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Soft Scaffolding Strategy: An Adaptive Post-Pandemic Learning to Facilitate Prospective Physics Teacher's PCK

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ABSTRACT

Teacher professional development programs extensively focus on enhancing teachers' pedagogical content knowledge (PCK). Given the ongoing programs targeting the improvement of existing teachers' PCK, there's an evident need for strategies that prepare future educators more effectively. While soft scaffolding has significantly contributed to fostering 21st-century skills among students, its potential in bolstering the PCK of prospective Physics teachers remains under-explored. This study addresses this gap by formulating a soft scaffolding strategy, tailored for post-pandemic learning scenarios, aimed at enriching the PCK of future physics educators. Employing a research and development approach, the ADDIE development design model was utilized. This strategy, termed EPiSODe, integrates key components: Encouraging students, Picking the learning concept, Simulating the learning process, Offering further consultation, and Demonstrating the learning process. Piloted with 52 prospective teachers in Lampung in their third year of Physics Courses, the strategy showcased effectiveness in augmenting their PCK.The results of the data analysis show that the soft scaffolding strategy was effective in increasing the PCK of prospective Physics teachers. The implications of this research include that soft scaffolding learning strategies can be implemented and adapted to the difficulties of candidates in developing PCK competencies. Therefore, to improve the quality of learning for prospective physics teachers and minimize misconceptions or low PCK, this strategy can continue to be developed in case-based learning activities or team-based projects at the higher education level.

INTRODUCTION

The profession of a teacher as an educator is a variable that is closely related to some of the specific knowledge and skills needed in the application of scientific disciplines (Aulia & Yuliani, 2023; Lestari et al., 2021). To be able to become a skilled physics teacher, students must not only master physics material (content) and teaching strategies, but also have a specific understanding and ability to integrate the knowledge of physics material, curriculum, learning, teaching, and student characteristics, resulting in an effective learning situation and conducive conditions can be realized (Allchin, 2022; Castañeda et al., 2022; Dirsa et al., 2022; Shing et al., 2018). This understanding is packaged in Pedagogical Content Knowledge (PCK). PCK is described as a dimension of teacher knowledge which is an integration of content and pedagogical knowledge, including the teacher's

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understanding of how students learn and the subject matter itself (Schiering et al., 2023). PCK has become a popular topic that has been extensively investigated in many teaching disciplines including science.

The government has put more attention to the issue of teacher knowledge regarding content and practice through the Teacher Competency Examination which was held nationally in Indonesia since 2015. This aims to evaluate and map the PCK of teachers in Indonesia. However, the Ministry of Education and Culture's records confirm that the results in the last three years since 2015 have not shown encouraging results. The average number of the results until 2017 was still below 70, for all levels of primary and secondary education. The percentage of scores for senior high school level that scored above 60 was only 53.55%. This data illustrates the achievement of teachers' cognitive abilities that were still low in terms of professional and pedagogical knowledge. Until now, the government is still promoting sustainable teacher development programs to increase teacher competence evenly, such as teacher professional programs, teacher mobilization programs, and so on.

The problem of teachers' PCK that showed not optimal achievement is not only an issue in the national scope but a global trend. Review research that described the profile of teachers' PCK showed that the results of teachers' PCK on indicators of teacher knowledge about content and students are still weak. Then the pre-service teachers and experienced teachers have different PCK levels in each component, where the PCK of pre-service teachers tends to be naturally low due to insufficient experience (Galimova et al., 2023). The recent research results also showed that teachers' PCK is still not optimal and still in question in the domain of understanding the nature of science and teachers' knowledge of effective science teaching (Malhotra & Masih, 2022).

Several studies have been directed at developing PCK pre-service teachers, such as exploring how to develop pre-service physics teacher’s PCK to a higher level (Schiering et al., 2023), conducting a university seminar to implement a teaching concept with some essential topics to foster this digital-media PCK of pre-service physics teachers (Große-Heilmann et al., 2022), using a field experience to develop pre-service physics teacher explaining skills (Kulgemeyer et al., 2020), and identifying the effect of using explicit and visible strategies to support the development of pre-service teacher’s PCK (Richardson et al., 2018).

Many teacher professional development programs also had been carried out and focus on developing teacher PCK (Carpendale, 2018; Carpendale & Hume, 2019; Hwang et al., 2018; Wiener et al., 2018). Studies that support teacher professional development programs in Indonesia have also been carried out (Rahman et al., 2015; Rochintaniawati et al., 2018; Soebari & Aldridge, 2016). If many studies and teacher professional development programs that have been carried out are developing or improving teacher PCK, then a solution is needed as a preparation effort to produce quality teacher candidates. Moreover, the results of recent research show that PCK science teacher candidates still show poor results, where prospective teachers are still less oriented towards teaching science than knowledge about the curriculum, knowledge about understanding students' abilities, learning strategies, and evaluation for the learning process to figure out the misconceptions still needs to be improved (Sutamrin et al., 2022). This means that efforts are still needed to produce qualified science teacher candidates. The meaning of qualified prospective teachers in this context is the mature readiness of these prospective teachers by demonstrating through optimal mastery of the required competencies, especially PCK when going into the field to act as teachers in a real context.

