1]. According to the research of Nurlaily et al., teachers struggle to develop and apply learning strategies because they have difficulty understanding each learning syntax in the learning model [2]. This is an issue that needs to be addressed and resolved to achieve the goals of the learning model training. According to PPPTKIPA's TNA (Training Need Analysis), teachers demand training phases that allow learners to interact actively and experience the learning model trained [3]. Identifying the need for teacher training is compatible with TNA's purpose, highlighting difficulties in school-based learning [4].

The introduction of the RADEC learning model, an alternative learning model, first presented at an international conference in Kuala Lumpur, Malaysia, signifies the emergence of learning models that depart from the typical difficulties in implementing classroom learning in Indonesia as a result of the country's specific conditions. The RADEC Learning Model is a new milestone in identifying a standard Indonesian learning model that meets the demands and environment of Indonesian education. Due to the volume of curriculum material that must be mastered, Indonesian elementary school students confront a substantial learning burden. The school and national examinations are two of the more significant challenges elementary school students in Indonesia must overcome [5]. The RADEC learning model must be developed to address the low quality of the process and student learning outcomes. The RADEC learning model has been demonstrated to have a positive impact; it can improve students' literacy skills, foster student independence in learning, enable students to produce work, foster students' ability to collaborate, and provide students with the resources they need to master a variety of 21st-century skills [6]. Hence, this study was conducted to establish training for elementary school teachers in the training centre using the RADEC learning model to improve training participants' knowledge of the learning model.

## Literature Review

### Training to Improve Teacher Competence

Teacher training is an activity that has to be carried out to increase the quality of instruction. According to Cowling and James, training is defined as the systematic development of attitudes, knowledge, abilities, and behaviours that enable instructors to do tasks or work adequately [7]. The benefits of training include increased and improved knowledge quality, improved teacher abilities and experience, and a firm foundation for carrying out the teaching and learning process [8]. Education and training align with worker growth, empowerment, and scientific and technological advancement demands. According to Loucks-Horsley, the professional development of teachers is an ongoing and challenging task. Regardless of the completion of formal education programs, it aims to improve educators' quality, and teacher development must be performed continuously with appropriate planning [9]. To test or analyze the demands of employees, for example, by asking employees or education workers how to determine the operational standards of a task that can be completed. Laird Dugan asserts that need analysis occurs when workers or educated individuals cannot do the assignment satisfactorily [10].

The global spread of the COVID-19 pandemic has been a boon for educators, who have been searching for acceptable learning models to implement during the epidemic, which began in 2020 and is ongoing. The imposition of large-scale social restrictions, a government decision made in anticipation of the spread of the COVID-19 virus, has a tremendous influence on the life of the general public. The main impact on Indonesian education, like in all nations, is the widespread closure of campuses, secondary schools, elementary schools, and early childhood education. To combat the COVID-19 pandemic, the Ministry of Education and Culture established a program that organized online learning at all levels of education [11]. The policy is thought to be capable of overcoming the hurdles of learning difficulties during the pandemic and can be accessed by students at all levels from their homes. Teacher education is projected to continue as a strategy of strengthening teacher competence during the pandemic. As a technical implementation unit of the Ministry of Education and Culture, PPPPTK IPA designed an online training program to improve teacher competency. This online course is an alternate approach for teachers who want to increase their competence and professionalism but are limited by cash and time. Online training for instructors is now available. Teachers who desire to improve their professionalism can self-register for online training at http://pkb.p4tkipa.kemdikbud.go.id/mooc. Teachers from anywhere and anytime who want to enhance their expertise can register for free training courses on the PPPPTK IPA e-training portal.

The online learning system is built and developed with the massively used and open concept, commonly known as massive and open online training (Didamba). This online course is one of the alternatives to traditional instruction, which the COVID-19 pandemic will hamper in early 2020. Didamba is an innovation in applying training given by PPPPTK IPA to expand services to teachers who desire to improve their professionalism. Didamba is an online learning program designed to be followed by many participants by accessing the web, which incorporates reading materials, videos, and tasks that can help users attain the skills presented. The Didamba curriculum includes an interactive discussion forum where participants can connect with teachers and other participants. Didamba training is accessible exclusively via the internet and can be completed anytime and from any location. Teachers from elementary, junior high, high school and vocational schools throughout Indonesia are welcome to enrol in the online training to develop their abilities and competencies in the relevant areas. The online training paradigm has a 12-day training period of three hours per day [12].

Moodle's training flow is organized into four sessions: introduction, core, close, and dissemination. The inaugural session is usually filled with a portion introducing the teacher/tutor, administrator, and evaluator. Sub-sessions of the initial test and self-assessment are also available. The core session consists of one, two, or three training material sessions, with the activities of the training participants divided into the following categories: introduction to the session; learning activities; forum sessions; doing assignments; feedback; and test sessions. The concluding session includes the following activities: final test, final self-assessment, conclusion and comments, instructor evaluation, and evaluation [13].

