

Enhancing teachers' pedagogical competence through the development of innovative learning tools based on the TPACK approach

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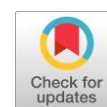
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ABSTRACT

This community service aimed to enhance the pedagogical competence of Pancasila and Civic Education (PPKn) teachers through a TPACK-based (Technological, Pedagogical, and Content Knowledge) workshop on innovative lesson plan (Rencana Pelaksanaan Pembelajaran/RPP) development. Low pedagogical competence in lesson planning remains a persistent challenge for PPKn teachers, as evidenced by below-standard national assessment scores. The workshop engaged junior and senior high school PPKn teachers affiliated with the Indonesian Pancasila and Citizenship Education Professional Association (AP3KnI) of East Java and was delivered online through interactive methods comprising theoretical instruction, learning strategy demonstrations, and guided hands-on practice. Evaluation results confirmed the workshop's effectiveness: mean pedagogical competence scores increased from 6.14 to 11.57, yielding an N-Gain of 63% (classified as "strong") and a large effect size (Cohen's $d = 2.046$). These findings demonstrate that short-term, structured TPACK-based interventions can produce significant and measurable gains in teacher competence, even in an online format. The workshop model is replicable and scalable, offering a practical reference for professional teacher associations and educational stakeholders seeking to advance technology-integrated instructional practices in 21st-century education.



KEYWORDS

Pedagogical competence
Lesson plan
TPACK



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1. Introduction

In today's modern era, the rapid advancement of science and technology continues to permeate all aspects of life, including education in Indonesia. To prepare students as future leaders and successors of the nation, teachers are expected to deliver quality education through effective and efficient teaching and learning processes. The provision of quality education must be supported by the implementation of appropriate educational models in classroom learning [1].

This aligns with the expectations for teachers to become professional educators, as outlined by the Ministry of Education and Culture in Indonesia. Professionalism is defined by four key competencies, as stated in Law Number 14 of 2005 on Teachers and Lecturers, specifically in Article 10, paragraph [1]: "pedagogical competence, personality competence, social competence, and professional competence, all of which are obtained through professional education". Pedagogical competence refers to a teacher's ability to apply knowledge in the learning field to design and implement lessons, evaluate learning outcomes, and understand students' development to nurture their talents and aspirations [2]. Personality competence reflects the teacher's maturity, wisdom, exemplary behavior, authority, and commendable morals [3]. Professional competence relates to a teacher's depth of knowledge, mastery of curriculum material, and scientific methodologies [4]. Finally, social competence encompasses the ability to establish effective and harmonious relationships with others, including students' parents or guardians [5].

Achieving quality education requires teachers to possess not only strong subject-matter expertise but also the professional capacity to integrate technology meaningfully into classroom instruction. This capacity encompasses effective classroom management, the ability to develop and deploy appropriate learning tools, and the flexibility to adapt strategies and methods to the specific demands of the subject being taught—all of which are recognized as significant determinants of classroom learning effectiveness [6]. Teacher performance in these areas is further shaped by broader dispositional and relational factors, including cultural intelligence, interpersonal communication, and organizational citizenship behavior, each of which contributes to a teacher's ability to adapt to diverse classroom settings [7], [8]. Classroom climate, too, plays a critical role: a positive learning environment, when combined with effective teacher performance, demonstrably fosters greater student engagement and more favorable attitudes toward learning [9]. Despite the recognized importance of these competencies, empirical data from national teacher competency assessments in Indonesia reveal a substantial gap between professional standards and actual teacher performance. Approximately 2.9 million teachers remain below the Standar Kompetensi Minimum (SKM) established by the Ministry of Education and Culture, with the national average score for pedagogical competence standing at only 48.94—a figure that underscores the urgency of systematic professional development [10].

