

Training on Developing Lesson Plan Through Utilizing Deep Learning Technology within the TPACK for Sociology Teachers in Karanganyar Regency

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Abstract

Background: The improvement of sociology learning quality at the Senior High School level requires teachers to be able to integrate pedagogical technology and content comprehensively and contextually.

Aims: This research is designed to equip teachers with the skill to develop teaching modules based on the utilizing deep learning technology within the TPACK.

Methods: Training was carried out in four stages: strengthening concept, composing modules, learning simulation, and feedback and reflection. The training method was participatory and contextual in nature, by emphasizing direct practice and collaboration between participants.

Results: The result of training shows that teachers experience significant improvement in comprehending TPACK and are capable of composing lesson plans that integrate sociological content, reflective and problem-based approach. Evaluation outcomes revealed a significant improvement in participants' comprehension, with average scores increasing from 70 (pretest) to 90 (posttest). The product yielded reflects in-depth contextual learning and involves technology use meaningfully. This training contributes to the transformation of teachers' role as the facilitator of learning in digital era.

Conclusion: The implication involves improved professionalism, digital literacy, and strengthened contextual learning strategy. The training resulted in an average increase of 20 points, signifying a shift in teachers' views on the holistic utilizing of technology, pedagogy, and content. The recommendation based on this activity is the need for sustainable facilitation and training model replication for other social science subjects.

A. Introduction

Sociology is the study about social life, social change, social causes and consequences of human behavior (Pike et al., 2017). Sociology attempts to investigate and comprehend the structure of groups, organizations, and societies and how people interact in social contexts (Serpa & Ferreira, 2019). Therefore, sociology learning requires an in-depth approach to enable the students not only to memorize concepts but also to apply them in real life. To achieve this, the utilizing deep learning technology within the Technological Pedagogical Content Knowledge (TPACK) is a relevant approach. Deep Learning helps students comprehend sociological concepts critically and analytically (Gilje, 2020), while TPACK ensures that the use of technology in learning is carried out effectively by considering pedagogical and content aspects (Latip et al., 2023).

The development of technology in the educational world requires teachers to adopt innovative approaches in learning. Deep Learning results from simple procedures that teachers can use to make learning more holistic, critical, and analytical (Hermes & Rimanoczy, 2018). Sociology, as a science studying social dynamics, requires an analytical and evidence-based learning approach. Utilizing Deep Learning, teachers can process and analyze social data in more depth, so that students can understand social phenomena with a more accurate data-based approach (Schmidhuber, 2015).

The TPACK framework emphasizes the balance between technology, pedagogy, and content in the learning process. Through the utilizing deep learning technology, teachers not only master sociology material, but are also capable of developing more innovative learning strategies, including the use of *machine learning* to analyze social trends or AI-based *chatbots* as discussion aids in class (Molina & Garip, 2019). Deep learning allows the development of a more personalized learning system (Damanik & Muhammad, 2025). With student data analysis, teachers can adjust teaching materials based on individual learning styles and levels of understanding. This can increase the effectiveness of sociology learning, because students gain learning experiences more suited to their needs.

Teachers need to apply TPACK and deep learning approaches because both complement each other in creating a contextual, adaptive, and meaningful learning process. TPACK used in learning can be applied in the attempt of improving the students' learning experiences related to the subject matter presented to make it more understandable (Hamid et al., 2023). In today's digital era, the students need not only mastery of subject matter, but also the ability to think critically, creatively, and reflectively. Using the TPACK approach, teachers can integrate technology appropriately with pedagogy and content to make learning more interactive and relevant to the students' lives (Aksin, 2023). Meanwhile, deep learning encourages the students to understand concepts deeply, explore meaning, and develop high order thinking skills, such as analysis, evaluation, and synthesis (Anwar, 2017).