Several recent studies also have been conducted to discuss strategies for developing the PCK of prospective teachers, such as developing prospective teacher's PCK in an elementary science methods course (Subramaniam, 2022), developing the PCK of prospective primary teachers through lesson study methods (Cardoso et al., 2022), and developing pre-service mathematics teacher's PCK through project work in their teacher education program (Podworny et al., 2023). However, these studies were still not aimed at prospective physics teachers. As for the latest research regarding prospective science teachers, that was promoting secondary science prospective teachers' development of PCK through school-based practicum activities (Wang & Oliver, 2022) also still met limitations, where the strategies and methods used were still not fully effective to be implemented, partly because the PCK of prospective teachers turns out to be of various levels and requires learning support to ensure prospective teachers can develop the appropriate PCK. Based on the weaknesses and recommendations of the research, authors saw the potential for providing scaffolding to be integrated into learning at the physics teacher education level, because scaffolding has the potential as a learning strategy by adjusting the level of support or assistance from lecturers to match the cognitive potential of prospective teachers to increase the competency of prospective teachers (Schons et al., 2022).

Several studies have discussed scaffolding at the teacher education level, for example, conducting technological and theoretical scaffolding to improve pre-service teacher's pedagogical technological knowledge and inquiry skills (Segal & Stupel, 2023) and also the use of the scaffolding strategy in optimizing the development of pre-service teachers' computational thinking. However, researchers are more focused on providing soft scaffolding strategies. This is based on empirical findings encountered by researchers regarding the needs of prospective physics teachers to improve their PCK. They need direct and spontaneous feedback assistance or support when they show their performance or when they experience difficulties. The delay or the length of time in providing feedback or assistance to them causes new problems such as misconceptions, and so on. Worse, after they access learning resources and believe that they understand the topic and do not need further instructions, prospective teachers tend to think that the lecturer's explanation is redundant even though they have misconceptions. Therefore, researchers are interested in developing a soft scaffolding strategy as an alternative problem-solving solving to improve the PCK of prospective physics teachers, because lecturers can provide direct assistance by adjusting the level of guidance or instruction to the potential of each group of prospective teachers when joining the course (Brush & Saye, 2002).

In addition, researchers view soft scaffolding as a strategy that can complement the provision of assistance in the form of hard scaffolding such as modules, teaching materials, or practicum guides. The application of soft scaffolding has played a major role and contributed to improving students' skills needed in the 21st century (Brush & Saye, 2002; Nurulsari & Suyatna, 2017). Moreover, an in-depth review of the literature leads to the conclusion that there is no research discussing the power of soft scaffolding strategies in boosting the PCK of science teacher candidates, especially in Physics. So, this study aimed to identify the internal validity of the soft scaffolding strategy that was developed. Besides, this study also describes the implementation of the soft scaffolding strategy to increase the PCK of prospective Physics teachers. Furthermore, the effectiveness of the soft scaffolding strategy to increase the PCK of prospective Physics teachers was also examined.

METHOD

This study was conducted using a research and development method that adopted the ADDIE development model that was represented in Figure 1.

Figure 1. Research Design Using ADDIE Model

In the implementation phase, the research design used was a hybrid design type III and a modified sequential explanatory mixed method design (Creswell & Creswell, 2017). Roughly speaking, the hybrid type III mixed method research design combined with an explanatory sequential design begins with preliminary research at the intervention strategies stage which is reviewed empirically and includes global and local problems related to PCK owned by prospective science teachers, especially in the field of Physics Education. The results of the preliminary research are the starting point in selecting appropriate learning strategies to address problems related to teacher PCK. In the study implementation research stage, we conducted a pretest to map the initial PCK before implementing the strategy, then proceeded with implementing the soft scaffolding strategy, followed by testing the implementation of the strategy. After the strategy was implemented, we conducted a posttest to see an increase in the PCK of prospective teachers followed by an in-depth interview about the strategy implemented. The overall results obtained (qualitative and quantitative data) are then interpreted to describe the implementation of the strategy and to determine the increase in PCK of prospective teachers after being given treatment. The research design can be seen in detail in Figure 2.

