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Science Teachers' Learning Management Competency through Professional Learning Communities to Promote Scientific Creativity and Sustainable Development Goals (SDGs)

Supattra Unyaphatariyakool[1], Chowwalit Chookhampaeng[1,], Jiraporn Chano[1], Chi Cheng Wu[2]*

[1]Mahasarakham University, Thailand
[2]Kun Shan University, Taiwan
Correspondence: E-mail: chowwalit@hotmail.com

ABSTRACT

This study examined guidelines and needs for developing science teachers' learning management competency through a professional learning community approach to promote secondary students' scientific creativity and support Sustainable Development Goals (SDGs). Data were collected from experts and science teachers using interviews and a questionnaire. Qualitative data were analyzed inductively, whereas quantitative data were summarized using means and standard deviations. The findings showed that the proposed training curriculum should integrate curriculum objectives, content, active learning, collaborative lesson development, authentic assessment, and reflection. Teachers reported a high development need, particularly for internet-based information searching, technology-supported instructional media, and varied teaching techniques. These findings guide sustainable teacher professional development and quality science education.

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1. INTRODUCTION

Effective teacher professional development should combine theoretical knowledge with authentic classroom practice. Evidence indicates that professional development becomes more meaningful when teachers actively participate, reflect on their teaching experiences, and apply new knowledge in real instructional settings [1]. Competency-based teacher education similarly emphasizes the integration of knowledge, skills, attitudes, and practical performance rather than the completion of isolated training activities [2]. Accordingly, teacher development programs should provide continuous opportunities for practice, feedback, collaboration, and professional reflection.

Professional Learning Communities (PLCs) offer an appropriate mechanism for continuous and collaborative teacher development. Through PLC activities, teachers can jointly design lessons, observe classroom implementation, exchange instructional experiences, and reflect on learning outcomes. In the Thai educational context, PLCs have been identified as an important approach for strengthening professional networks and supporting the sustainable implementation of improved teaching practices [3]. This collaborative model can reduce professional isolation and help teachers respond more effectively to challenges arising in their schools and classrooms.

Active learning is another important component of effective science education. It encourages students to construct knowledge through inquiry, experimentation, discussion, collaboration, and problem-solving activities. Inquiry-based learning, for example, allows students to investigate scientific questions systematically and develop evidence-based conclusions [4]. These learning processes can promote scientific creativity by providing opportunities for students to generate ideas, consider alternative solutions, and apply scientific knowledge to unfamiliar or authentic situations. However, the effective implementation of active learning depends strongly on teachers' ability to design suitable activities, facilitate student participation, and evaluate complex learning outcomes.

Scientific creativity is particularly important for preparing students to address emerging scientific, environmental, technological, and societal problems. It involves the ability to generate fluent, flexible, and original ideas within scientific contexts. Teachers must therefore be capable of creating learning environments that support questioning, experimentation, evidence-based reasoning, and creative problem-solving. The changing role of teachers from knowledge transmitters to learning facilitators further increases the need for competencies in instructional innovation, digital technology, and learner-centered learning management [5].

Previous research has examined teacher competency, PLCs, active learning, competency-based education, and scientific creativity. Nevertheless, these concepts have often been investigated separately. Studies of teacher education curricula have emphasized the importance of developing creativity, critical thinking, communication, and collaboration [6], while research on teacher competency has described competency as a multidimensional combination of knowledge, skills, and personal attributes [7]. However, limited attention has been given to an integrated mechanism that connects PLC-based professional development, active learning, teacher competency, and students' scientific creativity within a structured training curriculum.

