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Design of a New TPACK-SAMR Pedagogical Training Model Based on MOODLE to Develop 21st-Century Learning Design Skills

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Abstract: This study aims to develop and validate a new MOODLE-based TPACK-SAMR pedagogical training model to enhance teachers' competence in designing learning scenarios that foster 21st-century skills. This research and development study adopted the Borg and Gall model and was conducted at Satya Wacana Christian High School using a mixed-methods approach. The participants consisted of 12 teachers and one principal. Qualitative data were collected through interviews, document analysis, observations, questionnaires, and focus group discussions (FGDs), while quantitative data were obtained through questionnaires and pretest-posttest assessments. Qualitative data were analyzed using thematic analysis involving data reduction, data display, and conclusion verification. Quantitative data were analyzed using descriptive statistics, including scoring, percentages, and categorization, while the effectiveness of the training model was evaluated using inferential statistical analysis. The study resulted in a validated MOODLE-based TPACK-SAMR pedagogical training model designed to strengthen teachers' capacity to develop 21st-century learning scenarios. The model achieved an average validation score of 95.02% (Excellent) from two instructional design experts and 84.98% (Good) from one e-learning expert. In addition, participants' evaluation of the training model reached 95.21% (Excellent). The post-test results showed a statistically significant improvement in teachers' competencies (Sig. = 0.000, $p < 0.05$), indicating that the proposed MOODLE-based TPACK-SAMR pedagogical training model effectively enhances teachers' ability to design 21st-century learning scenarios. This model contributes to teachers' professional transformation from technology users to digital learning designers capable of developing students' Higher-Order Thinking Skills (HOTS) and 21st-century 4C competencies. Consequently, it provides an innovative pedagogical framework for strengthening teachers' digital pedagogical competence and addressing the evolving demands of education in the era of digital transformation.

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Introduction

The massive development of technology has brought impact to a wide range aspects of living. It changes the way people work, interact, and obtain information. Digital transformation, job automatizing, and artificial intelligence change the way people work, in term of method and location (Alarcón et al., 2025); (Çelik, F., & Baturay, 2024). There is a high demand that the world of education can help and prepare students to master knowledge and improve their skills needed to respond to the challenge of digital economy (Ebom-jebose, 2025) improving teachers' professional digital competence to deal with society transformation, more importantly to get students ready for the unknown future challenges.

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Students 'capability to respond to challenges brought up by the era of digital economy is determined by their skills in using technology acquired from learning activities at school as well as independent study. (Abduvakhidov et al., 2021)

In response to the development of technology and the demand of 21st century development, teachers are required to adapt their lesson plan and learning activities, integrating moral values and Higher Order Thinking Skills (HOTS) (Waruwu et al., 2025); (Misla & Mawardi, 2020) implementing pedagogical principles in order that students experience effective learning to improve attitude, knowledge, and skills according to the learning objectives (Mawardi et al., 2021).

Teacher should also improve their professional competence that enable them to plan meaningful and interesting learning activities for their students (Supriyanto & Mawardi, 2020). Training related to 21st century skills, Higher Order Thinking Skills (HOTS), and independent learning is substantial to help teachers acquire pedagogical competence which is beneficial for effective lesson planning. Furthermore, teachers must equip themselves with online learning competence and skills in using digital technology (Karatas & Arpaci, 2021). Nambiar et al., (2019) stated that despite the reformation of curriculum in Indonesia to accommodate 21st century skills in teaching approaches, teachers have not been provided with sufficient training for the implementation of the curriculum (Nambiar et al., 2019).

As teachers show their ability to integrate their pedagogical knowledge and digital skills properly, they will be able to help students developing a set of skills they need to respond to the challenge of the era of digital economy. Awareness about Technological Pedagogical and Content Knowledge (TPACK) framework helps teachers to choose an appropriate teaching and learning technology to apply in teaching certain topics. TPACK framework explain how a teacher's knowledge about the content material, his pedagogical competence, and the knowledge about using technology overlapped and interrelated in a teaching and learning situation. TPACK is a foundation for effective learning activities integrating technology, it supports a teacher's decision in choosing certain teaching approach and strategies (Bibi & Khan, 2017).