## Engineering-Oriented RADEC Learning Model

The engineering-oriented RADEC learning model is RADEC learning through engineering thinking in numerous elements of classroom learning activities. As an introduction, this course utilizes engineering-oriented learning methodologies by designing learning content led by learning objectives and projects. Furthermore, it fosters a learning environment for engineers. Engineering-oriented learning aims to help students develop a broad and flexible knowledge base by guiding them to solve complex practical engineering problems in order to cultivate and stimulate students' internal learning motivation and to develop new engineering aptitude skills, such as effective problem-solving ability, problem-solving ability, cooperative ability, independent learning ability, and lifelong learning ability [14]. The goal of this engineering-oriented learning is to create a network-like learning model, which includes the "teacher-student" teaching community, the "student-student" learning community, the "student-enterprise" practice community, and the "intra-advisor-extra advisor" guiding community. It challenges the standard teaching paradigm founded on the teacher subjectivity principle and focuses on "teacher, textbook, and class." Instead of receiving and retaining knowledge indirectly from teachers, students participate in engineering projects to foster networking links among teachers, other students, and the community [15].

Engineering project-based learning consists of four components: "project, teacher, student, and company." Projects are regarded as essential to arranging knowledge. A strong project case can pique students' interest in investigating and solving problems. Students are problem solvers. They identify the core of the problem, seek reasonable solutions to the problem, and endeavour to study and comprehend the practical importance of the situation. The teacher is the student's collaborator and mentor in the problem-solving process. They deliberately foster an open inquiry learning atmosphere for students. If we regard the school as a producer and the student as a product, society is a user of learning products. People's experiences and feelings do, to some part, reflect the impacts of learning. Allowing education consumers, or the general public, to participate directly in instructional activities will enable schools to comprehend industry needs properly and truly teach students how to use knowledge. In short, the project is the primary body in the independent curriculum system; the student is the centre, the teacher is the guide, and the community is the leader. By utilizing engineering project-based instruction, independent education can produce a seamless relationship between teaching, learning, and application.

Engineering-oriented learning is a learning strategy focusing on developing students' practical engineering abilities. Teachers must create engineering-oriented learning content that adheres to students' cognitive laws. According to the learning process from perceptual knowledge to logical knowledge and subsequently, to practical application, the classic learning chain of "knowledge plus experiment" is expanded to "knowledge plus experiment plus project." The project runs through the whole learning process in project-driven learning, including project-driven theoretical knowledge, project-driven experimental situations, and project-driven evaluation methodologies. It takes a specific scale of engineering projects matching the aim of independent learning as a learning case, the entire project development cycle as the primary learning, and project demonstration, project discussion, project design, and project execution as the learning material. Project-driven teaching attempts to map the practical problems to be solved in engineering projects into the information and technology taught in classroom learning so that students may grasp the whole project work process from planning, analysis, design, implementation, and maintenance. During the learning process, the teacher chooses a complete project relevant to the autonomous curriculum to organize the learning information. The learners consider the completion of tasks to be the essential learning mode. Ongineering-oriented learning has five stages: proposal, plan, decision, implement, and evaluation [16].

## Methods

Research is undertaken to learn about user demands, and development activities are carried out to create a research-based training model using ADDIE research and development methods. Evaluation in ADDIE, the evaluation of training programs, is integrated with the stages of Daniel Stufflebeam's training evaluation model, which include the Context, Input, Process, and Product (CIPP) stages [17].

The subjects of this study were primary school teachers from 35 cities and districts in 12 provinces in Indonesia, with the features of cities, districts, and border areas. Two kinds of research instruments were used: tests and non-tests. The test category included an essay and multiple choice questions to assess engineering literacy knowledge. The non-test category included questionnaires, observations, documents, and interviews. In addition, interview guidelines, observation sheets, training model validation sheets, training plans, training modules, trainee response questionnaires, test questions, and attitude evaluation sheets were utilized to collect various information and data. The study was conducted and controlled at the National Teacher Training Center of PPPPTKIPA using an online training format for 40 hours of meetings divided into eight sessions.

The research product is utilized in development research during the phases of constrained trials and comprehensive trials after its legitimacy has been established. Research products developed during the program's design phase are validated by a team of specialists in scientific education, curriculum, and evaluation. Validation is accomplished by supplying research tools (training tools, training materials, and research instruments) and assessment indicators to assist the validator team in carrying out research product validation. Data obtained during the execution of research and development comprise pre-test and post-test data, observation data, interview data, RADEC lesson plan product data, engineering orientation and engineering instruments, and participant attitude data answers.