This study investigates guidelines for developing science teachers' learning management competency through a PLC approach to promote scientific creativity among secondary school

students. It also examines teachers' perceived needs for competency development as a basis for designing a relevant training curriculum. The novelty of this study lies in the development of an integrated framework that connects Professional Learning Communities, active learning, competency-based teacher development, digital technology, and scientific creativity within a single training curriculum. Unlike previous studies that have generally examined these elements separately, this research explains how collaborative lesson design, authentic classroom practice, reflection, and continuous professional learning can be systematically organized to strengthen science teachers' learning management competency. The framework is also supported by empirical evidence from experts and science teachers, allowing the proposed curriculum to respond directly to teachers' actual professional needs. Furthermore, the study links teacher competency development with sustainable development goals (SDGs) by promoting quality education, instructional innovation, and sustainable professional learning. By integrating PLCs, active learning, competency-based education, digital technology, and scientific creativity, this study provides practical guidance for sustainable teacher professional development and contributes to the advancement of quality and innovative science education in accordance with SDG 4 and SDG 9.

2. METHODS

2.1. Research Design

This study employed a sequential mixed-methods design consisting of three phases: document and literature review, expert interviews, and a questionnaire survey. The methodological procedures were structured according to established principles for educational research design [8]. The phases were conducted to establish guidelines and identify the need for developing science teachers' learning management competency through a Professional Learning Community approach to promote scientific creativity among secondary school students. The research design integrated qualitative findings from the document review and expert interviews with quantitative evidence from the teacher questionnaire to support the development of the proposed training curriculum.

Table 1. Summary of the research phases.

PHASE	MAIN ACTIVITY	DATA SOURCE	MAIN PURPOSE
Phase I	Document and literature review	Relevant theories, policy documents, and previous studies	To identify the conceptual components of teacher competency, PLC, active learning, curriculum development, and scientific creativity
Phase II	Expert interviews	Seven curriculum, instruction, and science education experts	To obtain recommendations for developing the training curriculum
Phase III	Questionnaire survey	232 science teachers	To determine teachers' competency development needs and priorities

2.2. Phase I: Document and Literature Review

The first phase involved reviewing documents and previous studies related to teacher learning management competency, Professional Learning Communities, curriculum development, competency-based education, active learning, and scientific creativity. The

information was analyzed, synthesized, and summarized to establish the conceptual foundation for the proposed training curriculum.

2.3. Phase II: Expert Interviews

Seven experts were selected through purposive sampling. The expert panel comprised three specialists in curriculum and instruction and four specialists in science teaching. Curriculum and instruction experts were required to hold a doctoral degree in curriculum and instruction or a related discipline, or to have at least five years of teaching experience in higher education. Science teaching experts were required to have at least ten years of science-teaching experience in higher education or to hold advanced professional standing in science education. A semi-structured interview form was used to investigate:

(i) the role of PLCs in designing science learning activities;
(ii) methods for promoting and assessing scientific creativity;
(iii) factors affecting the development of teachers' learning management competency; and
(iv) recommendations for designing and implementing the training curriculum.

The interview form was developed from relevant literature and submitted to the research advisor for review. It was then evaluated by five experts using the Index of Item Objective Congruence. All interview items obtained an IOC value of 1.00. The wording and terminology were revised according to the experts' recommendations. The interviews were conducted directly with the participating experts. The responses were analyzed inductively to identify recurring themes and formulate guidelines for developing the training curriculum.

2.4. Phase III: Questionnaire Survey

The third phase examined the need for developing teachers' learning management competency. The participants comprised 232 science teachers working in schools under the Secondary Educational Service Area Office of Surin, Thailand, who participated in the questionnaire survey. The questionnaire was distributed electronically through Google Forms. The questionnaire consisted of two parts. The first part assessed teachers' perceived need for developing learning management competency using a five-point rating scale. The response categories ranged from 1, representing the lowest level of need, to 5, representing the highest level of need. The second part examined guidelines and methods for active learning management to promote scientific creativity.

Table 2. Participants, instruments, and data analysis.