The 21st century learning is designed and implemented to help students acquiring knowledge as well as developing 4 C (Critical Thinking, Creativity, Collaboration, Communication) skills (Pramono et al., 2023). In order to achieve this goal, teachers must be provided with a training to introduce a model of technology integration in learning known as Substitution Augmentation Modification and Redefinition (SAMR) model (Nair & Chuan, 2021). The integration of TPACK framework and SAMR model in teaching and learning process can promote the development of 21st century skills. SAMR model illustrates the impact of technology integration on each level, starting with improving teaching efficiency, moving toward the level of education transformation involving students' High Order Thinking Skill (Nair & Chuan, 2021). The result of document study on 10 randomly-chosen lesson plans and teaching modules developed by teachers of SMA Kristen Satya Wacana for 2023-2024 academic year in preliminary research shows that TPACK implementation in teaching and learning did not support the development of 21st century skills for teachers utilize technology only as a means presenting teaching materials and conducting multiple choice assessment. This practice shows the implementation of TPACK framework on Substitution level of SAMR model which only enhance the process of information and knowledge transfer, make it more effective.

Data obtained from a survey carried out during the preliminary study shows that 65,2% of the teachers, the subject of the study, often use technology in teaching, while 26,1%

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always do so. However, most of the them mentioned that the were not familiar with TPACK framework (56,5%) and SAMR model (65,2%). Using digital presentation application for delivering learning materials, using quiz application for assessment, social media or Learning Management System (LMS) for organizing learning material or assignment, are the dominant TPACK framework implementation by the teachers. Despite the majority respondents (86,9%) claiming to have participated in teacher training for ICT in teaching and learning, all respondent indicated the need of training for TPACK in teaching and learning.

A Moodle (Modular Object-Oriented Dynamic Learning Environment) -based training is believed to be effective and efficient for organizing learning activities. Using Moodle is more economical and flexible in term of time scheduling (Gamage et al., 2022); (Satyawati, 2020). Moodle platform is confirmed to be an effective learning media due to its interactive features which allow multi-media content sharing, collaboration, feedback, and material review (Aikina ,T.Y., & Bolsunovskaya, 2020). This LMS allows a teacher or training instructor to design the flow of learning activities in a way that enable monitoring of learning activities completion and progress.

This research is crucial in response to the demand of a design of a new model of Moodle based TPACK training in integration with SAMR. This new model of training is expected to improve teachers' competence in designing learning activities which accommodate the procurement of 21st century competence. A design of a new on-line self-paced training model is expected to be effective for the participating teachers considering its flexibility in term of learning time and pace. The absence of this new model design is influential toward the growth of teachers' competence. Teachers would be left incompetent in lesson planning which facilitates the development of 21st century skills. This then lead to the quality of teaching and learning activities and low level of students' 21st century skills. This research is in line with the priority of national research (*Prioritas Riset Nasional-PRN*) in education that is the community transformation in the era of digital revolution.

Grounded on the background problem outlined above, this research proposes a solution to the issue of the lack of teachers' competence in integrating 21st-century skill development (4Cs) into lesson planning, as well as teachers' unfamiliarity to the SAMR framework for integrating TPACK in 21st-century learning scenarios. This research is aimed to develop a new training model of TPACK implementation in learning process in integration with SAMR model which is flexible in terms of learning location and time, as well as being cost-effective.

This new design, compared to the existing TPACK training model, shows the novelty in term of the focus on the taxonomy level of TPACK implementation by incorporating SAMR model to enhance the transformation of 21st century learning. Some existing TPACK training developed in the previous research is a web-based self-directed TPACK training for teacher competence development a practiced-based TPACK training (20), TPACK training for lesson planning (Kayaalp, F., Gokbulut, B., Meral, E., & Basci Namli, 2022); (Teknolojik et al., 2022), and paper-based TPACK training (Wulandari & Iriani, 2018) were developed mainly for TPACK implementation without putting the taxonomy of implementation into consideration. The design of a new Moodle-Based TPACK integrated with SAMR training model is developed to highlight the improvement of teachers' pedagogical competence needed to design lesson plan which foster the development of 21st century skills and HOTS. The scenario, training materials, pre-test, and post-test for this training model are presented in LMS Moodle in order that training participants can access it using PCs, Laptops, or Smartphones using internet connection.