## Results and Discussion

### A. Training Model through engineering-oriented RADEC learning

Engineering-oriented RADEC learning model training design employs the phases of the RADEC learning model as a paradigm for teacher training implementation at the National Teacher Training Center PPPPTKIPA. The engineering-learning phase is the orientation in the Create Phase of the RADEC learning model. The aim of adapting engineering learning in the Create Phase is that teachers are required to generate training goods in the form of learning implementation plans and learning instruments that will be implemented in their classrooms. The RADEC learning model was chosen because it showed to be acceptable for usage in Indonesia as an alternate learning model to improve student learning results [5]. Table 1 describes the training activities conducted using the engineering-oriented RADEC learning model.

**Table 1. Phases of training activities through the engineering-oriented RADEC learning model**

| No. | Session | Teaching Hours | Activity |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1. | Session- 1 | 3 hours | ✓ Opening<br>✓ Greetings from the head of PPPPTKIPA<br>✓ Explanation of the structure of the engineering-oriented RADEC learning model training program<br>✓ Filling out the attendance list<br>✓ The collection of lesson plans and questions (UTS & UAS) created and used by teachers<br>✓ Filling out the teacher's identity<br>✓ Implementation of the preliminary test (Pre-test)<br>✓ Closing |
| 2. | Session- 2 | 3 hours | ✓ Filling out the attendance list<br>✓ "Read" stage. Instructors inform pre-learning questions and read assignments with pre-learning question guides on engineering-oriented learning.<br>✓ Participants dig up information from various sources, both books and other printed sources and other information sources such as the internet.<br>✓ Reflection activities<br>✓ Closing |
| 3. | Session- 3 | 3 hours | ✓ Filling out the attendance list<br>✓ "Answer" stage. Instructors monitor and motivate learners to read and do assignments.<br>✓ Participants answer pre-learning questions independently.<br>✓ Reflection activities<br>✓ Closing |
| 4. | Session- 4 | 3 hours | ✓ Filling out the attendance list<br>✓ "Discuss" stage. Group discussion, participants are divided into different rooms accompanied by facilitators.<br>✓ Group participants discuss answers to pre-study questions or assignments.<br>✓ Ensure communication between participants. Ensure that participants who have not mastered the material can ask their friends. The instructor motivates |

| | | | |
|---|---|---|---|
| | | | participants who complete their tasks to guide their friends who have not mastered the material.<br>✓ Reflection activities<br>✓ Closing |
| 5. | Session- 5 | 3 hours | ✓ Filling out the attendance list<br>✓ "Explain" stage. Representatives of the participants explained the essential concepts of engineering-oriented learning and engineering thinking habits they had mastered in front of the class.<br>✓ The instructor ensures that the presenter's explanation is scientifically correct and understood by the participants. Encourage participants to ask questions, argue, or add material presented by other group presenters. Explain essential concepts that the participants do not yet understand.<br>✓ Reflection activities<br>✓ Closing |
| 6. | Session- 6 | 5 hours | ✓ Filling out the attendance list<br>✓ "Create" stage.<br>✓ Proposal: The facilitator inspires participants with creative ideas in engineering-oriented learning<br>✓ Plan: The facilitator facilitates data analysis and applies knowledge to conclude.<br>✓ Decision: the facilitator facilitates solutions outlined in the draft concept of creative ideas about the project in engineering-oriented learning that can explore engineering thinking habits,<br>✓ Implement: the facilitator facilitates the activities of realizing creative ideas in the form of engineering project design and recognized in the form of products.<br>✓ Evaluation: facilitators facilitate product presentations, discussion of improvements, and design revisions.<br>✓ Discussion and reflection activities.<br>✓ Closing |

| | | | |
|---|---|---|---|
| 7. | Session- 7 | 15 hours | ✓ Filling out the attendance list<br>✓ Workshop preparation of follow-up plan dissemination of engineering-oriented learning<br>✓ Composing instruments of engineering-oriented learning<br>✓ Discussion and reflection activities<br>✓ Closing |
| 8. | Session- 8 | 5 hours | ✓ Filling out the attendance list<br>✓ Implementation of the final test (post-test)<br>✓ The teacher response questionnaire<br>✓ Engineering-oriented learning questionnaire filled in<br>✓ Closing |
| **Total Hours** | | **40** hours | |

Training implementation utilizing the RADEC learning model-oriented engineering has specific properties. Figure 1 exhibits the flowchart of training implementation using the engineering-oriented RADEC learning model phases, and the flowchart of the implementation of engineering learning in the "Create" stage in teacher training is shown in Figure 2. The training is distinguished by the participation of primary school teachers from 35 districts or cities across 12 provinces, with primary schools located in cities, districts, and borders. The subjects are elementary school instructors who have been in the classroom for more than five years, male and female teachers, certified and uncertified teachers, and teachers who are currently at the school. The teachers already have some conceptual knowledge of the training materials offered because this program aims to improve the competency of the teachers.