RESEARCH PHASE	PARTICIPANTS OR DATA SOURCE	INSTRUMENT	ANALYSIS
Phase I	Documents and related studies	Document review framework	Analysis, synthesis, and summary
Phase II	Seven experts	Semi-structured interview form	Inductive analysis
Phase III	232 science teachers	Five-point rating-scale questionnaire	Mean and standard deviation

2.5. Instrument Validation and Reliability

The questionnaire was evaluated by five experts, comprising three science-teaching experts and two curriculum and instruction experts. Content validity was examined using the Index of Item Objective Congruence. All questionnaire items obtained an IOC value of 1.00.

The questionnaire was then piloted with 30 science teachers at Weerawat Yotin School. Item discrimination indices ranged from 0.55 to 0.83. Eighteen items satisfied the predetermined criteria and were retained. The questionnaire achieved a Cronbach's alpha coefficient of 0.94, indicating high internal consistency.

Table 3. Instrument quality indicators.

INSTRUMENT	QUALITY ASSESSMENT	PARTICIPANTS OR EVALUATORS	RESULT
Semi-structured interview form	Index of Item Objective Congruence	Five experts	IOC = 1.00 for all items
Questionnaire	Index of Item Objective Congruence	Five experts	IOC = 1.00 for all items
Questionnaire	Pilot-test item discrimination	30 science teachers	0.55-0.83
Questionnaire	Internal consistency	30 science teachers	Cronbach's $\alpha = 0.94$
Questionnaire	Retained items	Pilot-test results	18 items

2.6. Data Collection

In Phase II, we contacted the selected experts and conducted in-depth interviews. In Phase III, the online questionnaire was distributed to 232 science teachers through Google Forms. The collected data were used to formulate a conceptual framework for developing teachers' learning management competency through the PLC approach.

2.7. Data Analysis

Qualitative data from the document review and expert interviews were analyzed using inductive analysis. We identified, synthesized, and summarized recurring concepts related to teacher competency, PLC implementation, active learning, scientific creativity, and curriculum development.

Quantitative questionnaire data were analyzed using descriptive statistics, specifically the mean and standard deviation, while responses concerning preferred learning activities and instructional formats were summarized descriptively. These statistics were used to determine the overall level of need and identify the competency-development items receiving the highest ratings.

3. RESULTS

3.1. Guidelines for Developing Teachers' Learning Management Competency

The document review and synthesis identified five principal components for developing science teachers' learning management competency through a Professional Learning Community approach. These components were teacher competency, PLC-based professional collaboration, active learning, scientific creativity, and curriculum development.

Teacher competency encompassed professional knowledge, instructional skills, personal attributes, and the ability to apply these elements in classroom practice. The PLC component emphasized collegial collaboration, collaborative lesson development, classroom observation, and reflective discussion. Active learning required varied instructional activities that encouraged participation, experimentation, expression of ideas, and systematic problem-solving.

Scientific creativity was represented through product, trait, and process dimensions and could be assessed using an established scientific creativity assessment framework. Curriculum development involved the formulation of curriculum aims, objectives, content, learning activities, and evaluation procedures. The findings indicate that the proposed training curriculum should not focus solely on theoretical knowledge. It should provide opportunities for teachers to collaboratively design lessons, implement instructional activities, observe classroom practices, reflect on teaching outcomes, and continuously improve their learning management competency.

Table 4. Components of the proposed teacher competency development framework.

COMPONENT	PRINCIPAL ELEMENTS	INTENDED CONTRIBUTION
Teacher competency	Professional knowledge, instructional skills, personal attributes, and practical performance	Strengthening teachers' capacity to design and implement effective science learning
Professional Learning Community	Collegial collaboration, lesson study, classroom observation, and reflection	Supporting continuous and collaborative professional development
Active learning	Participation, hands-on practice, discussion, inquiry, and problem-solving	Developing students' higher-order thinking and active engagement
Scientific creativity	Product, trait, and process dimensions	Promoting fluency, flexibility, and originality in scientific thinking
Curriculum development	Aims, objectives, content, learning management, and evaluation	Structuring a systematic training curriculum

3.2. Expert Opinions on the Proposed Training Curriculum

The interviews with seven experts indicated that the training curriculum should combine conceptual understanding with practical application. Teachers should receive guidance on active learning principles and then apply those principles through collaborative planning, hands-on activities, group discussion, and classroom implementation.