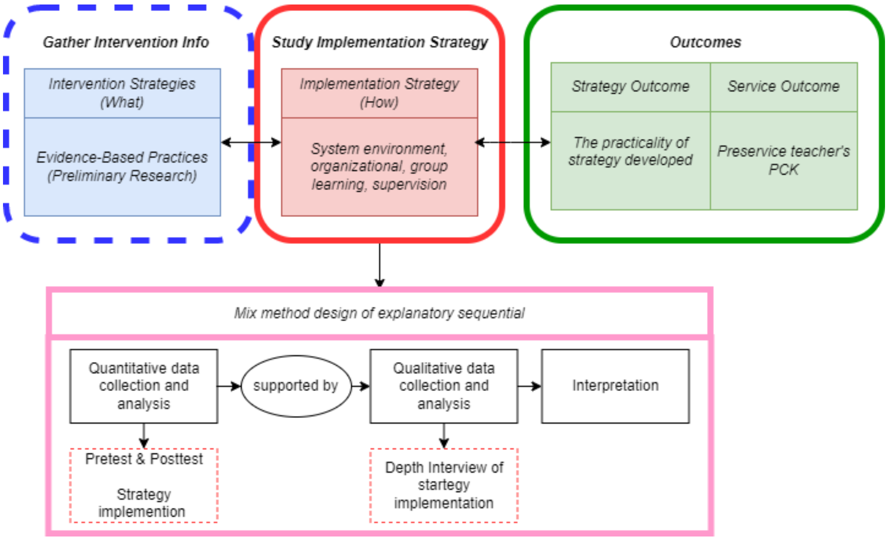

Figure 2. Hybrid Design Type III + Explanatory Sequential Mixed Method Design

Participants and Data Collecting

Two experts were involved in the internal validation process. Furthermore, the data on the soft scaffolding strategy implementation was collected from 52 physics education students who were selected purposively. Researchers involved the same subject to obtain data regarding the effectiveness of the developed strategy. Then this data will be studied intensively through qualitative and quantitative methods.

Research Instruments

The feasibility of the product was described by using an internal validation test questionnaire in terms of construction (9 items) and substance (19 items) with a minimum score of 1 and a maximum of 4. The implementation of the strategy was indicated by using an observation instrument. The instrument consisted of 12 items that represent the activities based on the learning model syntax. Furthermore, the effectiveness of the strategy for increasing the PCK of prospective teachers is obtained through testing instruments that contain indicators of pedagogical abilities and content owned by prospective teachers.

Data Analysis

Data analysis techniques regarding the need analysis, the validity of the product, and the implementation of the soft scaffolding strategy were analyzed using a descriptive quantitative approach. Meanwhile, data analysis regarding the effectiveness of implementing the strategy was obtained based on an analysis of the PCK increase of prospective teachers from pretest-posttest scores, and an analysis of the average gain value. Pretest-posttest score data were analyzed using inferential statistics t-test with the paired sample t-test analysis technique to see the enhancement of the prospective teachers' PCK. The effectiveness of the strategy is seen by increasing the PCK of prospective teachers based on the n-gain value. The average n-gain value was also analyzed to determine the effectiveness of implementing the soft scaffolding strategy. The average gain value $\langle g \rangle$ is interpreted based on the criteria of the average gain value (Roni et al., 2020).

RESULTS AND DISCUSSION

This study developed an adaptive soft scaffolding strategy and identified the impact of implementing the soft scaffolding strategy on the pedagogical content knowledge (PCK) of Physics teacher candidates. This impact is reviewed from the implementation and effectiveness of the implementation of the soft scaffolding strategy that we have developed. The results obtained are described as follows.

ANALYSIS PHASE

PCK Existing Conditions for Prospective Physics Teachers

The initial research that we conducted aimed to identify the PCK level of Physics teacher candidates based on the perceptions and initial abilities of the prospective teachers. Exploration of pre-teacher mastery of PCK indicators was analyzed using an interview guide or protocol (Brereton et al., 2008). The prospective teachers' responses were then categorized based on the tendencies that are shown in Table 1.