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This study aims to develop a new validated MOODLE-based TPACK-SAMR pedagogical training model to meet the needs of improving teacher competence in designing learning scenarios to develop 21st century skills. This model contributes to the professional transformation of teachers from mere technology users into digital learning designers who are able to develop students' Higher-Order Thinking Skills (HOTS) and 21st-century 4C competencies (Critical Thinking, Creativity, Communication, and Collaboration), thereby addressing the evolving demands of education in the era of digital transformation.

Research Method

This research and development uses the Borg, W. R., & Gall, (1983) model with a mixed method approach with the following procedures: 1) Research and information collecting, including literature studies, field observations, and needs analysis to identify the main problems that need to be solved; 2) Planning, including designing research instruments, collecting and validating data; 3) Developing a preliminary form of product, including determining the model design and model validation testing; 4) Preliminary field testing, to test the practicality and effectiveness of the product; 5) Main product revision, revising the product based on the trial results.

This research took place at SMA Kristen Satya Wacana in Salatiga, This research was conducted at Satya Wacana Christian High School in Salatiga, involving 12 teachers and the principal. Subjects were selected using purposive sampling, taking into account the school's relatively stable internet connection and the teachers' facilities for working online.

Interviews, document analysis, observation techniques, and focus group discussions (FGDs) were used to obtain qualitative data. Quantitative data were obtained using surveys, questionnaires, and tests. Data collection instruments included interview and focus group discussion (FGD) guidelines, observation rubrics, Likert scales, and pre- and post-test instruments. Instrument validation for quantitative data collection using expert judgment methods was conducted by experts to confirm the validity of the questionnaire content. Validity checks for qualitative data were conducted using data sources and data collection. Qualitative data analysis followed the procedures of Miles, M. and Huberman, (1984): data reduction, data presentation, and conclusions. Quantitative data resulting from expert validation of the new Moodle-Based TPACK-SAMR Pedagogical Training Model design were analyzed using descriptive quantitative methods using percentages and categorization. Scores were calculated by dividing the validation score by the maximum score multiplied by 100%. Validation results were classified into the following categories:

Table 1. Score Criteria and Interpretation

Percentage	Category
88% - 100%	Excellent/Completely Valid
71% - 87%	Good/Valid
54% - 70%	Fair/Fairly Valid
37% - 53%	Less than Fair/Not Valid
20% - 36%	Poor/Unacceptable

Source: Sugiyono, 2015

To test the significance of differences between pre- and post-test results, a Paired T-Test (T-Test) was used. The statistical hypotheses used were: 1) H0: $\mu 1 = \mu 2$ (There is no difference in average scores before and after using the product). 2) Ha: $\mu 1 \neq \mu 2$ (There is a difference in the average score before and after using the product). This means that the null

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hypothesis (H0) is rejected if the Sig. Value (2-tailed) is <0.05, which indicates that the new design of the Moodle-Based TPACK-SAMR Pedagogical Training Model improves teachers' abilities in developing 21st-century learning scenarios.

Results and Discussion

Need Analysis

The needs analysis revealed that teachers had already demonstrated adequate technological skills and had participated in various ICT-related professional development programs. However, the integration of technology into classroom practices remained limited to basic functions such as presenting learning materials, administering quizzes, and distributing assignments through digital platforms. Most teachers were unfamiliar with the TPACK framework and the SAMR model, resulting in technology being used primarily as a substitute for traditional tools rather than as a means to transform learning and foster 21st-century skills. Interviews with school leaders and teachers indicated that previous training programs focused mainly on improving technical competencies, with little attention given to pedagogical strategies for meaningful technology integration. Although the school had provided sufficient technological infrastructure and internet access, teachers still experienced difficulties in designing learning activities that effectively combined pedagogy, content, and technology. Consequently, technology integration had not significantly contributed to the development of higher-order thinking skills (HOTS) and 4C competencies among students.

The findings also highlighted teachers' need for a flexible and accessible professional development model. Participants expressed challenges in managing and revisiting training materials distributed through conventional methods. Therefore, a MOODLE-based TPACK-SAMR pedagogical training model was identified as an appropriate solution, offering self-paced learning, organized learning resources, and structured learning activities. Such a model is expected to strengthen teachers' pedagogical competence and support the design of technology-enhanced learning experiences that promote 21st-century skills.