The experts emphasized that science learning activities should encourage students to participate actively, conduct investigations, express opinions, reflect on their experiences, and solve problems systematically. Suggested approaches included Inquiry-Based Learning, STEM education, project-based learning, the G5Step learning model, and stepwise learning activities that connect prior knowledge with new knowledge.

For the assessment of scientific creativity, the experts recommended combining objective and subjective assessment methods. Suggested approaches included evidence-based reasoning, assessment rubrics, formative assessment, summative assessment, and collaborative assessment design among teachers. The experts also emphasized that assessment should capture both the quality of the final response and the depth and originality of students' thinking processes.

Practice-based workshops, adequate training duration, classroom application, group activities, continuous advisory support, and professional networking were identified as important conditions for effective competency development. Teachers should also be encouraged to incorporate contemporary and real-world issues into science learning activities.

Table 5. Main recommendations obtained from the expert interviews.

AREA	EXPERT RECOMMENDATION
Training orientation	Combine conceptual understanding with hands-on practice
Learning design	Emphasize participation, inquiry, experimentation, reflection, and problem-solving
Instructional approaches	Apply inquiry-based learning, STEM education, project-based learning, and other active learning models
Creativity assessment	Use objective and subjective methods, clear rubrics, and formative and summative assessment
Professional collaboration	Incorporate collaborative planning, brainstorming, lesson design, and reflection
Training implementation	Provide sufficient time for teachers to apply knowledge in authentic classrooms
Continuing support	Maintain advisory support, coordination, networking, and ongoing professional development
Contextual relevance	Integrate current real-world situations and future educational trends

3.3. Teachers' Need for Competency Development

The questionnaire findings showed that science teachers perceived a high overall need for developing their learning management competency through a Professional Learning Community approach to promote scientific creativity among secondary school students. The overall mean score was 4.30 with a standard deviation of 0.53. The detailed results for all 18 competency items are presented in **Table 6**. All competency items were rated at either a high or the highest level. The highest-rated item was searching for information through the internet to support learning management (M = 4.58, S.D. = 0.66). This was followed by using computer technology to produce instructional media or learning innovations (M = 4.51, S.D. = 0.71). Two items shared the next-highest mean score of 4.43: applying psychological principles in learning management so that students could learn happily and develop to their full potential (S.D. = 0.66), and using varied media, innovations, and technology appropriate to the learning content and activities (S.D. = 0.65). These findings indicate that teachers placed particular importance on digital competency, technology-supported instruction, learner-centered pedagogy, and supportive learning environments.

3.4. Preferred Learning Activities and Media

Responses regarding preferred learning activities indicated that instructional activities should be engaging and provide students with opportunities to express their ideas freely. Suggested formats included discussion, lectures, exhibitions, infographic development, digital platforms, podcasts, videos, and role-play.

These findings reinforce the need for a training curriculum that integrates active learning, digital technology, collaborative professional learning, and varied forms of student expression. Such integration can support teacher professional development while promoting scientific creativity and contributing to SDG 4 through improved instructional quality and SDG 9 through educational innovation and technology use.