Table 2. Initial PCK Mastery Based on Prospective Teacher's Perspectives

PCK Sub-Indicator	Categorized Responses
Give three examples of things that need to be prepared before the teaching class.	Relevant answers (65%): Learning materials/content, learning methods, learning techniques, assignments for students, curriculum syllabus, learning implementation plans (RPP), modules or books, learning media, learning strategies, and evaluation systems.
Provide examples of information to students along with the learning environment needed.	Relevant answers (26%): • For example, students learn about water rockets, so students must study in an environment that has a large yard to make it easier to test water rockets. • For global warming material, students can be invited to study outdoors to observe natural conditions. • To find out the height of the shadow formed by an object, students need an environment that provides a light source.
Determine the material to be taught, then the appropriate teaching materials and learning theories.	Relevant answers (30%): • Applying constructivism learning theory to teach about Work and energy, mechanics, and dynamic electricity. • Applying cognitive learning theory to teach about static fluids, rectilinear motion, electricity, waves, heat, and quantities.
Explain learning methods that are suitable for learning Physics in high school when students learn optics.	No correct answer. Students were correct in differentiating the learning models and methods, but those were not suitable for learning Optics.
Mention the strategies used in accessing information in planning the content to be taught.	More than 95% of prospective teachers stated that they use the Internet to access information. They are also directed to do the same thing in accessing student information. Meanwhile, 5% of prospective teachers only use printed books as a source of information to prepare material to be studied.
Explain how to overcome misconceptions that arise in students related to Physics material.	More than 60% do not know how to overcome misconceptions that arise in students. Even though they have explained directly.
Give examples of how to evaluate student success.	Only less than 3% provided the instruments that correspond to the domain to be measured. Then indicators of completeness are decided by comparing student learning outcomes with the minimum completeness criteria that have been determined.

Based on Table 1, there were still prospective teachers who still facing difficulties a preparation before teaching. Planning is a crucial thing that must be conducted by teachers before a learning process (Mahajan & Jadhav, 2019). Then, almost all prospective teachers gave irrelevant answers related to the learning environment. The learning environment can be defined as a physical location for student learning which includes the context being studied and also the student learning culture (Goldie, 2016). Then, Table 1 showed that student's knowledge about learning theories needed to be upgraded. Furthermore, almost all teacher candidates answered that the way to evaluate student success was by giving a written test in the form of an exam for each chapter or basic competency, then indicators of success were measured by comparing student scores with standards they set themselves without any clarity source. Whereas learning evaluation must be carried out by referring to several principles and assessment methods (Bryson & Mobolurin, 1997; Maclellan, 2004). The results show that in general, the PCK level of Physics teacher candidates are still not optimal, both in the preparation, implementation, and evaluation stages. They still experience difficulties in choosing learning designs that are adapted to the topics to be taught. In connection with the research that has been done a lot, PCK is said to contribute to effective teaching.

Document Analysis of the Lesson Plan

Furthermore, we conducted a document analysis that was designed by students when attending courses related to learning design. We do document analysis in such a way as to get findings about how prospective teachers design a lesson they will hold. First, we analyzed whether the lesson plans that had been developed by prospective teachers met the indicators of PCK mastery. Second, we analyze whether lesson plans that have been developed by prospective teachers are adaptive to the demands of future education. We analyzed lesson plans by taking 1 sample lesson plan at random for each material that had been developed by each prospective teacher. The physics topics contained in the lesson plan consist of 13 topics, namely (1) straight motion, (2) work and energy, (3) momentum and impulse, (4) equilibrium and rotational dynamics, (5) static fluid, (6) temperature and heat (7) waves, (8) geometry optics (optical instruments), (9) static electricity, (10) direct current circuits, (11) magnetic fields, (12) electromagnetic induction, (13) alternating currents.

First, we analyzed the lesson plan documents to examine the knowledge that prospective teachers have about the curriculum. This is reflected in the formulation of competency achievement indicators and learning objectives based on the basic competencies set by the Government. The results of the analysis related to the curriculum knowledge possessed by the candidates in the formulation of learning objectives as an example are shown in Figure 3.