This training implementation technique is carried out throughout six primary sessions. Session-1, exploring information through assignments in the "Read" phase guided by pre-learning questions about teacher competence, engineering-oriented learning, engineering thinking habits, engineering applications in learning associated with the concept of science (temperature and heat), and engineering-oriented learning assessment; Session-2, trainees answered pre-learning questions in the "Answer" phase session which were carried out independently.



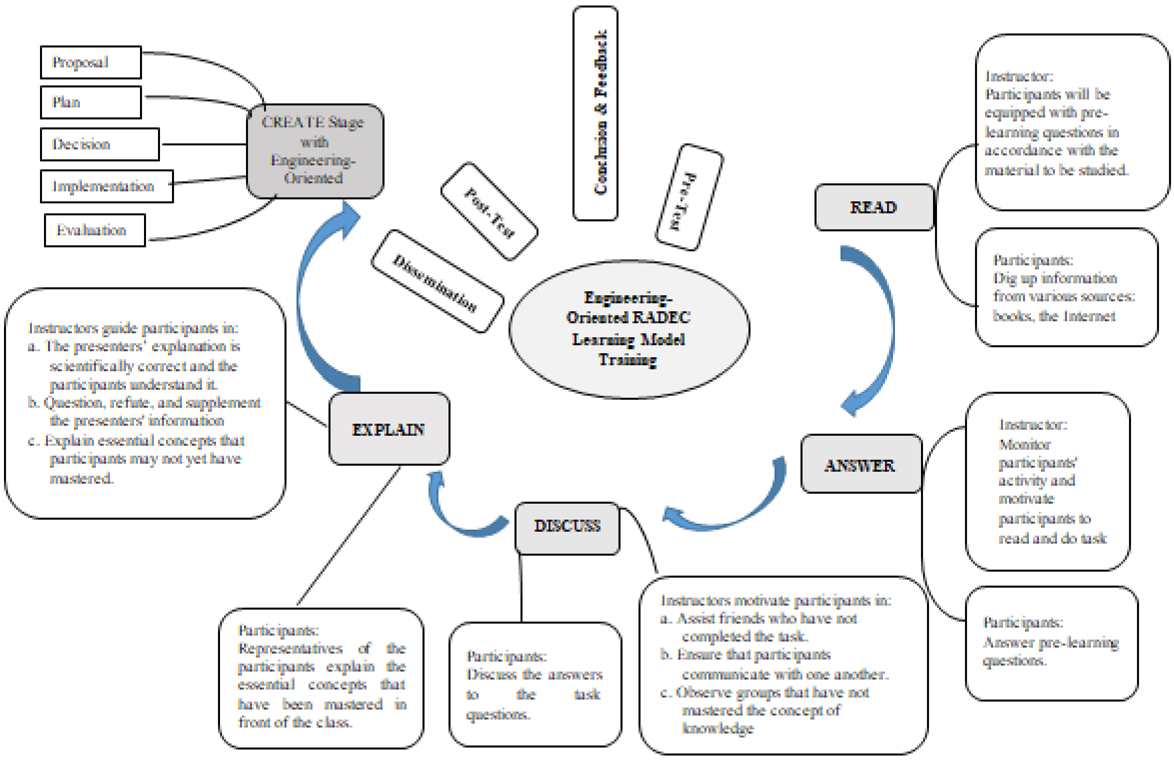
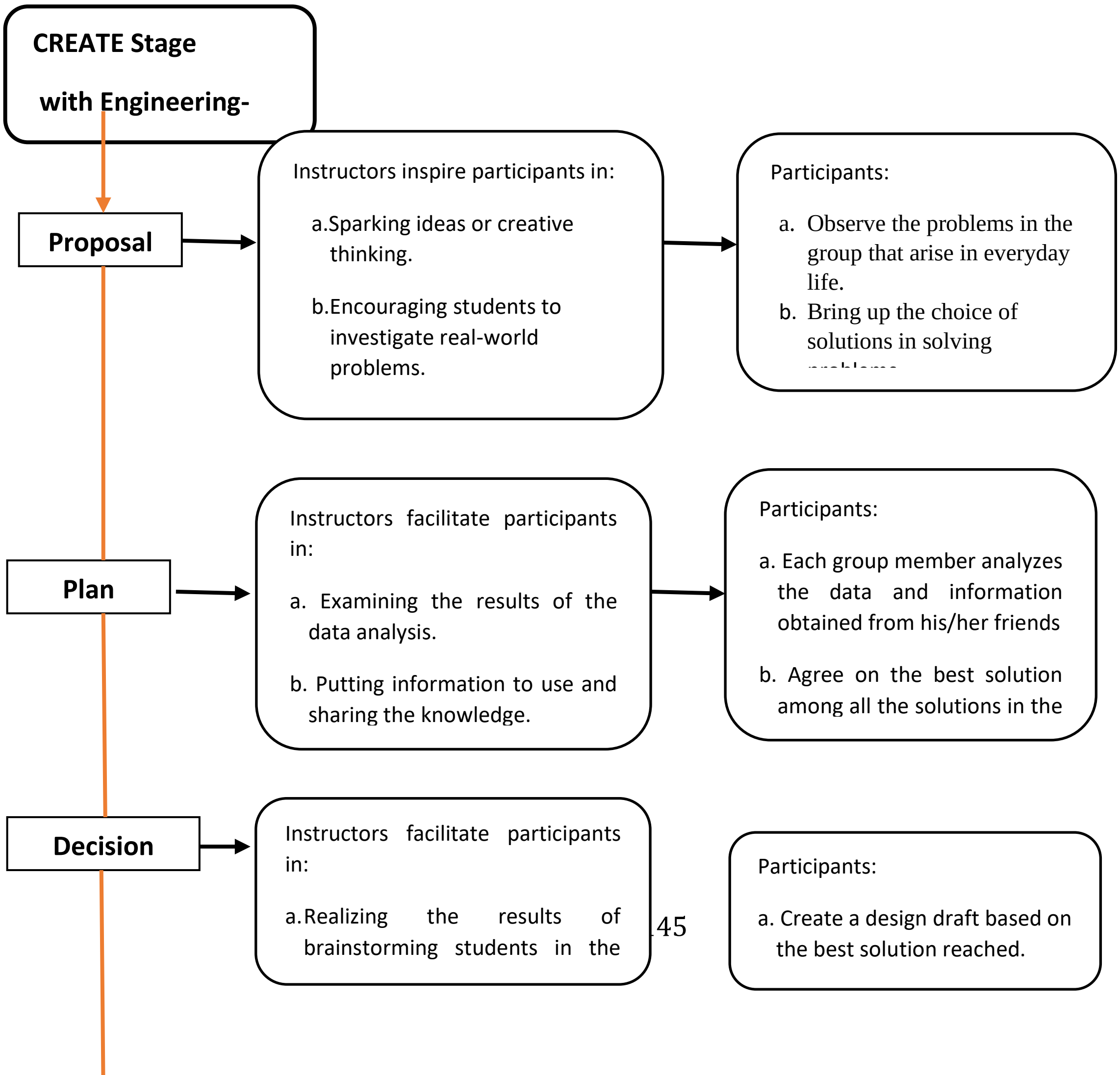