This competency deficit is particularly pronounced among Pancasila and Civic Education (PPKn) teachers, whose instructional practices continue to reflect a heavy reliance on conventional, lecture-based, and memorization-focused methods. Such approaches are symptomatic of a broader structural problem: the PPKn curriculum has long been criticized for being rigid, teacher-centered, and disproportionately focused on political indoctrination rather than on developing students' critical thinking and civic agency [11], [12]. This orientation aligns with Kerr's [13] characterization of Indonesian civic education as predominantly concerned with "education about citizenship," a minimalist approach that prioritizes the transmission of civic content over active civic participation. Classroom practices in this domain frequently lack democratic processes and fail to engage students with broader societal issues, thereby limiting opportunities for meaningful civic participation [14]. Further complicating the landscape, teachers in religious school contexts often navigate tensions between state-mandated civic education and personal religious commitments, generating ambiguity in the teaching of nationalism and patriotism [15], [16]. Collectively, these conditions have produced an evaluation culture within PPKn that remains predominantly cognitive and didactic, neglecting the dynamic, interactive, and student-centered practices increasingly called for in contemporary educational discourse [17].

To address these multifaceted challenges, scholars and practitioners have advocated for a fundamental reorientation of PPKn toward more flexible, student-centered approaches—including project-based learning and portfolio assessments—that cultivate critical thinking and deepen civic engagement [11], [12], [17]. Central to this reorientation is the imperative for teachers to harness advancements in information and communication technology (ICT) to diversify instructional resources and make learning more accessible and relevant to students. Technological development has not only transformed the tools available to educators but has fundamentally reshaped the goals and expectations of 21st-century education. In this context, the TPACK (Technological, Pedagogical, and Content Knowledge) framework has emerged as a robust and widely adopted approach for integrating content mastery, pedagogical skill, and technological proficiency into coherent instructional design [18]. Building upon the earlier PCK (Pedagogical Content Knowledge) model, which combined pedagogy and content knowledge, TPACK extends this foundation by incorporating technology across four dimensions: Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and the integrative TPACK itself—complemented by three foundational knowledge types: Pedagogical Knowledge (PK), Content Knowledge (CK), and Pedagogical Content Knowledge (PCK) [19]. TPACK thus serves as an essential framework for educators seeking to integrate technology seamlessly into effective, contemporary teaching practice [20].

Despite the growing body of literature supporting the TPACK framework and the well-documented deficiencies in PPKn pedagogical practice, there remains a notable gap in empirically validated, practice-oriented interventions that apply TPACK specifically to the development of PPKn lesson plans (Rencana Pelaksanaan Pembelajaran/RPP) within the Indonesian professional development context. Existing studies have largely addressed TPACK at a theoretical or generalist level, without attending to the distinctive curricular, cultural, and institutional challenges that characterize PPKn instruction—including

its tension between civic formation and democratic pedagogy, and the competing demands faced by teachers in diverse school contexts. This present study operationalizes the TPACK framework within a targeted community service initiative designed specifically for PPKn teachers affiliated with the Indonesian Pancasila and Citizenship Education Professional Association (AP3KnI) in East Java, generating empirical evidence for the effectiveness of short-term, online, TPACK-based professional development in measurably improving pedagogical competence. In doing so, this study contributes both a replicable professional development model and subject-specific empirical data to the ongoing effort to modernize PPKn instruction and align it with the demands of 21st-century civic education.

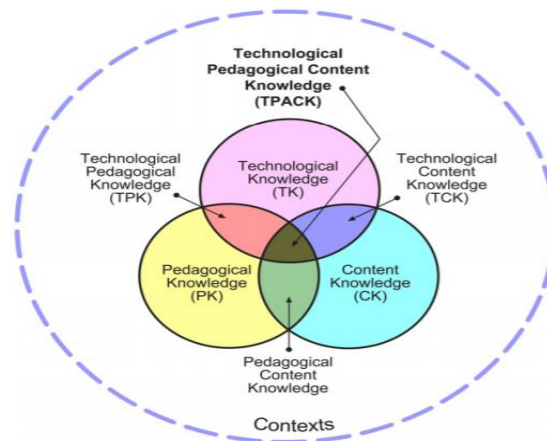


Fig. 1. Technological Pedagogical Content Knowledge (TPACK) Framework [21]

Technological Pedagogical Content Knowledge (TPACK) refers to the integration of technology, pedagogy, and content knowledge to facilitate effective learning and training for participants across specific subject areas. This framework provides insights into how these components interact, enabling educators to design teaching approaches that effectively utilize technological tools while aligning with pedagogical strategies and content requirements. Understanding the relationships among these variables helps identify the most significant factors influencing teachers' practices in the teaching and learning process, thereby guiding future planning to enhance the quality of professional and ICT-based teaching. As shown in Fig. 1, TPACK is influenced by seven interrelated variables [21], [22].