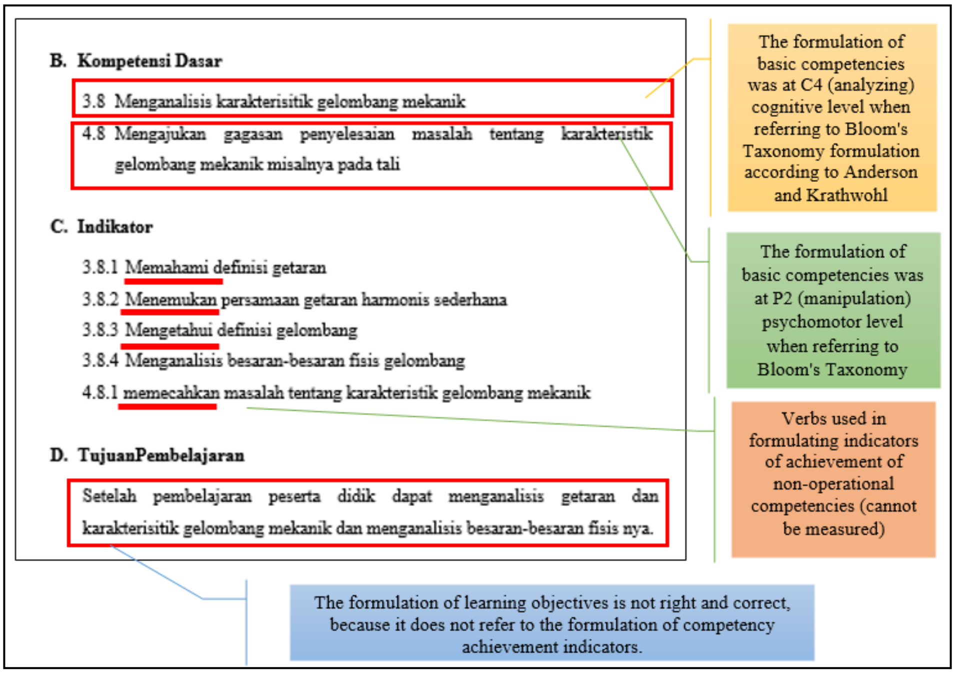

Figure 3. Analysis of Student's Knowledge Regarding the Formulation of Objectives

The results show that there is a discrepancy between the learning objectives and the basic competencies in the curriculum. In addition, the learning objectives have not shown the description of the indicators. The formulation of clear learning objectives is important because it becomes a reference for all learning activities (Wijngaards-de Meij & Merx, 2018) as a consideration and reference in determining the learning experience that will be given to students. The results illustrate that PPT lacks knowledge about setting learning objectives.

The lesson plan does not prove that prospective teachers can teach Physics material systematically based on the basic concepts (Sorge et al., 2019). Furthermore, the lesson plan being developed is still general in nature and not specific in content and there has been no innovation in the learning design towards the subject matter. This illustrates the position of prospective teachers' understanding of mastery of subject matter. In addition, the development of various learning designs on a particular topic has not yet appeared. Next, we analyzed the Physics content in lesson plans. For example, we focused on finding the general wave equation. The physics content in lesson plans shows that students do not fully understand the concept of how to transform the material into an appropriate form of learning design, for example making the learning process into project-based learning by producing a sensor-based to see the wave propagation.

The analysis of the lesson plan that we randomly selected shows that the learning sequence has not accommodated students to develop higher-order thinking skills and master the skills needed in the future. A lesson plan is like a road map (McDowell, 2019), which describes where prospective teachers take students in learning. Whereas the 'learning roadmap' is not capable of being a bridge for students to be sensitive to future demands and skills needed. Based on these findings, we do not claim that prospective teachers are incompetent to become teachers, but there must be alternative solutions that can guide them in enhancing their PCK, from designing appropriate lesson plans to considering futuristic aspects based on future student needs.

DESIGN PHASE

The soft scaffolding strategy that we developed is based on the needs of our sample Physics teacher candidates and is based on theoretical analysis that produces activity derivatives. The findings from document analysis and interviews with teacher candidates allowed us to design a hypothetical model that could be used to assist teacher candidates in developing PCK. We analyze the needs of prospective teachers using protocol instruments such as when we identified initial mastery of prospective teacher PCK dimensions. Because we implemented the strategy in the School Physics course which would be taken by prospective teachers in the fifth semester, we analyzed the need for developing a strategy based on their perspective.

The results showed that the prospective teachers need more assistance in the form of soft scaffolding to guide them in developing their PCK, they need direct interaction or assistance. Soft scaffolding is a direct and dynamic type of assistance (Brush & Saye, 2002). Soft scaffolding has been shown to improve creative thinking skills (Nurulsari & Suyatna, 2017), which means that soft scaffolding has the potential to help prospective teachers improve their higher-order thinking skills, especially in developing the PCK dimension. After mapping the need for developing strategies based on the perspective of prospective teachers, we then determine the theoretical rationale for obtaining the main activities in each strategy component. The strategic activities in general are presented in Figure 4.