**Figure 1: Flowchart of training implementation using engineering-oriented RADEC learning model phases**



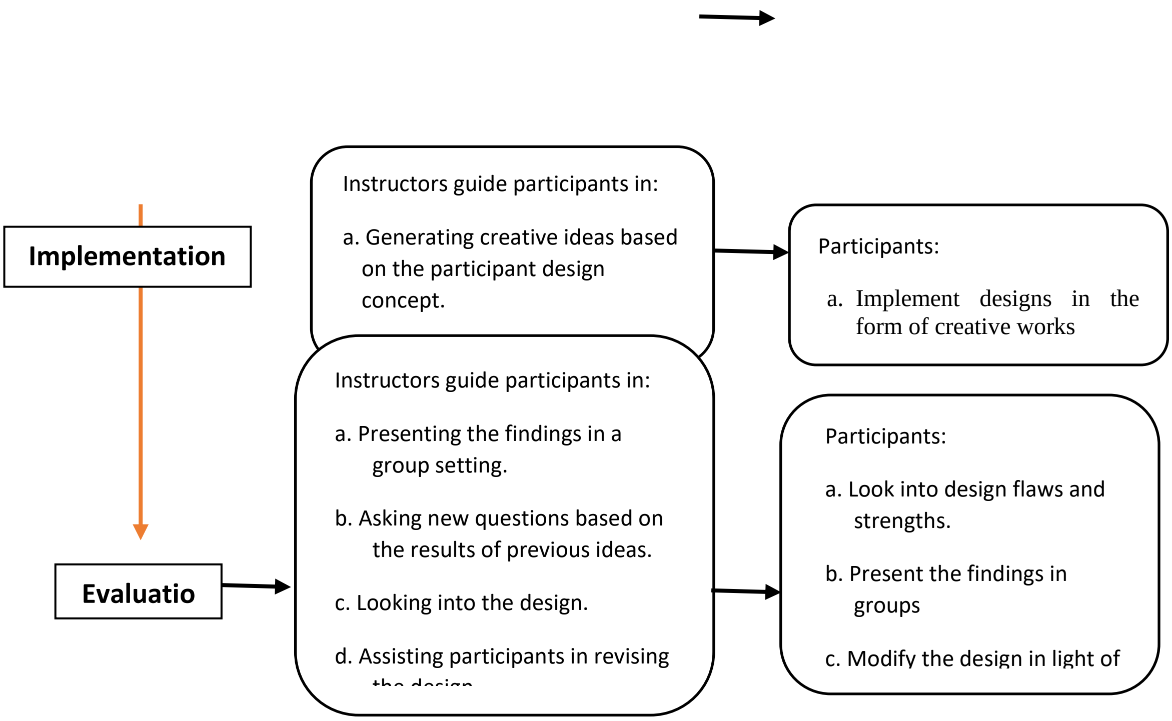



**Figure 2: Flow chart of the implementation of engineering learning in the "Create" stage in teacher training.**

The instructor monitors and motivates participants to read information sources and complete their tasks. In Session 3, participants carry out group discussion activities in the "Discuss" phase. Participants discuss answers to questions or tasks in groups. Instructors motivate participants who have found the answer by giving guidance to their friends who have not mastered the task. In addition to ensuring that participants communicate with one another, instructors observe which groups have mastered the topic and which have not. In Session 4, in the "Explain" phase, the participants' representatives explain the essential concepts they have mastered in front of the class. The instructor ensures that the presenter's explanation is scientifically correct and that the participants understand it. The instructor encourages participants to ask, argue, and add information from the presenter. The instructor must explain the essential concepts the participants have not mastered. In Session 5, participants carry out the "Create" phase through the engineering learning sequence as follows: a) "Proposal" in which participants observe problems about temperature and heat in the group that arise in daily life. Participants bring up a choice of solutions to solve problems. Instructors must inspire participants to spark ideas or creative thinking and motivate participants to explore new information; b) "Plan" in which participants analyze data and information and agree on the best solution among all solutions in the group. Instructors facilitate participants in analyzing data findings, applying information and guiding participants in making plans; c) "Decision" in which participants make a design draft based on the best-agreed solution to the issue of temperature and heat. Instructors facilitate participants in realizing the results of brainstorming sessions in the form of new concepts; d) "Carrying out", in which the participants realize the design of the design in the form of creative works on temperature and heat. Instructors guide participants in making creative ideas based on the design concept and facilitate participants in realizing the design; e) "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. The instructor guides the participants in the presentation of the findings in the group and in revising the design and presentation of the findings in the classroom. In Session 6, participants develop a follow-up plan to disseminate engineering-oriented learning to colleagues in the TWG (Teachers Working Group). The six main sessions of training activities through the engineering-oriented RADEC learning model for elementary school teachers were carried out in the online form. One session was held at the school: the implementation session of science learning devices with engineering-oriented learning. The implementation of the learning tool was carried out by three participants (teachers) by representing the characteristics of each region, namely one teacher from the city, one teacher from the district, and one from the border.

The activities can add knowledge and experience to the teacher in understanding the relationship between engineering-oriented learning and RADEC learning models, understanding the concept of engineering thinking habits, and developing learning tools with a science-based learning approach. It is envisaged that engineering-oriented learning model resources for elementary school instructors gained through training will be implemented to create, organize, and measure students' ability to produce. The time necessary for RADEC engineering-oriented learning model training activities for elementary school teachers is tailored to the training materials' narrowness. In total, 40 hours of meetings were taken place during the course. Table 1 displays the duration of each training session. The selected Science concept is the Class 5 Science material: temperature and heat. The engineering-oriented RADEC learning methodology incorporates science material discussion into each training program. All training materials are delivered using the RADEC learning model and engineering-oriented learning.

## B. Discussion

Table 2 shows the overall 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 assessed using N-Gain.

**Table 2. Improvement of engineering-oriented learning knowledge**

| No. | Participant | Pre-test | Post-test | N-Gain (%) |
|---|---|---|---|---|
| 1. | 01 | 60 | 80 | 50.00 |
| 2. | 04 | 53 | 87 | 72.34 |
| 3. | 06 | 73 | 87 | 51.85 |
| 4. | 07 | 60 | 73 | 32.50 |
| 5. | 09 | 53 | 80 | 57.45 |
| 6. | 10 | 47 | 87 | 75.47 |
| 7. | 12 | 67 | 100 | 100.00 |

| | | | | |
|---|---|---|---|---|
| 8. | 13 | 47 | 73 | 49.06 |
| 9. | 15 | 73 | 100 | 100.00 |
| 10. | 17 | 53 | 93 | 85.11 |
| 11. | 18 | 47 | 80 | 62.26 |
| 12. | 19 | 67 | 87 | 60.61 |
| 13. | 20 | 47 | 87 | 75.47 |
| 14. | 23 | 60 | 93 | 82.50 |
| **Average** | | | | **68.19** |