- Technological Knowledge (TK) refers to knowledge about operating computers and utilizing relevant software effectively.
- Pedagogical Knowledge (PK) represents the ability to manage and facilitate student learning processes.
- Content Knowledge (CK) encompasses subject matter expertise, such as knowledge of disciplines like language, mathematics, and natural sciences.
- Technological Content Knowledge (TCK) involves understanding how technology can be used to explore or represent content, such as employing computer simulations to model the movement of the earth's crust.
- Pedagogical Content Knowledge (PCK) refers to knowledge of how to represent and communicate subject matter in ways that make it comprehensible to learners.
- Technological Pedagogical Knowledge (TPK) entails understanding how technology can enhance pedagogical strategies, such as utilizing asynchronous forums to facilitate the social construction of knowledge.

The ranking results from the Program for International Student Assessment (PISA) in 2018 clearly illustrate the challenges faced by Indonesian students in comparison to their global peers. Among the 79 countries surveyed, Indonesia ranked 74th, well below the global average [23]. Based on the evaluated indicators, which include literacy, mathematics, and science, it is evident that Indonesian students require significant changes in learning patterns to catch up with other nations. In response to this challenge,

TPACK-based learning presents itself as a promising solution for teachers. Not only does it offer a novel learning experience, but it also serves as a means for teachers to enhance their pedagogical competence. By mastering TPACK, teachers gain pedagogical advantages, enabling them to design learning experiences rooted in educational principles, learning theories, and tailored strategies that address the unique characteristics of digital-age students. This contextualized approach ensures that content mastery aligns seamlessly with students' familiarity with technology. Moreover, the use of technology is widely recognized for its potential to strengthen professional competence, particularly in fostering classroom innovation.

However, the integration of technology in education remains suboptimal. Teachers have yet to fully exploit internet-based technologies to improve the quality of learning. Furthermore, traditional teaching approaches and strategies often fail to address the diverse needs and characteristics of modern learners. First, students' affinity for technology should not be viewed as a barrier to content mastery or value transmission but rather as an opportunity for deeper engagement. Second, students exist in an era of abundant information, necessitating efficient and simplified approaches that enable holistic and integrative learning. In this context, students' knowledge should transcend disciplinary boundaries, embracing multidisciplinary and transdisciplinary perspectives to equip them with broader, interconnected insights.

The quality of classroom learning depends substantially on teachers' capacity to plan and implement instruction effectively, yet empirical data from national pedagogical competence assessments reveal that many Pancasila and Civic Education (PPKn) teachers in Indonesia consistently score below the established standard, particularly in lesson planning. To address this gap, this community service initiative delivered a structured workshop for PPKn teachers affiliated with the Indonesian Pancasila and Citizenship Education Professional Association (AP3KnI) in East Java, focusing on the development of innovative lesson plans (Rencana Pelaksanaan Pembelajaran/RPP) through the TPACK (Technological, Pedagogical, and Content Knowledge) framework. TPACK was selected for its capacity to integrate subject-matter expertise, pedagogical knowledge, and technological proficiency into a coherent model for instructional design—competencies that are increasingly essential in 21st-century educational contexts yet frequently underdeveloped among practicing teachers. This initiative makes two primary contributions: it directly enhances participating teachers' lesson planning competence through a combination of theoretical instruction, demonstration of innovative learning strategies, and guided hands-on practice; and it generates empirical evidence for the effectiveness of short-term, online, competency-focused professional development as a scalable model for teacher capacity building. Beyond the immediate participants, the findings carry broader implications for regional teacher associations, subject-area professional bodies, and educational policymakers seeking replicable approaches to integrating technology meaningfully into classroom instruction, with the ultimate aim of improving learning outcomes for students in civic education and beyond.

The workshop on designing innovative lesson plans using the TPACK approach for Civics Education teachers is anticipated to offer several key benefits to participants, including:

- Enabling Civics Education teachers to better understand and respond to changes in student dynamics brought about by technological advancements.
- Equipping Civics Education teachers with the knowledge to select appropriate media for learning based on the material to be taught.
- Enhancing teachers' comprehension of models, methods, strategies, and approaches applicable in the learning process to address contemporary changes and developments.