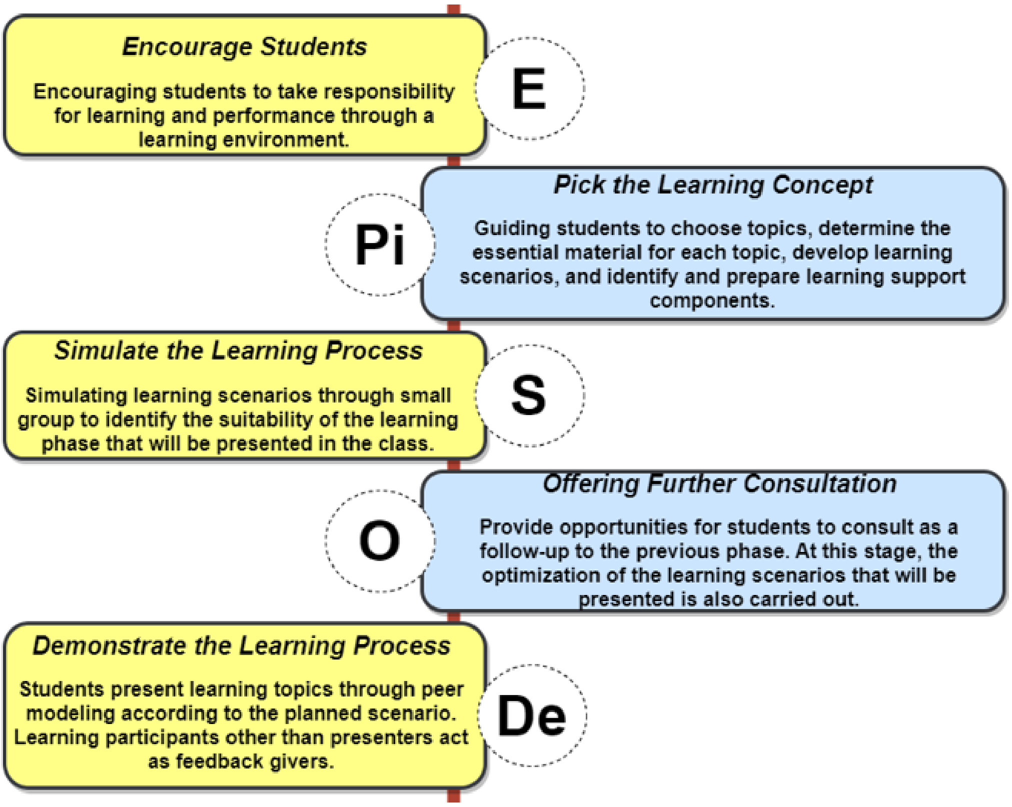

Figure 4. EPiSODe Soft Scaffolding Strategy

DEVELOPMENT PHASE

We develop each component of the strategy obtained by detailed teacher and student activities which can be seen in Table 2. We determine the activity derivative based on theoretical rationality using several relevant sources. We also developed learning scenarios related to models, approaches, and learning methods that are appropriate to the subjects being taught.

Table 2. The Description of Strategy Component Activities

No	Strategy Components	Student's Activities	Teacher's/Mentor's Activities in the Soft Scaffolding Form
1	*Encourage Students*	Provide feedback on the stimulus delivered by the mentor	Provide a stimulus that candidates need to learn how to be productive and proficient in their profession.
			Increase the awareness of prospective teachers about the urgency of PCK.
		Organize students in small groups (2-3 students)	Introducing the mentoring method as a form of support to prospective teachers in teaching and learning physics.
2	***Pi**ck the Learning Concept*	Choose learning topics based on the list presented.	Presents a list of learning topics that will be modeled based on the latest and relevant regulations.
		Analyze core and basic competencies along with learning indicators based on the topics that have been selected.	Explain the scope of core and basic competencies.
		Mapping the core or essential material of each topic.	

No	Strategy Components	Student's Activities	Teacher's/Mentor's Activities in the Soft Scaffolding Form
		Make learning scenarios in general.	Guide prospective teachers on the format of planning implementation of learning in general.
3	***S**imulate the Learning Process*	Modeling learning based on learning scenarios in the previous stage.	Observing the process of running a small group simulation (learning modeling).
		Record or document any input given by the mentor.	Provide input on any weaknesses of prospective teachers in presenting and delivering material.
		Discuss the improvement plan for the next stage.	
4	***O**ffer Further Consultation*	Consulting learning devices as a whole and planning the actualization of learning plans.	Finding PCK problems for prospective teachers that still appear in the learning materials and actualization plans for the lesson plans that have been prepared.
			Provide solutions to problems faced by prospective teachers.
		Consult the task of each group member for peer teaching activities	Dividing work proportionally for each group member so that PCK actualization can emerge from each individual.
5	***D**emonstrate the Learning Process*	Demonstrating the most effective form of learning in the form of learning modeling (peer teaching) based on learning tools that have been designed.	Observe and record the process of organizing learning.
			Provide reinforcement and emphasis on PCK aspects, especially on subject matter knowledge.
			Give feedback for teamwork efforts.

The soft scaffolding strategy that we have developed has been validated by two experts in the fields of Physics Education and Science Education. The validation test by experts covers the substance and construction aspects. The results of the validation test are recapitulated and presented in Figure 5.