Planning Model Designing

Design of a New MOODLE-Based TPACK-SAMR Pedagogical Training Model is developed to instill 21st Century Skills through teaching learning activities integrating technology. This model is designed by combining two frameworks for technology integration for teaching and learning, those are TPACK and SAMR. The training material consists of explanations on the concepts of TPACK, SAMR, and the implementation of technology at each SAMR level, competency tests, reflections, and action plans. This training model is delivered through the Moodle LMS, which is an open-source application. The pedagogical training material on TPACK - SAMR is presented in six topics, namely: the concept of TPACK, the concept of SAMR, the implementation of TPACK at the Substitution level, the implementation of TPACK at the Augmentation level, the implementation of TPACK at the Modification level, and the implementation of TPACK at the Redefinition level.

Development Model Designing

Based on the procedure design chart of the training, the researcher developed a TPACK-SAMR pedagogical competency training model hosted on the Moodle LMS, which is already owned by the school. The product of the training design development produced in this research is the book titled *"Designing a New TPACK-SAMR Pedagogical Training Model Based on MOODLE to Develop 21st Century Learning Design Skills"*, complete with a user guide to help users implement the model. The book *Designing a New TPACK-SAMR Pedagogical Training Model Based on MOODLE* contains the following sections:

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Introduction, Theoretical Review, Model Concepts, User Guide, Conclusion, Recommendations, and References.

The TPACK-SAMR Pedagogical Training Model Based on Moodle to Develop 21st Century Learning Design Skills book can be accessed at: https://heyzine.com/flip-book/6baa782fb4.html. Separately, the user guide for the training model can be accessed through the link: https://heyzine.com/flip-book/a8f351a2c9.html. The guide explains that in order to join the training activities, both instructors and participants must be registered by the LMS admin as users with specific roles. Instructors will be registered with the role of Teacher, while training participants will be registered with the role of Student.

Users will receive a Username and Password, which will be sent to the email address provided during registration. These Username and Password credentials will be used by participants to join the training class by accessing the login page at: https://sekolahlab.sch.id/eclass/login/index.php. Participants should enter their Username in the "User Name" field and their Password in the "Password" field. After that, they should follow the steps outlined in the guide. The training model is designed as self-paced training module hosted in Moodle LMS. A link navigating to the embedded guide book is provided on the introduction page which will be directing to a digital guide book for the teachers as training participants.

Validation Model Designing

Forum group discussion over the model book and the e-module was carried out for better result. Revision based on the result of the FGD was completed before validation test by experts. Based on expert feedback, revisions made before expert validation included: 1) The symbols of TPACK and SAMR framework sre lain out side by side above a picture ilustrating an IT assisted learning activity, 2) Some passages from the training material in each section completed with examples of learning activities are displayed in the training model book; 3) Citation from three articles are added for profound discussion about the features in Moodle LMS and the effectiveness of the LMS, 4) Reflection section uses 3 What Model by Driscoll (What – So What – Now What), 5) Competence test section for each topic section is placed after lesson menu in which the material is provided and before the reflection assignment section. Before the trial was conducted, the model book was validated by E-Learning Experts and Training Design Experts. The results of the Training Design validation can be seen in the following table.

Table 2. Validation Results of Training Design Experts

No	Assessment Aspect	Score
1	Content Feasibility	95.00%
2	Delivery Feasibility	97.22%
3	Language Feasibility	92.85%
	Average	**95.02%**

Validation results from the training design experts yielded an average score of 95.02% (Excellent), indicating that the proposed training model possesses a very high level of validity. This high score can be attributed to the systematic development process, which was grounded in teachers' needs analysis and supported by the robust theoretical foundations of the TPACK and SAMR frameworks. The strongest aspect was *Delivery Feasibility* (97.22%), suggesting that the training procedures, instructional strategies, and MOODLE-based delivery system were considered highly effective and practical for implementation. These findings imply that the model is highly suitable for use as a professional development

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program aimed at enhancing teachers' capacity to design technology-integrated 21st-century learning experiences.The validation results by the E-Learning expert are shown in the following table.