The combination of these two approaches not only increases the students' motivation and engagement, but also has been empirically proven to improve their learning outcomes significantly. Integrating deep learning into high school sociology education offers transformative potential to equip the students with critical analytical skills, problem-solving abilities, and a deeper understanding of social phenomena (Damanik & Muhammad, 2025). Deep learning technology allows for a more personalized and adaptive learning experience, while a positive psychological approach enhances the students' motivation and psychological well-being (Hartoyo & Murtaqi, 2025). Integrating deep learning into lesson plan helps teachers and students develop critical thinking, data analysis, and technology-based problem-solving skills. These skills are essential in facing social challenges in the digital era and supporting students in understanding and respond to social change in a more thoughtful and evidence-based manner.

Currently, the curriculum in Indonesia emphasizes flexibility in the learning process and the development of materials that are relevant to students' needs. The use of deep learning-based technology in lesson plans helps teacher design project-based learning, problem-based learning, and interdisciplinary approaches the Freedom Curriculum (Indonesian: *Kurikulum Merdeka*). Utilizing Deep Learning, the teachers can conduct automatic analysis on the students' learning progress through evaluation data collected systematically (Mutzel & Ollion, 2024). This technology helps provide faster, more accurate, and data-based feedback to enable the teachers to adjust teaching strategies more effectively.

The results of the observation show that the teachers have limitations in the concept of deep learning particularly in its implementation. In addition, the Deep Learning program in mathematics education gave participants a foundational grasp of Deep Learning, ignited teachers' creativity, and paved the way for the creation of a virtual learning community (Sugandi et al., 2025). Deep Learning is a part of artificial intelligence using artificial neural networks to analyze data in a complex way. Many sociology teachers have not had a deep understanding of how this technology works and applied in learning. The results of the research showed that learning sociology by utilizing learning media matching the students' needs can increase learning interest and outcomes (Sastri, 2021). The results of research showed that the senior high school students' level of familiarity with artificial intelligence was quite high in the context of learning (Susmita et al., 2024; Kholis & Muhtadibillah, 2025).

Therefore, the development of lesson plan through the utilizing deep learning technology within the TPACK is a strategic step for sociology teachers to improve the quality of technology-based learning. Using this approach, the teachers can create more engaging, data-based, and student-oriented learning experiences, while preparing them to face the challenges of the digital world more critically and analytically.

B. Methods

The method of implementing training for developing lesson plans for Sociology teachers through integrating in deep learning with the TPACK approach is designed with a collaborative, participatory, and practice-based approach. Thus, the training method employs participatory action, highlighting cooperation among teachers and facilitators to foster significant improvements in the educational setting. This training is carried out in several stages: (1) strengthening the understanding of TPACK and deep learning concepts, (2) guidance in compiling lesson plans based on learning outcomes and graduate profile dimensions, (3) simulation of module implementation using supporting technology, and (4) reflection and evaluation between teachers in a practice community. This approach refers to the adaptive and reflective platform-based training model that evidently improves the understanding of concepts and motivation of the senior high school teachers (Hartoyo & Murtaqi, 2025). In deep learning can encourage the teachers to design learning concentrated on essential understanding, contextual problem solving, and strengthening student character (Nugraha & Hasanah, 2021). Meanwhile, the TPACK approach is used to select relevant strategies, methods, and technological media to compile lesson plans that is not only informative, but also transformative and contextual. Professional learning community-based training, in this case Subject Teacher Working Group (Indonesian: MGMP) of Sociology, is useful for sharing and reflecting on learning practices (Hardanti et al., 2024). This approach can result in increased pedagogical skills of sociology teachers, thereby helping produce lesson plans appropriate to students' needs.