The specific objectives of this workshop are:

- To increase the knowledge and understanding of Civics Education teachers in integrating technology into the learning process, adapting to the evolving conditions and needs of students.
- To foster innovation and creativity among Civics Education teachers in leveraging technological advancements as a source of teaching materials for students.
- To motivate Civics Education teachers to implement TPACK-based learning approaches that incorporate essential skills, such as Higher-Order Thinking Skills (HOTS), literacy, Pendidikan Karakter (PPK), and the 4Cs (critical thinking, creativity, communication, and collaboration).

- To encourage Civics Education teachers to continually strive for the development of their pedagogical competence, ensuring alignment with the demands of modern education.

2. Method

The workshop on designing innovative lesson plans using the TPACK approach was conducted online via the Zoom Meeting platform on June 18, 2021. Participants included Civic Education teachers from junior high schools and senior high schools who were members of AP3KnI. The activity was structured into two main sessions, with the time allocated as follows:

The first session featured an opening speech delivered by the speaker, expressing appreciation and gratitude on behalf of the community service implementation team to the participants for their involvement in the activity. The second session consisted of a presentation by the speaker, divided into several components. These included an overview of foundational concepts and theories in educational science, the role of teachers in the 21st century, and strategies for innovative learning that emphasized teacher creativity and effective teaching methods.

At the conclusion of the workshop, an evaluation was conducted to assess its effectiveness. The evaluation involved a pretest and posttest to measure the pedagogical competence of Civic Education teachers regarding the workshop content. The results of these tests served as the basis for determining the extent of learning and competency development achieved through the activity. The workshop was facilitated by a lecturer who was responsible for the overall implementation, including preparing the proposal, delivering the material, and compiling the workshop report. Two students supported the lecturer in executing the workshop activities.

3. Results and Discussion

3.1. Workshop Implementation

The workshop on designing innovative lesson plans using the TPACK approach was conducted online via the Zoom Meeting platform on Friday, June 18, 2021 as show in Fig. 3 and Fig. 4. Participants included Junior High School and Senior High School Civic Education teachers who are members of AP3KnI. The one-day workshop employed an interactive method, allowing participants to engage in hands-on practice guided by the speaker. The workshop content is outlined as follows.

In the first session, the speaker delivered an opening speech expressing appreciation and gratitude on behalf of the community service team to the participants for their involvement in the activity. The second session featured the presentation of materials, which were organized into several components: foundational concepts and theories of educational science, the role of teachers in the 21st century, and innovative teaching strategies and creativity as approaches to implementing effective learning.

Initially, the speaker discussed the fundamental concepts of educational science that underpin classroom teaching and learning activities. This included theories and principles essential for effective instruction and the critical elements necessary to ensure classroom learning processes run smoothly and achieve the intended objectives. The speaker emphasized that teachers must be adequately prepared to deliver effective instruction by staying informed about current developments and adapting to the evolving demands of the modern educational context.



Fig. 2. Workshop Creating Lesson Plan

Second, the discussion focused on the role of teachers in 21st-century education. In this segment, the speaker emphasized the primary responsibilities of teachers as educators in preparing the core competencies students need to face current and future challenges. This discussion highlighted the evolving role of teachers in the modern era, particularly as they navigate the rapid technological advancements that permeate all aspects of life, including education.

The third segment expanded on the previous discussions by addressing innovative learning as a strategy and approach teachers can adopt to tackle challenges arising from technological developments. These changes are characteristic of the transition from the Industry 4.0 era to Society 5.0, where technology and the internet are integral to daily life and activities. The speaker underscored the importance of innovative teaching practices in responding to these advancements, particularly for Civic Education teachers.

The presentation on 21st-century innovative learning included strategies for designing effective lesson plan. These strategies focus on fostering holistic and integrative student abilities that align with the evolving characteristics and learning needs of students in the 21st century. The speaker highlighted that by incorporating such innovative practices into lesson planning, teachers can better equip students to thrive in an increasingly complex and technology-driven world.