Table 3. Result of Validation from expert of E-Learning

No	Assessment Aspect	Score
1	Interface Aspect	84.37%
2	Access	83.33%
3	Material Aspect	88.89%
4	Training Efectivity	83.33%
	Average	**84.98%**

The e-learning expert validation yielded an average score of 84.98% (Good), indicating that the MOODLE-based training platform is valid and feasible for implementation. The highest score was achieved in the *Material Aspect* (88.89%), reflecting the relevance and quality of the training content. These results suggest that the platform effectively supports the implementation of the TPACK-SAMR training model, with only minor improvements needed in usability and accessibility.

A limited feasibility test was conducted with 12 subject teachers and 1 school principal from Satya Wacana Christian High School as training participants, showing the results in the following table.

Table 4. Trial Results of the TPACK – SAMR Pedagogical Training Model

No	Assessment Aspect	Score
1	Display Aspect	93.07%
2	Accessibility Aspect	97.43%
3	Material Aspect	93.26%
4	Training Effectiveness Aspect	93.07%
	Average	**95.21%**

The trial results showed an average score of 95.21% (Excellent), indicating a very high level of user acceptance toward the TPACK-SAMR Pedagogical Training Model. The highest score was obtained in the *Accessibility Aspect* (97.43%), suggesting that participants found the MOODLE-based training easy to access and use. These findings imply that the model is practical, effective, and highly suitable for supporting teachers' professional development in designing 21st-century learning.

The average pre-test score of 68.00 increased to 91.20 in the post-test, indicating an increase of 23.20 points (34.12%). All 12 participants experienced an increase in scores. Based on the results of the Shapiro-Wilk test, the Pre-Test data obtained a Sig. value of 0.756 > 0.05, which means the data is normally distributed. Meanwhile, the T-Test results showed that the Post-Test data obtained a Sig. value of 0.000 < 0.05. This means the hypothesis is accepted, indicating that the new design of the Moodle-Based TPACK-SAMR Pedagogical Training Model improves teachers' abilities in developing 21st-century learning scenarios.

Discussion

Training related to 21st-century skills, higher-order thinking abilities, and self-directed learning is essential for teachers today so that with good pedagogical competencies, teachers can design effective learning (Yeliz Bolat, 2024); (Crystal et al., 2024); (Muhammad Izzat Mailis, 2025). The Technology Pedagogical and Content Knowledge (TPACK) framework helps teachers understand how to teach a specific topic by effectively using technology (Yanti, 2024); (Rachel Sullivan, Jordan Wintle, & Natalie campbell, 2024). The TPACK framework provides an understanding of how teachers' knowledge of subject matter,

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pedagogical competencies, and knowledge of using technology intersect and relate in the learning process. TPACK underpins effective learning using technology to help students acquire high-level knowledge skills by utilizing technology and information, and strengthens teachers' decisions in choosing teaching approaches or strategies (Nguyen et al., 2024); (Ahmad Yani , Asep Mulyadi, 2025).

In line with the findings of (Abdykerimova & Assainova, 2024), it is stated that teachers face difficulties in effectively applying digital technology in teaching due to a lack of understanding and relevant skills to integrate digital technology into classroom practices. The application of technology without adequate didactic knowledge only results in the use of technology as an alternative teaching tool without transforming the learning process. Therefore, this practice will not help students develop higher-order thinking skills. Research by (Meroño, L., Calderón, A., & Arias-Estero, 2021) reveals that digital pedagogical training has helped improve teachers' competencies. This emphasizes that pedagogical training integrated with technology competency training is the solution to meet teachers' needs.

The use of Learning Management Systems (LMS) in training will help teachers organize training materials (Hudiah et al., 2024). This is supported by (Laisa & Razilu, 2025), who confirm that Moodle, as one LMS, can be used as a repository for learning materials and a means of distributing information. The LMS used in this training employs the Moodle application. According to (Allison Abel, 2024), Moodle has several advantages as a medium for independent training: 1) Flexibility in time and place: Moodle allows participants to access learning materials anytime and anywhere as long as they have internet access. This is ideal for self-directed learning without fixed schedules, 2) Various interactive features: Moodle provides various features such as quizzes, discussion forums, assignments, and other interactive modules that support active learning. This helps participants learn in-depth in an engaging way, 3) Personalized learning: Moodle allows instructors to customize materials based on participants' needs. The material can be organized progressively according to participants' development, 4) Open-source and cost-efficient: Moodle is an open-source platform, allowing institutions to use it without large licensing fees. Its additional features also allow further development as needed, 5) Monitoring and evaluation features: Moodle provides tools to monitor participants' progress, such as activity reports, assignment achievements, and quiz results. Instructors can easily evaluate participants' progress.