Table 6. Science teachers' learning management competency development needs

NO	COMPETENCY AREA	QUESTIONNAIRE ITEM	MEAN	S.D.	LEVEL
Knowledge and Ability in Learning Design					
1	Learning Design	Formulating learning outcomes emphasizing analysis, synthesis, and appropriate application that are aligned with the subject content, learner characteristics, and individual differences.	4.27	0.64	High
2	Learning Design	Designing diverse learning activities appropriate to learners' age, needs, and community context.	4.28	0.62	High
3	Learning Design	Developing varied learning activities that are appropriate to learners' age, needs, and community context.	4.23	0.67	High
4	Learning Design	Preparing integrated lesson plans systematically, implementing the planned instruction, and adapting learning activities appropriately to achieve the expected learning outcomes.	4.27	0.70	High
5	Learning Design	Evaluating learning designs for continuous improvement and development.	4.21	0.72	High
Learner-Centered Learning Management					
6	Learner-Centered Learning	Establishing learner databases to support learner-centered instructional design.	4.33	0.72	High
7	Learner-Centered Learning	Using diverse instructional strategies and techniques to enable learners to reach their full potential.	4.41	0.68	High
8	Learner-Centered Learning	Organizing learning activities that promote desirable learner characteristics and competencies.	4.39	0.74	High
9	Learner-Centered Learning	Applying psychological principles in learning management so that learners enjoy learning and achieve their full potential.	4.43	0.66	High
10	Learner-Centered Learning	Utilizing local learning resources and community wisdom in instructional management.	4.01	0.85	High
11	Learner-Centered Learning	Developing learning networks among schools, parents, and communities.	4.08	0.76	High
Use and Development of Instructional Media, Innovation, and Technology					
12	Media and Technology	Using instructional media, innovations, and technology appropriately according to learning content and activities.	4.43	0.65	High
13	Media and Technology	Searching for information through the internet to support learning management.	4.58	0.66	Highest
14	Media and Technology	Using computer technology to produce instructional media and learning innovations.	4.51	0.71	Highest
Learning Assessment and Evaluation					
15	Assessment	Designing various assessment methods appropriate to learning content, activities, and learner characteristics.	4.26	0.78	High
16	Assessment	Developing and appropriately using learning assessment instruments.	4.18	0.77	High
17	Assessment	Assessing learners through authentic assessment.	4.37	0.73	High
18	Assessment	Using assessment results to improve learning management.	4.23	0.81	High
	Overall Mean		4.30	0.53	High

4. DISCUSSION

Developing science teachers' learning management competency requires an integrated professional development system rather than isolated training activities. The proposed framework combines teacher competency, Professional Learning Communities, active learning, scientific creativity, and curriculum development. This integration is important because effective professional development should connect theoretical knowledge with authentic classroom practice, collaborative reflection, and continuous improvement [1]. Similarly, competency-based teacher education emphasizes the practical application of knowledge, skills, and professional attributes in real teaching contexts [2].

The role of the Professional Learning Community was central to the proposed development process. The experts recommended collaborative lesson planning, classroom observation, brainstorming, reflective discussion, and continued professional support. These findings are consistent with evidence that PLCs can strengthen professional networks, facilitate knowledge exchange, and sustain instructional improvement within Thai schools [3]. Instead of positioning teachers as individual recipients of training, the PLC approach enables them to jointly identify instructional challenges, test teaching strategies, and evaluate classroom outcomes.

The integration of Lesson Study and open classroom observation may further strengthen this collaborative process. Teachers can design lessons together, observe their implementation, and revise the lessons based on evidence from classroom practice. Such activities connect teacher learning directly with instructional improvement. However, the current study identified guidelines and perceived needs rather than testing the effectiveness of a fully implemented PLC-based training curriculum. Therefore, the findings support the design of the curriculum but should not yet be interpreted as evidence that the proposed framework directly improves student achievement or scientific creativity.

Active learning was also identified as a major component of teacher competency development. The experts recommended inquiry-based learning, STEM education, project-based learning, hands-on experimentation, discussion, reflection, and problem-solving. These methods allow students to participate in knowledge construction rather than passively receive information. Inquiry-based learning is particularly relevant because it engages students in asking questions, investigating evidence, developing explanations, and communicating conclusions [4]. These processes may provide suitable conditions for developing scientific fluency, flexibility, and originality.

The findings further suggest that promoting scientific creativity requires alignment between instructional design and assessment. The experts recommended using both objective and subjective assessments, clear rubrics, evidence-based reasoning, and formative and summative evaluation. This combination is necessary because scientific creativity involves not only a final answer or product but also the processes through which students generate, evaluate, and improve ideas. Authentic assessment can therefore help teachers examine whether students can apply scientific knowledge creatively in unfamiliar and real-world contexts.