Based on the data recapitulation from the initial analysis of improving participants' understanding of engineering-oriented learning, an average of 68.19% falls into the high group. This increase in the high category shows that the teacher's engineering knowledge is good but might be improved by participating in various professional development activities, particularly those that focus on learning implementation. As a result, continual training activities on generating engineering-oriented learning lesson plans are required to ensure that teachers' overall awareness of engineering-oriented learning in preparing learning devices is gained. Teachers with a strong understanding of engineering can include engineering-oriented learning activities in the classroom learning process. This is consistent with Lally's belief that instructors must have good engineering learning skills to carry out their duties as school educators. A lack of engineering learning skills can diminish the essence of the 21st Century Education Quality [18]. As an integral component of teaching and learning, engineering-oriented learning is a critical professional competency for teachers in the twenty-first century [19]. Teachers spend more time in observing attitudes throughout the learning process while carrying out their obligations as teachers. Teachers devote over half of their professional time to tasks connected to the observation of attitudes in learners, both during the learning process and afterwards [20].

Engineering-oriented learning flow consists of the following steps: proposal, planning, decision, implementation, and evaluation [16]. Teachers who can use good engineering thinking habits will be able to recognize engineering attitudes, work in teams, be creative in problem-solving, understand the attitude assessment methods used to collect reliable information and learner learning achievements, communicate assessment results effectively (whether using report cards, test scores, portfolios, or school conferences), and optimize student motivation and learning by encouraging students. On the other hand, "engineering thinking habits" are used to characterize cognitive processes in engineering learning. The American Association for the Advancement of Science endorsed the thinking habit in the book Science for All Americans [21]. Engineering thinking habits include the values, attitudes, and thinking skills associated with engineering actions and are strongly tied to the 21st Century Skills. The National Academy of Engineering offers six engineering thinking habits: (1) systems thinking, (2) issue solving, (3) visualizing, (4) improving, (5) creative problem solving, and (6) registering [22]. According to Henry Petroski, engineering ideals, attitudes, and thinking skills emerge at a young age. Petroski recognizes that learners are naturally involved in engineering through playing. When children play, they design, invent, and construct their toys, games, and artefacts, allowing them to choose what they use. According to Petroski, engineering practice is reflected in student behaviours such as moving sand in a sandbox with a garbage truck, building structures out of unit blocks, changing direction when cooking snacks, or manipulating things by referring to a light source to generate a specific form of shadow. According to Petroski, the action of design is incorporated into learners' imaginations, choices, and play activities with objects [23]. Unfortunately, these activities are rarely prioritized in formal schools as the first thing to perform when time is limited. What is commonly seen and even dismissed as "simple play" is frequently the beginning of engineering or habitual thinking and must be fostered in the early grades.

One of the purposes of engineering education is to provide students with technical knowledge, practical skills, and a sense of responsibility that will prepare them for success in life [24]. To accomplish this, schools must adapt to rapid changes in science and technology and teach students to be ready to adapt as science advances with technological advancements [25]. Trainees are present for the implementation of learning in primary schools. Learning implementation was accomplished through the direct deployment of the learning implementation plan (RPP) developed by participants in the workshop on developing an engineering-oriented lesson plan, conducted by three participants (teachers) to represent each primary school in the city centre, suburbs, and borders. Elementary school instructors teach science concepts in Grade 5 in the city center, suburbs, and boundaries. Each of them learns for 3 x 35 minutes. The results of post-teaching interviews with teachers indicate that teaching using engineering-oriented learning is very effective and straightforward because they are accustomed to teaching using STEM approaches by varying learning methods, which are improvised with the stages of engineering-oriented learning, but all stages are successfully completed. It is hoped that engineering-oriented learning can be one of the alternatives to learning approaches in the classroom, alongside STEM approaches and creative learning models suggested for use in implementing the 2013 curriculum. Engineering-oriented learning that is diverse with numerous learning techniques makes students happy since they are directly involved in the application stage, making learning pleasant for students. As a result, education and training are critical for teachers, as the success of engineering-oriented RADEC learning model training ultimately influences how teachers teach and help learners' engineering thought processes in the classroom [26].

## Conclusion

The engineering-oriented RADEC learning model was used to train elementary school teachers in two stages: a restricted trial including seven elementary school teachers and a large trial involving fourteen elementary school teachers from city, suburban, and border districts. The training is implemented following the stages of the RADEC learning model. The results of the average observations are extraordinarily high. The efficiency of such training implementation in terms of expanding knowledge of engineering-oriented learning is in the medium range. Improving one's knowledge and one's way of thinking about engineering is very important. Knowledge enhancement based on regional features falls under the medium category. Improvement before and after training is significantly different. Analyzing instructors' skills in designing engineering-oriented learning devices yields positive findings.