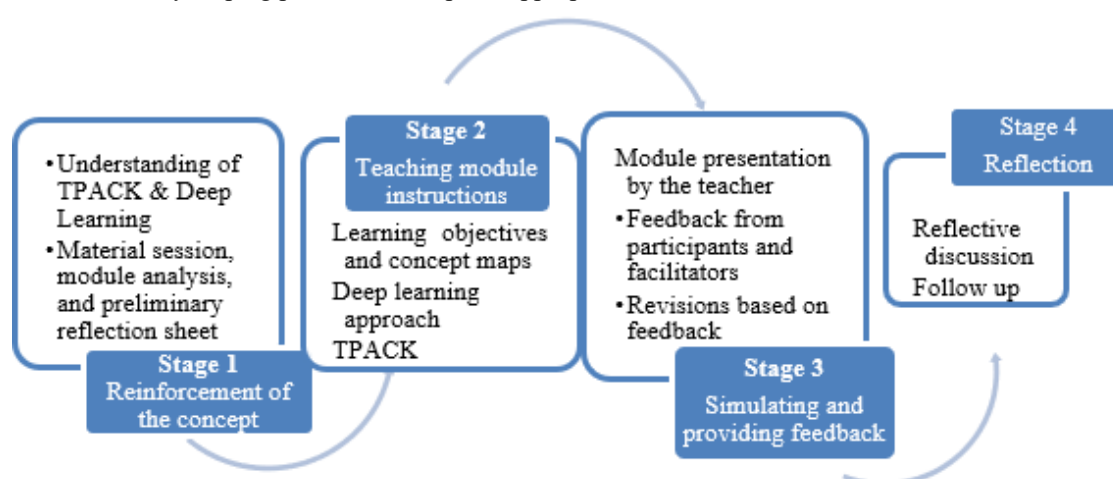


Figure 1. Training Implementation Stage

The first stage, strengthening the concept of TPACK and deep learning, aims to build teachers' understanding of the theory and basic principles of TPACK and deep learning. The activities carried out include attending material sessions, analyzing examples of sociology lesson plans, filling out initial reflection sheets, and doing pretest and posttest related to their experience in using technology and learning practices. The second stage, guidance on compiling lesson plan, is that teachers compile integrative and contextual sociology lesson plans. The activity involves teachers designing learning objectives and concept maps of sociology material. Thereafter, a method was chosen in accordance with the deep learning approach. The important thing regarding this activity is that the teachers ensure that they integrate relevant technology to support learning activities. Furthermore, the teachers use the TPACK format as a design framework running concomitantly with learning materials and activities.

The third stage, simulation and feedback, is to test the feasibility of teaching modules so that it can be used in learning. Training activities include conducting learning simulations in small groups (peer-teaching) involving 10 teachers in one group. The criteria for inclusion focused on teachers who have a background in sociology and sociology education, possess Certificate 4, have been active MGMP members for over five years, and hold a teaching certificate. Teachers who hold a sociology teaching certificate but do not have a background in sociology or sociology education were included in the exclusion criteria. In peer-teaching, the selected teachers present the learning flow and strategies of the teaching module that has been prepared. Participants who were not selected provide feedback regarding the effectiveness of integrating TPACK with deep learning. Furthermore, teachers and their groups revise the module based on the input provided. The fourth stage, reflection and strengthening the community of practice, is to foster collaborative culture and sustainability of good practices. Resource persons and participants reflect together on the

changes in understanding and challenges faced during the training. Then, a follow-up plan is prepared for development in the school-level learning community or through MGMP. Descriptive analysis of pretest and posttest was conducted to assess the growth in conceptual understanding, whereas reflection and discussion sheets were qualitatively analyzed to determine changes in teachers' attitudes and learning practices.

C. Results and Discussion

1. Results

The training, implemented in 4 stages shows real and constructive results. This can be measured from the compilation of 3 lesson plans that can be implemented in sociology class. The lesson plans come from 3 peer teachings that have gone through a process of feedback and reflection. In the first stage, teachers gain conceptual reinforcement on the TPACK framework and deep learning principles. The teachers begin to understand the importance of technology not merely as a visual aid, but also as a strategic media integrated with content and pedagogical approaches. Initial reflections show that most teachers were previously more accustomed to using technology partially, and after the training session, the teachers realized the need for more systemic technology utilizing.