Fig. 3. Screenshot of Workshop Materials

In this presentation, the speaker explains strategies for creating lesson plans using the TPACK approach. This approach is regarded as highly suitable for preparing students to navigate the demands of the modern era and future challenges. It effectively integrates mastery of disciplinary knowledge, lifelong learning skills, and technology use. Moreover, the TPACK approach aims to transform traditional teaching methods commonly employed by Civic Education teachers, such as lecture-based instruction, rote memorization, limited and monotonous learning resources, cognitive-focused evaluations, and didactic practices.

Following the speaker's presentation on developing innovative lesson plans using the TPACK approach, the activity continues with an evaluation. Participants complete a questionnaire via Google Forms, which serves as a posttest to measure their pedagogical competence. This posttest is conducted to assess the effectiveness of the workshop in enhancing participants' teaching competencies, comparing their skill levels before and after the workshop.

3.2. Discussion

Before the workshop on creating innovative lesson plans using the TPACK approach begins, all participants complete a questionnaire provided via Google Forms. The questionnaire primarily assesses participants' understanding of the aspects and components required in lesson plan development, which serves as a guide for implementing teaching and learning activities in the classroom. This pre-activity questionnaire also provides an initial overview of participants' pedagogical competence before receiving

the workshop material. The responses are used to generate pretest scores, aimed at identifying the participants' baseline level of pedagogical competence related to the TPACK framework.

The workshop starts with a presentation by the speaker, who introduces the foundational concepts and theories of educational science necessary for teachers to effectively engage students in the learning process. The speaker then connects these concepts to the teacher's role as an educator in facilitating effective learning experiences and equipping students with the skills needed to navigate changes and developments in the modern era.

The outcomes of this workshop are reflected in the improvement of participants' competencies concerning TPACK components in Civic Education learning tools. This improvement is particularly evident in the lesson plan created by the participants and evaluated by the speaker. The evaluations reveal that while most participants demonstrate progress, many still need to integrate a greater number of TPACK components into classroom learning practices.

In addition to the evaluation based on the workshop participants' lesson plans, the evaluation of this activity is also evident from the pretest and posttest scores of the workshop participants, which can be seen in [Table 1](#), [Table 2](#), and [Table 3](#) below.

Table 1. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	<i>Pretest</i>	6.14	7	3.436	1.299
	<i>Posttest</i>	11.57	7	1.718	.649

^a Source: Output SPSS Versi 25

Table 1 presents descriptive statistics for participants' pedagogical competence scores before and after the workshop. The mean pretest score was 6.14, rising to 11.57 at posttest, indicating a substantive descriptive improvement in pedagogical competence following the intervention. This improvement is consistent with the growing body of evidence demonstrating that structured, need-based training models—including workshops, simulations, and guided classroom practice—can significantly enhance teachers' pedagogical competence when they are designed in direct response to identified professional needs [24], [25]. The present workshop was grounded in precisely this principle, having been developed in response to documented deficiencies in PPKn teachers' lesson planning competence, as evidenced by below-standard national competency assessment scores [10].

Table 2. Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	<i>Pretest & Posttest</i>	7	.972	.000

^b Source: Output SPSS Version 25

To establish the statistical significance of these improvements, [Table 2](#) and [Table 3](#) present correlation and paired-samples test results, respectively. In [Table 2](#), the correlation coefficient between pretest and posttest scores is 0.972, with a significance value of 0.000 ($p < 0.05$), confirming a strong and statistically significant relationship between participants' pre- and post-intervention competence levels. [Table 3](#) further corroborates this finding: the Paired Samples Test yields a Sig. (2-tailed) value of 0.000 ($p < 0.05$), leading to the rejection of H_0 and acceptance of H_a . The mean score difference of -5.429 and a t -count of 7.924 —exceeding the t -table value of 2.447 ($df = 6, \alpha/2$)—confirm that the TPACK-based lesson plan development workshop produced a statistically significant improvement in participants' pedagogical competence. These results are consistent with prior research demonstrating that TPACK-focused professional development effectively enhances teachers' capacity to employ technology-based learning media, address classroom challenges, and strengthen instructional planning, assessment strategies, and classroom management [26]. Furthermore, teachers who participate in structured workshop interventions demonstrate enhanced interaction with students and greater facilitation of participatory, interactive teaching practices [27]. The significance of these gains is further underscored by the recognition that TPACK represents a 21st-century learning model requiring educators to operationalize technology within the learning process—a competence that is increasingly indispensable in contemporary educational settings [28].

