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Factors of Shaping Pedagogical Content Knowledge Self-efficacy for Preservice Physics Teachers Throughout Microteaching Course

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Abstract

The teacher's teaching ability is closely related to Pedagogical Content Knowledge (PCK). Teachers need to have PCK self-efficacy to support producing good performance in integrating PCK when teaching. Therefore, teacher education institutions must pay attention to PCK self-efficacy. During microteaching course activities, we learned that mastery of knowledge and teaching practices could increase PCK self-efficacy. Still, there is a decrease in PCK self-efficacy after self-reflection activities. Thus, we researched how these factors can increase or decrease their PCK self-efficacy. Research questions in this study include 1) How can mastery of knowledge and teaching practice shape the PCK self-efficacy of preservice physics teachers? and 2) How does teaching reflection shape the self-efficacy PCK of physics teacher candidates? This research is qualitative, with interviews. This study collected data by interviewing 17 of 51 preservice teachers with significant self-efficacy changes. The interview data was processed by giving codes; then, the codes were summarized to be used as conclusions. It was obtained that mastery of knowledge related to PCK makes them feel ready to teach. This readiness makes PCK self-efficacy increase. Positive reactions and feedback from lecturers and peers also increase the PCK self-efficacy of preservice teachers as validation that teaching abilities are indeed good. The increase in PCK self-efficacy after teaching practice activities was allegedly caused by the "reality shock" experienced. The decrease in self-efficacy is related to their metacognitive ability to realize that their teaching ability is still lacking. Therefore, we recommend further research on metacognition's role in preservice teachers' self-efficacy.

Keywords: Pedagogical and Content Knowledge (PCK), preservice teacher, self-efficacy.

Introduction

The quality of teachers is one of the main factors that affect the quality of education (Basaran & Yalman, 2020; Wiyarsi, Sutrisno, & Rohaeti, 2019)understanding of context-based learning (UCB. Preparing preservice teachers needs to be the focus of teacher education institutions to produce good teachers in teaching (Sæleset & Friedrichsen, 2022). Teaching is complex, including information content and presentation (Haryanto et al., 2021). Moreover, the teacher's ability to teach is closely related to Pedagogical Content Knowledge (PCK), which can be interpreted as integrating educational knowledge to teach specific content (Basaran & Yalman, 2020; Wiyarsi et al., 2019)understanding of context-based learning (UCB.

Self-efficacy is an important thing that teachers need to have in implementing learning (Handtke, Richter-Beuschel, & Bögeholz, 2022). Self-efficacy can influence teachers' emotions (Uzuntiryaki-Kondakci, Kirbulut, Oktay, & Sarici, 2022), teaching practice (Kruse et al., 2021), motivations (Vukelić, 2022) and the decision to determine the activities and arrangements of teaching activities (Kurosh, Yousefi, & Kashef, 2020; Semilarski, Soobard, Holbrook, & Rannikmäe, 2022). Self-efficacy has an essential role in the competency and teaching quality of a teacher or preservice teacher (Jia & Hermans, 2022; Mesci, Schwartz, & Pleasants, 2020) and can affect the achievement of student learning outcomes (De Smul, Heirweg, Van Keer, Devos, & Vandevelde, 2018; Karlen, Hertel, & Hirt, 2020).Teacher self-efficacy can be used to predict the teacher's active involvement (Johnson, King-Sears, & Miller, 2022) and joy in learning (Daumiller

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et al., 2021). Teacher self-efficacy is a belief in the teacher's ability to teach, including their confidence to connect with students and engage in learning (Walag, Fajardo, Bacarrisas, & Guimary, 2022); it is related to PCK. PCK has become famous and influential in promoting teacher competency (Vogelsang, Kulgemeyer, & Riese, 2022; Yanti, Riandi, & Suhandi, 2020). PCK is considered one the professional knowledge that is an essential source of teacher action in the classroom (Kulgemeyer et al., 2020). Good PCK illustrates good quality by the teacher in teaching (Efwinda & Mannan, 2021; Melo et al., 2020).

Teacher self-efficacy can be used to predict the teacher's active involvement (Johnson, King-Sears, & Miller, 2022) and joy in learning (Daumiller et al., 2021). Teacher self-efficacy is a belief in the teacher's ability to teach, including their confidence to connect with students and engage in learning (Walag, Fajardo, Bacarrisas, & Guimary, 2022); it is related to PCK. PCK has become famous and influential in promoting teacher competency (Vogelsang, Kulgemeyer, & Riese, 2022; Yanti, Riandi, & Suhandi, 2020). PCK is considered one the professional knowledge that is an essential source of teacher action in the classroom (Kulgemeyer et al., 2020). Good PCK illustrates good quality by the teacher in teaching (Efwinda & Mannan, 2021; Melo et al., 2020).

Research by Sorge et al. (2019) shows that someone with a higher PCK has a higher self-concept. High teaching self-efficacy can make teachers more open to implementing various learning methods to support student success (Karlen et al., 2020; Walag et al., 2022). In other words, the ability of PCK can increase self-efficacy (Haryanto, Sulaeman, Nuryadin, Putra, et al., 2021). Low self-efficacy can affect the type of learning method teachers implement (Kinskey & Callahan, 2022) and ultimately make them prefer traditional teaching methods (Jia & Hermans, 2022). Several studies related to efforts to improve teaching self-efficacy, for example, through successful teaching experience (Menon & Azam, 2021), collaboration among teachers (Johari, Saad, & Kasim, 2022)as well as data on teacher collaboration and self-efficacy.
 A number of 410 secondary school teachers in the northern part of peninsular Malaysia were involved in the study as survey respondents. The collected data was processed and analyzed using statistical package for the social sciences (SPSS, reflection and collaborative activities (Li et al., 2022), training guidance (Haatainen, Turkka, & Aksela, 2021), mastery of knowledge, and reflection on teaching experience (Sharma et al., 2021). However, not all research shows that teaching reflection is related to teaching self-efficacy, for example, a study by Kurosh et al. (2020). Menon & Azam (2021) state that further research is needed to explore the relationship between teaching reflection activities and their teaching self-efficacy and how these two aspects interact to form self-efficacy in the long term.