Based on pretest and posttest results showing significant improvement, these data indicate that the training has a positive impact on increasing teacher understanding of the concept of TPACK and deep learning. Almost all participants experienced an increase of about 20 points, indicating the effectiveness of the training method based on direct practice and reflection.

In the second stage, teachers begin to compile lesson plans by referring to learning outcomes and graduate profile dimensions. The lesson plans feature project-based learning activities, case studies, and contextual social problem solving. An example of a contextual module is the analysis of the impact on social differences due to digital urbanization. The learning activities presented encourage students to observe these social phenomena through exploring social media and discussing through Padlet. Thereafter, students discuss and write in the form of infographics using Canva or Google Slides. In this learning process, the teacher's use of technology is in line with the theme, fostering collaboration and reflection.

The simulation and feedback stage is carried out through peer-teaching, where teachers practice learning from the selected teaching module to get evaluation from colleagues and facilitators. Teachers demonstrate the ability to organize a logical flow of activities, using relevant technology, and developing high-order thinking skills (HOTS) triggering critical discussion among the students. Several modules were revised based on feedback, such as refining project instructions, adjusting the level of exploratory questions, and selecting more appropriate digital media.

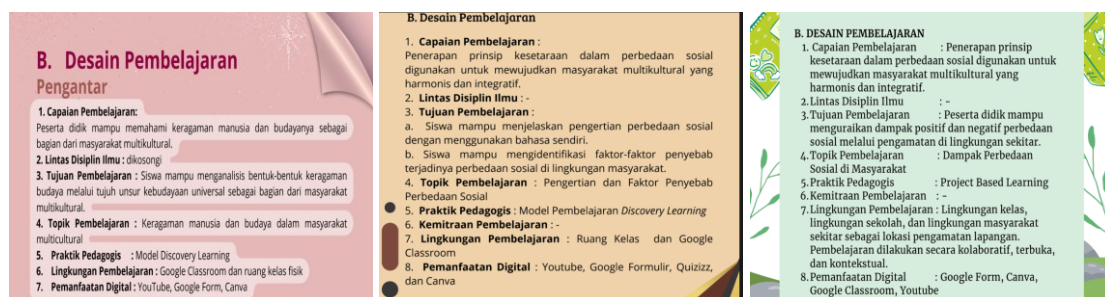


Figure 2. Example of a Teaching Module Developed by a Teacher

In the fourth stage, teachers conduct collective reflection on the training process and results. The results of reflection show an increase in teachers' motivation and confidence in compiling and implementing innovative and contextual lesson plans. The learning community is the key to sharing and discussing the implementation of lesson plan in the classroom. The resulting lesson plans are expected to enable the students to discuss more actively, connect sociology material to local social issues, and show an increase in the results of applicable project assignments.

Based on the significant differences between pretest and posttest results, these data indicate that the training has a positive impact on increasing the teachers' understanding of the concept of TPACK and deep learning. Almost all participants experienced an increase in score by 20 points, implying the effectiveness of the training method based on direct practice and reflection (see figure 3).