Table 3. Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 Pretest - Posttest	-5.429	1.813	.685	-7.105	-3.752	-7.924	6	.000

^c Source: Output SPSS version 25

Fig. 4 presents a comparison of pretest, posttest, and N-Gain scores, providing a visual illustration of the workshop's impact. The N-Gain analysis yields an average score of 0.63 (63%), classifying the workshop's effectiveness in the "moderate-to-strong" category and confirming a meaningful upward shift in participants' competence levels. This finding is reinforced by the calculated effect size of 2.046 (Cohen's d), which falls within the "strong effect" category according to Cohen's [29] established criteria, indicating that the workshop produced a substantial and practically significant impact on participants' pedagogical skills. These outcomes reflect the broader imperative facing the Indonesian education system: with approximately 2.9 million teachers still performing below the Standar Kompetensi Minimum, targeted, evidence-based professional development of the kind demonstrated here is not merely beneficial but structurally necessary [10]. Moreover, in an era characterized by rapid technological transformation and the rise of the digital native generation, the competence and quality of teachers in navigating 21st-century educational technology have become critical determinants of student engagement and learning outcomes [30]. The TPACK framework directly addresses this imperative by equipping teachers with an integrated model of technological, pedagogical, and content knowledge [20].

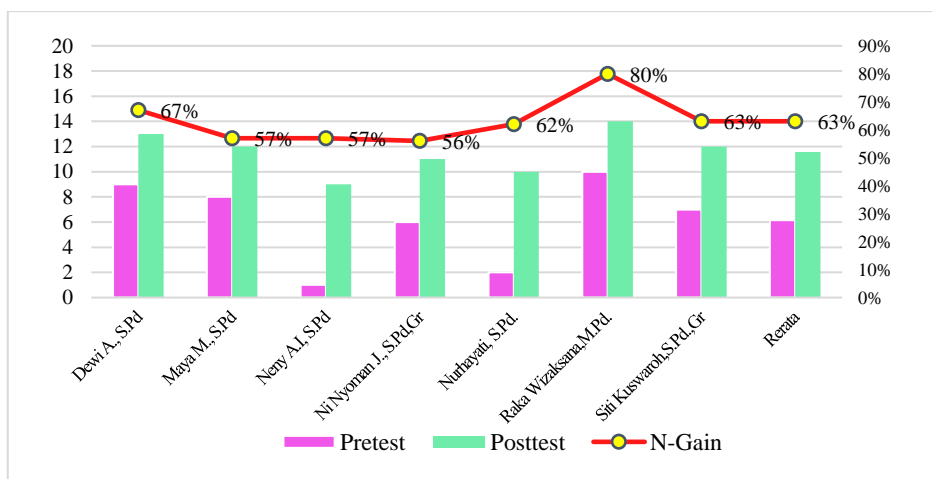


Fig. 4. Comparison of Pretest-Posttest and N-Gain Scores

Table 4, which outlines Cohen's effect size categorization criteria, provides further validation of these results, confirming that the workshop's implementation significantly and effectively contributed to participants' professional development.

Table 4. Interpretasi Effect Size Criteria

Size	Interpretation
0 - 0.20	Weak Effect
0.21-0.50	Modest Effect
0.51-1.00	Moderat Effect
>1.00	Strong Effect

^d Source: [31]

As shown in Table 4, the implementation of the innovative lesson plan creation workshop using the TPACK approach is highly effective in enhancing the pedagogical skills of Civic Education teachers. The workshop successfully meets its objectives, demonstrating significant effectiveness and promising benefits

for the participants. These benefits include improved delivery of materials and implementation of learning in the classroom. This aligns with the TPACK mastery criteria, which emphasize integrating technology effectively with teaching and learning processes [21].

The improvement in Civic Education teachers' pedagogical skills enables them to incorporate technological advancements and innovations into the classroom. By aligning learning materials, media, and methods effectively, teachers can create a more engaging and effective learning environment, helping students to better comprehend the material.