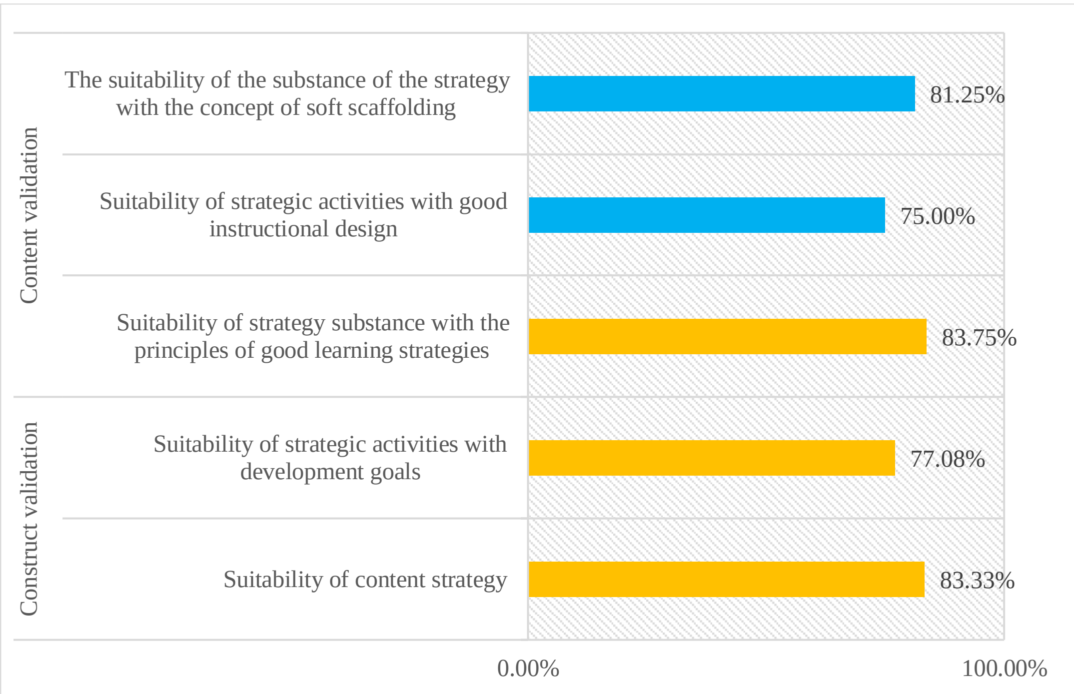

Figure 5. Expert Validation Results

Based on Figure 5 and referring to the validation score interpretation of (Elangovan & Sundaravel, 2021), it can be indicated that the soft scaffolding strategy developed is in a good category in terms of construction and substance or is feasible to implement. We revised several sections related to format and writing procedures according to the validator's suggestions. At this stage, the researchers also developed an instrument that we developed consisting of 10 questions in the form of multiple choices and descriptions which included indicators of pedagogical ability and physics content.

IMPLEMENTATION PHASE

Implementation of the Soft Scaffolding Strategy to Increase the PCK of Prospective Physics Teachers

Data on the implementation of the developed soft scaffolding strategy were obtained using observation instruments to reveal the implementation of the strategy, which consisted of the implementation of the strategy components, the implementation of the social system, and the implementation of the reaction principle. The strategy was implemented for 52 prospective physics teachers in Lampung. The implementation of the strategy component was reviewed based on the activities of researchers and prospective teachers, where the observers were 1 team lecturer other than a researcher in the School Physics course and 1 final year student who had taken the School Physics course. The implementation of the strategy was observed during 8 face-to-face meetings with 3 credits load and a time allocation of 150 minutes for each face-to-face meeting.

The strategy components were implemented at high or very high categories, which means that the soft scaffolding strategy developed had been implemented well. The low score lies in the activities of prospective teachers when they analyze the core and basic competencies with learning indicators based on the topics that have been selected. Based on observation results, prospective teachers were not optimal in mapping competency achievement indicators. In addition, low scores are also found in the activities of prospective teachers when mapping the core or essential material of each topic. The prospective teachers did not understand the essential material for each topic that had been selected, so they were confused about mapping the core material and branch material so the implementation of the strategy in this phase was not optimal. We also asked observers to observe social systems and principles of reaction when implementing the strategies developed. The results of the observations showed that the social system and the principle of reaction when implementing the soft scaffolding strategy were well implemented.

The Effectiveness of the Soft Scaffolding Strategy in Increasing the PCK of Prospective Physics Teachers

Data regarding the effectiveness of strategies for improving the PCK of prospective teachers were obtained through test instruments that contained indicators of pedagogical ability and content owned by prospective teachers. We analyzed the pre-test and post-test scores with descriptive statistics as shown in Table 3. The results of the analysis show that the pre-test and post-test data are not normally distributed. Then the data were analyzed using the non-parametric analysis of the Wilcoxon Signed Rank Test. The results of the analysis of paired data tests are presented in Table 4 and Table 5.