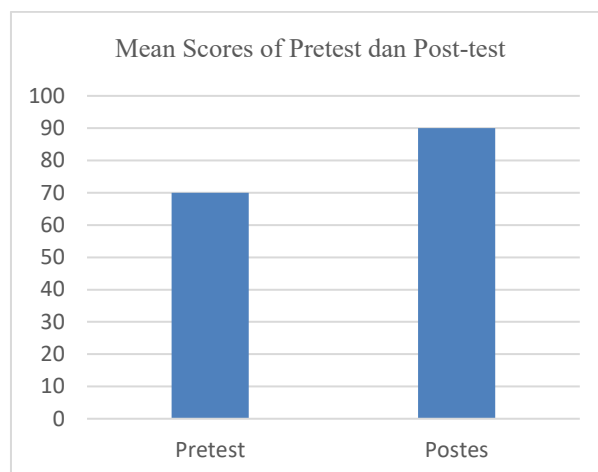


Figure 3. Mean Scores of Pretest and Posttest

In general, this training has successfully developed in compiling teaching materials. Teachers' capacity not only in accordance with curriculum needs, but also capable of activating the students' potential through meaningful and technology-based learning. This success indicates that the integrative approach between TPACK and deep learning is an appropriate strategy in the development of sociology teachers in the digital era.

2. Discussion

The training results showed that teaching modules developed by integrating deep learning and TPACK significantly improved Sociology teachers' pedagogical skills and conceptual understanding. The training's success in transferring knowledge and shifting teachers' mindsets, particularly regarding the holistic utilizing of technology, pedagogy, and content, is reflected in the average 20-point increase in pretest and posttest scores. Educators who had relied on technology solely as a visual aid started to acknowledge its strategic importance as a key component of transformative learning strategies. The teaching modules created by the participants embody this comprehension, incorporating project-based learning strategies, case studies, and contextual social problem-solving, while using digital media that aligns with the needs and traits of contemporary students.

Moreover, the training process rooted in practical experience and reflection via peer-teaching simulations has effectively cultivated a culture of mutual feedback, bolstered the MGMP learning community, and enhanced teachers' confidence in creating and applying relevant and contextual teaching modules. Students' motivation and comprehension of innovative learning approaches can be enhanced through reflective practice-based learning (Widiansyah & Saputra, 2021). Other studies highlight the significance of in-depth learning for fostering students' fundamental understanding of concepts and their ability to critically address social problems (Schmidhuber, 2015). This training has already resulted in an enhancement of teachers' digital literacy, indicating the necessity of preparing educators to use technology for social data analysis (Molina & Garip, 2019), even though it has not yet advanced to the stage of incorporating artificial intelligence.

Consequently, this training generates a final product in the form of a ready-to-use teaching module and establishes a new framework for teachers to create sociology lessons that are more reflective, adaptive, and data-driven. The changes reflect the effectiveness of the TPACK-based training method and deep learning in meeting the challenges of sociology learning in the digital age.

2.1. Implications

Training on developing lesson plans based on the utilizing deep learning technology within the TPACK has important implications for sociology teachers' improved pedagogical capacity, especially in responding to the changes in learning paradigms and national curriculum approaches. Teachers become more aware that the use of technology is not merely about displaying visual materials, but also an integral part of creating collaborative, reflective, and meaningful learning experiences (Aksin, 2023). Another implication is the teachers' increased ability in designing learning that fosters critical thinking and social awareness in students through an in-depth learning approach by inviting students to relate sociology material to real life-contexts (Subekti et al., 2022).

This training has an impact on the transformation of sociology teachers' teaching practices at the senior high school level. An important implication is the growth of teachers' pedagogical awareness of the importance of integrating content, teaching strategies, and learning technology in designing a complete and meaningful learning experience. The application of TPACK approach encourages teachers to no longer treat technology as an isolated tool, but as an integral part of instructional design (Fredlina et al., 2021). In addition, understanding the principles of deep learning makes teachers more focused on essential learning objectives and high-order thinking processes. Teachers have started to abandon one-way teaching patterns and switch to learning models based on social problem solving and student reflection in line with the spirit of deep learning. This implies that teachers were starting to position themselves not only as the bearer of material, but also as the facilitator in the process of creating deep, critical, and contextual understanding among the students.

Furthermore, this training also implies the need for increased institutional support so that good practices developed during the training can be implemented systemically in schools. The results of the research showed that support from the principal and the professional community greatly determines the successful implementation of teacher training results (Siregar et al., 2024). Thus, this training not only changes the teachers' technical skills in compiling lesson plan, but also changes the paradigm and pedagogical orientation towards learning that is more relevant to the characteristics of students as a digital generation (Leba et al., 2024).