In addition to the presentations and discussions led by the speakers, participants engaged in dialogues about challenges and obstacles they face during the teaching process. Feedback was also gathered from participants regarding the workshop's implementation and their assessment of the speakers. The insights from this feedback are visually represented in Fig. 5, Fig. 6, and Fig. 7, providing additional evidence of the workshop's impact and reception among participants.

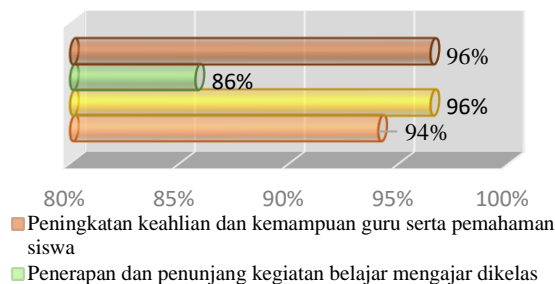


Fig. 5. Participants' achievements after attending the workshop

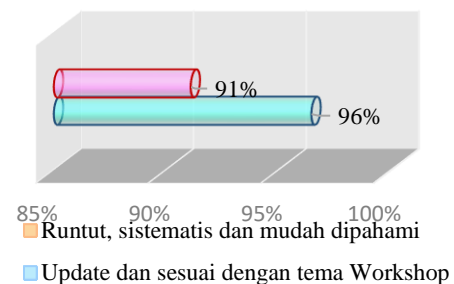


Fig. 6. Presentation of Resource Material

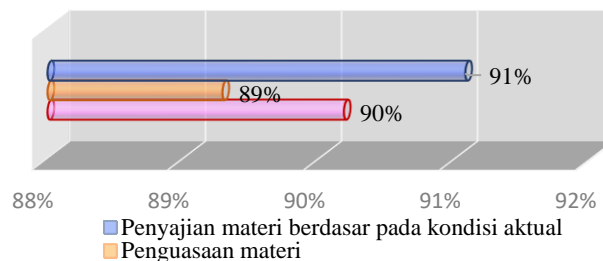


Fig. 7. Speaker Performance

Fig. 5, Fig. 6, and Fig. 7 report participants' overall satisfaction with the workshop, with an average response score of 93%, placing it in the "very satisfied" category. Participants expressed high levels of satisfaction across all evaluated dimensions, including the relevance and quality of workshop materials, the effectiveness of speakers' delivery, and the perceived practical benefits of the content. This high satisfaction rate is noteworthy, as participant engagement and positive perception are recognized prerequisites for the transfer of training to actual classroom practice [32], [33]. Reflective practices embedded within training programs—such as structured self-assessment and iterative feedback—are particularly critical in helping teachers align newly acquired strategies with their existing pedagogical approaches, thereby consolidating competence gains over time [32]. These results collectively confirm that the TPACK-based lesson plan development workshop was both rigorously implemented and highly effective, as evidenced by the convergence of quantitative competence gains and high participant satisfaction. The findings further align with the arguments advanced by Warjito [34] and Santoso [35], who emphasize that workshops targeting lesson plan development yield their most sustained effects when complemented by academic supervision and structured individual mentoring programs—follow-up mechanisms that ensure ongoing quality improvement in teaching practice and continued growth in pedagogical competence.

4. Conclusion

The workshop on designing innovative lesson plans using the TPACK approach demonstrates an increase in the pedagogical competence of Civics Education teachers by integrating technology into the learning process, aligning content and materials with the methods used, and aiming for effective education and learning outcomes. The pretest and posttest results indicate a significant improvement in participants' pedagogical competence, with posttest scores substantially higher than pretest scores, showing a statistically significant difference. The effectiveness of the workshop is further evidenced by the calculated t-value (7.924), which exceeds the t-table value (2.447), and an average N-Gain score of 0.63, corresponding to a 63% improvement. These results place the workshop's effectiveness in the moderate category. Overall, the workshop successfully enhances participants' pedagogical competence, particularly in understanding and applying the components of TPACK by integrating technology into the learning process and adapting instructional strategies to the materials taught. The outcomes suggest that such workshops can effectively support teachers in improving their teaching practices and achieving better learning outcomes.

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Declarations

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Conflict of interest. The authors declare no conflict of interest.

Additional information. No additional information is available for this paper.

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