The teachers reported an overall high need for competency development, with a mean of 4.30 and a standard deviation of 0.53. The highest-rated need was searching for information through the internet, followed by producing instructional media using computer technology.

These results indicate that digital competency is a major professional development priority. The findings are consistent with the changing role of teachers in the post-pandemic educational environment, where teachers increasingly function as learning facilitators who must integrate technology, learner-centered instruction, and flexible learning resources [5].

The high ratings for digital information searching and instructional media production should not be interpreted only as a demand for technical training. Digital competency also includes evaluating the reliability of online information, selecting appropriate digital resources, designing pedagogically meaningful media, protecting student data, and ensuring equitable access. Therefore, the proposed training curriculum should integrate technological skills with pedagogical decision-making rather than treating digital tools as separate instructional additions.

The need for diverse instructional formats also received a high rating. This finding indicates that teachers recognize the importance of adapting learning activities to students' abilities, interests, and learning contexts. Teacher education curricula that emphasize creativity, communication, collaboration, and critical thinking can support such adaptation [6]. Furthermore, teacher competency should be understood as a multidimensional construct involving knowledge, instructional abilities, professional attitudes, and interpersonal capacities [7]. Training should therefore address both technical classroom skills and broader professional competencies.

The proposed curriculum structure (consisting of aims, objectives, content, learning management, and evaluation) provides a systematic basis for teacher development. Nevertheless, its effectiveness will depend on implementation conditions. The expert findings emphasize sufficient training duration, opportunities for classroom application, continuing advisory support, professional networking, and reflection. Practice-based training connected to authentic school contexts has been reported to improve teaching practices more effectively than activities that remain detached from classroom realities [9].

The results also have implications for the Sustainable Development Goals. Strengthening teacher competency, learner-centered instruction, and scientific creativity supports SDG 4 by contributing to educational quality and teacher professional development. The emphasis on digital technology, instructional media, STEM learning, and scientific innovation is also aligned with SDG 9 through the promotion of innovation and technology-supported education. Moreover, PLC-based professional development may support sustainability by embedding continuous improvement within schools instead of depending exclusively on temporary external training programs. However, several limitations should guide the interpretation of the findings. First, the study focused on science teachers under the Secondary Educational Service Area Office of Surin, which may limit the transferability of the findings to other regions or educational systems. Second, the quantitative results were based on self-reported needs and may reflect participants' perceptions rather than their demonstrated competencies. Third, the study did not implement and experimentally evaluate the proposed training curriculum. Fourth, the qualitative findings were derived from seven purposively selected experts and should therefore be understood as informed professional perspectives rather than statistically representative opinions.

The study provides an empirical foundation for designing a PLC-based training curriculum that integrates active learning, digital competency, authentic assessment, and scientific creativity. Its main contribution lies in organizing previously separate elements into a

coherent professional development framework. Future research should implement the curriculum, measure changes in teachers' competencies, and examine whether these changes lead to measurable improvements in students' scientific creativity. This study contributes to the literature on teacher professional development by integrating PLC-based collaboration, active learning, digital competency, assessment, and scientific creativity within a coherent training framework. The emphasis on teachers' digital competency is consistent with previous research on teachers' skills in developing e-learning content [10], while the inclusion of assessment competencies reflects the importance of formative evaluation strategies in supporting learning outcomes [11]. The collaborative dimension of the framework also recognizes the broader role of school, parent, and community participation in educational development [12, 13]. Furthermore, attention to learner diversity and professional creativity is consistent with previous studies addressing classroom characteristics in special education [14] and the development of professional and pedagogical creativity among teachers [15].