21st-century learning is designed and implemented to master knowledge while also developing 4C skills (Pramono, M.H., Ismanto, B., & Satyawati, 2023). The Substitution, Augmentation, Modification, and Redefinition (SAMR) framework needs to be introduced in teacher training (Nair & Chuan, 2021). The implementation of TPACK integrated with the SAMR model can effectively promote the achievement of 21st-century skills. The SAMR model illustrates the impact of technology integration stages, from levels that increase effectiveness to stages that transform and involve higher-order thinking skills (HOTS) (Blundell et al., 2022).

Each training session is structured into three parts: the explanation of TPACK concepts and their implementation, competency tests, and reflections. These allow participants to assess the success of their training and make improvements, ensuring that they acquire the expected skills. A study by Zhang, (2023) shows that training based on the TPACK framework can improve teachers' knowledge transfer abilities, particularly through structured approaches such as the use of smart tools, practice-based pedagogy, and microlearning integration. The reflection component in this training helps participants

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evaluate and improve their performance during the training process. Meletiou-Mavrotheris and Paparistodemou (2024) describe how reflection and competency tests are applied in TPACK-SAMR-based training. This research emphasizes the importance of reflection sessions to allow teachers to evaluate their achievements and develop improvement plans, in line with the principles of competency-based and reflective learning.

The new TPACK-SAMR pedagogical training model has been validated by learning design experts and IT, E-Learning experts with an "excellent" category, indicating that this research product is suitable for use as a training model to help teachers design 21st-century learning. According to AERA (American Educational Research Association) (2018), validation by experts in research, especially in the development of models or products, is crucial for several reasons: 1) Accuracy and reliability: Validation by experts ensures that the research product or model meets the expected quality standards. This reduces potential errors or weaknesses that might not be visible to the researcher, 2) Increased credibility: By receiving approval or feedback from experts in the relevant field, the research product will be more accepted and valued by the academic and professional community. This validation strengthens the credibility of the research, 3) Relevance and alignment with best practices: Experts can provide perspectives on how the research product or model aligns with best practices in the field, particularly in technology and education, 4) Field acceptance: Research products that have been validated by experts are often more easily accepted by end users, such as teachers or practitioners, because they see validation from competent authorities.

The trial results with potential users indicate a very good outcome, showing that teachers have a strong need for the training model. This new training model is developed as a self-regulated and self-paced training. The result of preliminary field test shows that the users, teachers as the training participants, find the training model as effective, as the score of training effectivity is 93% falling into the category of excellent. (Goldstein, I. L., & Ford, 2002) stated that one factor contributing training effectivity is the appropriate choice of training approach. Self regulated training is mostly used in institution for resource development due to its time and place flexibility.

Conclusion

This study successfully developed and validated a MOODLE-based TPACK-SAMR Pedagogical Training Model to improve teachers' competence in designing 21st-century learning. The validation and trial results indicate that the model is feasible, practical, and effective for implementation. The model contributes to teacher professional development by strengthening teachers' ability to integrate technology, pedagogy, and content knowledge in ways that foster HOTS and 4C skills. Theoretically, it extends the integration of TPACK and SAMR in teacher training, while practically providing a flexible and scalable strategy for supporting educational digital transformation.

Recommendation

1) Schools should implement this model for teacher professional development and further develop training materials for more diverse distribution methods.
2) Educational policymakers are recommended to integrate technology-enhanced pedagogical training, particularly TPACK-SAMR-based programs, into teacher professional development initiatives. Providing sustainable access to Learning Management Systems (LMS) and supporting continuous digital competency

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development can help teachers effectively design and implement 21st-century learning in schools.

3) Further research evaluating implementation would be invaluable for improving the model.

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