Table 3. Results of Pre-test Post-test Data Analysis with Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test_PCK	52	.00	45.90	16.7373	10.17637
Post-test_PCK	52	29.84	85.57	55.6877	12.86598
Valid N (listwise)	52				

Table 4. Ranks Analysis Results Using the Wilcoxon Signed Rank Test

		N	Mean Rank	Sum of Ranks
Posttest_PCK - Pretest_PCK	Negative Ranks	0[a]	.00	.00
	Positive Ranks	52[b]	26.50	1378.00
	Ties	0[c]		
	Total	52		

a. Posttest_PCK < Pretest_PCK
b. Posttest_PCK > Pretest_PCK
c. Posttest_PCK = Pretest_PCK

Table 5. Wilcoxon Signed Rank Test

	Posttest_PCK - Pretest_PCK
Z	-6.276[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

The Wilcoxon Signed Rank Test showed that the Z value is -6.276 with a p-value of 0.000 which means there is a significant difference between the pre-test and post-test mean. Based on the ranks analysis in Table 4.12, it is known that the average post-test score is higher than the pre-test score, this means that there is a significant increase in PCK after the soft scaffolding strategy implemented as a result of the development.

The effectiveness of implementing the developed soft scaffolding strategy is known through N-gain analysis. The average Gain value obtained based on the calculation results is 0.47 which means that the soft scaffolding strategy developed is effective in increasing the PCK of prospective Physics teachers. Several recent studies have identified pathways or frameworks for developing the PCK of prospective science teachers (Park et al., 2018; Richardson et al., 2018; Rollnick, 2017; Wilson et al., 2019; Wongsopawiro et al., 2017) tested the impact of implementing explicit and visible strategies to support the development of prospective teacher PCK, and the results showed positive results. Mavhunga et al (Mavhunga et al., 2016) have even researched the use of competency transfer strategies to change content knowledge learned in electric circuit material to new topics in chemistry or physics. However, of the many existing studies, none have focused on research samples with special characteristics. Our research is concerned with the characteristics of the sample we select using a purposive sampling technique, where the consideration is that we select prospective teachers who are very passive in learning. The characteristics of the sample were tracked and identified when researchers gave their lectures in courses other than School Physics. Researchers thought their passivity only existed in a few courses, but it wasn't. The prospective teachers that we sampled showed consistency of passivity when attending lectures in any subject. Researchers obtained these results based on the results of interviews with several lecturers in charge of the courses that involved our sample. They never ask when asked to ask, do not answer when asked to answer, and are just silent, they very rarely ask questions or opinions. They don't seem to show enthusiasm for studying. These findings reinforce the researchers' assumptions about the characteristics of prospective Physics teachers. Therefore, the novelty in our research is that we produce a soft scaffolding strategy that can be used to increase the PCK of prospective teachers who tend to be passive in attending lectures.

Furthermore, researchers not only measure the increase in PCK but also measure the PCK development of prospective teachers through each stage of the soft scaffolding strategy. PCK development data for prospective teachers is obtained through the existence of performance records of prospective teachers made by lecturers (mentors) starting from the stage of designing learning scenarios to the final stage in the form of peer teaching.

EVALUATION PHASE (FINAL PRODUCT)

At the evaluation stage, researchers make revisions and improvements related to the products developed to obtain the final product. The details of the activities in each strategy component in developing the PCK of physics teacher candidates are detailed at this stage.

The contribution to this research is that the researchers focus on how researchers develop soft scaffolding strategies that are easy for lecturers/mentors to apply to prospective teachers for the development of their PCK. A form of soft scaffolding that is developed in detail and is highly operational in technical terms. No research discusses as much detail as what the researchers have designed.

CONCLUSION AND SUGGESTION

The soft scaffolding strategy that we developed is based on the needs of our sample Physics teacher candidates and based on theoretical analysis that produces activity derivatives. The strategy is named EPiSODe which is an acronym for the strategy components which include: Encourage students, Pick the learning concept, Simulate the learning process, offer further consultation, and demonstrate the learning process. The internal validity showed that the soft scaffolding strategy was feasible to be implemented. Each strategy component is implemented at high or very high criteria, which means that the soft scaffolding strategy developed has been implemented properly. The social system and the principle of reaction when implementing the soft scaffolding strategy that we have developed are also implemented well. The average Gain value obtained based on the calculation results is 0.47 which means that the soft scaffolding strategy developed is effective in increasing the PCK of prospective Physics teachers. Each stage of the implementation of the strategy components developed shows that the PCK of the Physics teacher candidate is showing results towards positive developments. This study has a weakness where the analysis of the effectiveness of implementing the strategy is seen from the number of lecture participants who still tend to have a small sample. Therefore, future research is expected to be able to review the impact of implementing the soft scaffolding strategy that we have developed on a wider scale and with various sample characteristics.

AUTHOR CONTRIBUTIONS

NN and AB conducted a study on designing and implementing in the classroom and drafted an article. ES, IWD, and CE researched the development of the Soft Scaffolding Strategy. All authors read and approved the final draft article.

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