5. CONCLUSION

This study developed guidelines for enhancing science teachers' learning management competency through a Professional Learning Community (PLC) approach to promote scientific creativity among secondary school students. The findings indicate that an effective teacher development framework should integrate competency-based education, collaborative professional learning, active learning, authentic assessment, and digital technology within a structured training curriculum. Science teachers reported a high level of need for competency development, particularly in digital information literacy, technology-supported instructional media, and diverse learner-centered teaching strategies. These findings provide empirical support for designing sustainable teacher professional development programs that strengthen instructional quality, foster scientific creativity, and encourage continuous professional learning. The proposed framework is aligned with SDG 4 through its emphasis on teacher competency and quality education and with SDG 9 through its emphasis on educational innovation and technology integration. Future studies should implement and evaluate the proposed curriculum in diverse educational contexts using longitudinal and experimental research designs.

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7. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper is free from plagiarism.

8. REFERENCES

[1] Asterhan, C. S. C., and Lefstein, A. (2024). The search for evidence-based features of effective teacher professional development: A critical analysis of the literature. *Professional Development in Education, 50*(1), 11-23.

[2] Lopez Requena, E., Lopez Secanell, I., and Rodenas i Marco, I. (2025). Competency-based approach in the initial training of secondary education teachers: A case study. *Journal of Curriculum and Teaching, 14*(4), 98-107.

[3] Erawan, P., and Erawan, W. (2024). Effective approaches to teacher professional development in Thailand: Case study. *Journal of Education and Learning, 13*(2), 64-74.

[4] Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., and Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review, 14*, 47-61.

[5] Ratten, V. (2023). The post-COVID-19 pandemic era: Changes in teaching and learning methods for management educators. *The International Journal of Management Education, 21*(2), Article 100777.

[6] Osiesi, M. P., and Blignaut, S. (2025). Impact of the teacher education curriculum on the development of 21st-century skills: Pre-service teachers' perceptions. *Social Sciences and Humanities Open, 11*, Article 101317.

[7] Peng, L., and Jiang, M. (2023). A study on the competency of physical education teachers at the basic education level in China. *Educational Research and Reviews, 18*(8), 218-224.

[8] Susilawati, A., Nandiyanti, S. R., Siddik, N. A. C., and Nandiyanto, A. B. D. (2025). How to do research in science and engineering education: A methodological framework with lessons learned from common research failures, bibliometric analysis, and practical insights. *ASEAN Journal of Educational Research and Technology*, *4*(3), 507-522.

[9] Pandi, P. N. M., Labitad, G. F., and Comon, J. D. (2025). In-service training program and teaching practices: Basis for school training development plan. *American Journal of Arts and Human Science, 4*(1), 103-121.

[10] Nafsi, N. R. R., and Maryanti, M. (2022). Analysis of teacher skills in e-learning content development during distance learning during the COVID-19 pandemic. *ASEAN Journal for Science Education*, *1*(1), 23-32.

[11] Awofala, A. O. A., and Olaniyi, A. O. (2023). Assessing teachers' formative evaluation strategy as related to senior secondary school students' achievement in mathematics. *ASEAN Journal for Science Education*, *2*(2), 77-86.

[12] Oladimeji, R. M., Odefunsho, O. A., and Adeoye, M. A. (2023). Community service perspective on intervention strategies by parents-teachers associations: Challenges and prospect. *ASEAN Journal of Community Service and Education*, *2*(1), 45-50.

[13] Saadu, U.T., and Lawal, A. (2023). Parents and teachers' perceived effect of banditry activities on pupils enrollment in selected public primary schools. *ASEAN Journal of Community Service and Education*, *2*(1), 85-92.

[14] Musayaroh, S. (2022). Behaviors of concern to special education teachers in their classroom: class characteristics and class composition predictors. *ASEAN Journal of Community and Special Needs Education*, *1*(2), 55-60.

[15] Hasanovna, H.M. (2023). The mechanism of development of professional and pedagogical creativity of future physical education teachers based on a competent approach. *ASEAN Journal of Physical Education and Sport Science*, *2*(1), 17-22.