2.2. Research Contribution

This training activity contributes to two dimensions. Firstly, professionally, teachers get direct experience with compiling lesson plans combining content, pedagogy, and technology dimensions in accordance with the principles of TPACK. This enriches learning innovation and encourages the implementation of curriculum through a concrete in-depth learning approach (Hamid et al., 2023). Secondly, in terms of strengthening a collaborative culture, the establishment of a teacher practice community becomes a forum supporting the sustainability of innovation and joint reflection on learning practices (Hartoyo & Murtaqi, 2025). This shows that training not only focuses on the output of teaching, but also builds a support system between teachers for sustainable improvement. This is because of limited facilities and infrastructure in schools to support TPACK-based learning (Nabila et al., 2025). This process encourages teachers to align learning strategies with the use of appropriate digital media supporting learning objectives. Teachers get direct experience with compiling lesson plan based on TPACK and contextual integration.

Secondly, in terms of strengthening collaborative culture, the establishment of a teacher practice community serves a forum to support the sustainability of innovation and collective reflection on learning practices (Hartoyo & Murtaqi, 2025). This indicates that training not only focuses on the output of teaching products, but also builds a support system among teachers for sustainable improvement. The professional learning community becomes a reflective space where teachers can share good practices between teachers, with the potential to improve the quality of learning collectively. In addition, collaboration within this community encourages teachers to continue learning and to adapt to the challenges of learning in digital era. Another equally important contribution is the teachers' increased awareness of their role as agents of educational change not only mastering the content, but also being capable of managing strategies and technology in a humanistic and meaningful learning process.

2.3. Limitations

Despite the positive results, the training still has several limitations. The main limitation is, among others, the relatively short training time, so that not all teachers have time to implement their lesson plans in their entirety in class and evaluate the results systematically. In addition, the teachers' ability to integrate digital media is also unequal. Some teachers still need technical support in using design-based or collaboration-based digital platforms. This indicates the need for further training emphasizing gradual technical assistance.

2.4. Suggestions

Based on the implications, contributions, and limitations of this training 4 recommendations are proposed. Firstly, post training assistance is required, e.g. through coaching, peer supervision, or lesson study to ensure that the implementation of teaching module is effective. Secondly, the training should be expanded to other subjects in the social sciences because the characteristics of content are in line with the principles of deep learning based on contextual social issues. Thirdly, an online learning community based on subjects needs to be established to allow the exchange of modules, class reflections and discussions related to the

implementation of TPACK and deep learning. Fourthly, sustainable improvement should be made to teachers' digital literacy, through task-based micro-training and case studies to reduce the gap in technological capabilities among teachers and between teachers and students.

D. Conclusion

The training on developing sociology lesson plans based on the utilizing deep learning technology within the TPACK implemented in 4 stages has shown significant results in improving teachers' professional capacity. Teachers are not only able to understand the concept of TPACK and deep learning theoretically, but also apply it directly in the design and simulation of innovative and contextual lesson plan. This activity not only provides products in the form of lesson plans that can be directly implemented in the classroom, but also builds a spirit of collaboration and reflective culture among teachers through the practical community established. In the future, this activity's sustainability can be achieved through follow-up mentoring and expanding the training model to other subjects with the same social contextual character. Thus, this training can be a model of good practice in developing the teaching profession that is responsive to curriculum demands and the 21st century's needs.

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F. Author Contribution Statement

ACB designed the idea and design of the training activities, compiled the conceptual framework of the article, and wrote the introduction and results of training. SIL is responsible for the technical implementation of the training, documentation of activities, and preparation of the methods section and analysis of training findings. BNP carried out literature review, integration of scientific references, final editing of the manuscript, and preparation of the manuscript for the publication process.

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