## References

[1]. Friani, I. F., Sulaiman, S., & Mislinawati, M. (2017). Kendala guru dalam menerapkan model pembelajaran pada pembelajaran tematik berdasarkan kurikulum 2013 di SD Negeri 2 Kota Banda Aceh. Jurnal Ilmiah Pendidikan Guru Sekolah Dasar FKIP Unsyiah, 2(1), 88-97.

[2]. Nurlaily, V. A., Soegiyanto, H., & Usodo, B. (2019). Elementary school teachers' obstacles in the implementation of problem-based learning model in mathematics learning. Journal on Mathematics Education, 10(2), 229-238.

[3]. PPPPTKIPA. (2018). Rencana Strategis 2020-2024. Bandung: PPPPTKIPA.

[4]. Rossett, A. (1987). Training needs assessment. Educational Technology.

[5]. Sopandi, W. (2017). The quality improvement of learning processes and achievements through the read-answer-discuss-explain-and create learning model implementation. In Proceeding 8th Pedagogy International Seminar (Vol. 8, pp. 132-139).

[6]. Sukmawati, D., Sopandi, W., & Sujana, A. (2020). The application of read-answer-discuss-explain-and-creat (RADEC) models to improve student learning outcomes in Class V Elementary School on human respiratory system. In International Conference on Elementary Education (Vol. 2, No. 1, pp. 1734-1742).

[7]. Santoso, B. W. J., Hasyim, M. Y. A., & Oesman, A. M. (2021). Peningkatan keprofesian guru dalam penulisan best practice melalui workshop bagi guru bahasa Indonesia tingkat SMP di kota Semarang. Journal of Curriculum Indonesia, 4(2), 92-102.

[8]. Sudana, I. M. (2011). Analisis meta pada manajemen pasca pelatihan untuk meningkatkan produktivitas guru di SMK. Jurnal Pendidikan Vokasi, 143-144.

[9]. Sunardi, S., & Sudjimat, D. A. (2016). Magang industri untuk meningkatkan relevansi kompetensi profesional guru produktif SMK. Teknologi dan Kejuruan: Jurnal teknologi, Kejuruan dan Pengajarannya, 39(2).

[10]. Schlegel, M. J. (1995). A Handbook of Instructional and Training Program Design.

[11]. Kemdikbud. (2020). Pedoman Pelaksanaan Belajar dari Rumah Selama Darurat Bencana. Jakarta: BKHM Kemdikbud.

[12]. PPPPTKIPA. (2020). Panduan Pelatihan Didamba. Bandung: PPPPTKIPA.

[13]. PPPPTKIPA. (2020). Struktur Program Diklat Didamba. Bandung: PPPPTKIPA.

[14]. Wu, M., & Xiong, G. J. (2010). Study on competence-oriented engineering education reform. Journal of Higher Education in Science & Technology, 3, 54-59.

[15]. Schuster, K., Groß, K., Vossen, R., Richert, A., & Jeschke, S. (2016). Preparing for industry 4.0-collaborative virtual learning environments in engineering education. In Engineering Education 4.0 (pp. 477-487). Springer, Cham.

[16]. Li, Y., Niu, J., Zhang, J., & Hao, R. (2019). Study of engineering-oriented teaching method in C programming course based on emerging engineering education. In 2019 IEEE Frontiers in Education Conference (FIE) (pp. 1-7). IEEE.

[17]. Stufflebeam, D. L. (2000). The CIPP model for evaluation. In Evaluation models (pp. 279-317). Springer, Dordrecht.

[18]. Lally P, van Jaarsveld CHM, Potts HWW, Wardle J. 2010. How are habits formed: Modelling habit formation in the real world. European Journal of Social Psychology, 40 (6), 998-1009.

[19]. Wood, W., & Runger, D. (2016). Psychology of habit. Annual Review of Psychology, 67(67), 289–314.

[20]. Johnston, P. (2005). Literacy assessment and the future. The Reading Teacher, 58(7), 684-686.

[21]. Rutherford, F. J., & Ahlgren, A. (1991). Science for all Americans. Oxford university press.

[22]. Lucas, B., & Hanson, J. (2016). Thinking like an engineer: Using engineering habits of mind and using signature pedagogies to redesign engineering education. IJEP, 6(20), 4-13.

[23]. Petroski, H. (2003). Engineering: Early education. American Scientist, 91(3), 206-209.
[24]. Neeley, W. L., Sheppard, S., & Leifer, L. (2006). Design is design is design (or is it?): What we say vs what we do in engineering design education. In 2006 Annual Conference & Exposition (pp. 11-405).
[25]. National Research Council. (2004). National Academy of Engineering. The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs, 4-8.
[26]. Cachia, R., Ferrari, A., Ala-Mutka, K., & Punie, Y. (2010). Creative learning and innovative teaching: Final report on the study on creativity and innovation in education in EU member states. JRC Working Papers, (JRC62370).