Several studies related to efforts to improve teaching self-efficacy, for example, through successful teaching experience (Menon & Azam, 2021), collaboration among teachers (Johari, Saad, & Kasim, 2022), reflection and collaborative activities (Li et al., 2022), training guidance (Haatainen, Turkka, & Aksela, 2021), mastery of knowledge, and reflection on teaching experience (Sharma et al., 2021). However, not all research shows that teaching reflection is related to teaching self-efficacy, for example, a study by Kurosh et al. (2020). Menon & Azam (2021) state that further research is needed to explore the relationship between teaching reflection activities and their teaching self-efficacy and how these two aspects interact to form self-efficacy in the long term.

Our previous study (Haryanto et al., 2023) showed that the PCK self-efficacy of preservice teachers increased after lecturers' presentation of information about PCK and teaching practice activities by preservice teachers in microteaching courses. Still, the self-efficacy PCK of preservice teachers decreased after the self-reflection activity. Therefore, it is crucial to dig deeper into how mastery of knowledge, teaching practice, and reflection activities can shape the teaching self-efficacy of preservice teachers. The research questions in this study are as follows:

1) How can mastery of knowledge and teaching practice shape the PCK self-efficacy of preservice physics teachers?
2) How does teaching reflection shape the self-efficacy PCK of physics teacher candidates?

Method

This research is qualitative, with interviews. As a first step, we distributed the self-efficacy PCK questionnaire adapted from Arsal to map changes in self-efficacy during microteaching lectures. PCK self-efficacy in the questionnaire is divided into three domains, including Pedagogical Knowledge (PK), Content Knowledge (CK), and Pedagogical Content Knowledge (PCK). The PK domain is related to applying pedagogical knowledge well, such as believing they can understand student characteristics. The CK domain relates to the belief that preservice teachers use knowledge of the physics content that will be taught, for example, the belief that they can convey teaching material without causing misconceptions. The PCK domain relates to beliefs in integrating educational knowledge and the content to be taught, for example, the belief in choosing and using appropriate learning approaches, methods, and models by adjusting the characteristics of students and the material to be taught.

Research Design

In the previous study, we provide two treatments to improve the PCK self-efficacy of preservice teachers, as shown in Figure 1.

Figure 1 shows that the treatment given to treatment 1 presents information about PCK and teaching practice, and the second is a teaching reflection activity. The mapping questionnaire was given three times before and after treatment one and after treatment 2. The questionnaire results show that the PCK self-efficacy of preservice teachers increased after treatment one but decreased after treatment 2. Based on these results, in this study we conducted interviews with participants who had extreme changes in self-efficacy. This research explores how these factors (mastery of knowledge, teaching practice, and reflection activities) shape the teaching self-efficacy of preservice teachers.

Furthermore, the activities and Potential Sources of self-efficacy contained in the Microteaching course are presented in Table 1.

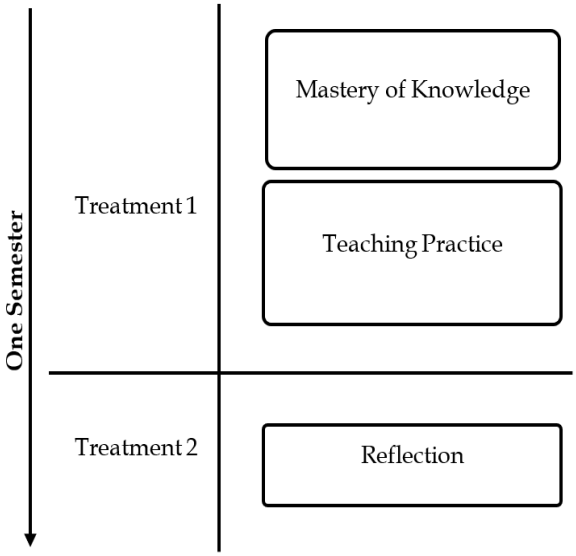

Fig. 1: Research Flowchart

Table 1: Activity details and potential sources of self-efficacy

The meeting	*Detailed descriptions of discussions or assignments in the course Microteaching*	*Potential Sources of Self-efficacy*
	Pre-Test	
1	Introduction to PCK (Discussion about content standards and learning process standards)	Mastery of knowledge (Sharma et al., 2021),training guidance (Haatainen et al., 2021)
2	Introduction to TPACK	
3	(Discussion, creation, and guidance on high school physics learning plans) Assignment of making a concept map of one of the physics materials and	
4	a video explaining the material (CK Strengthening)	
5	Discussion of strategies approaches, and learning models that follow	
6	physics material (Reinforcement of PK) x	
	physics material (Reinforcement of PK)	
7	(Training Strengthening)	
	Midtest	
9	Discussion of Senior high school Physics curriculum (PCK Strengthening) (Teaching Practice for High School Physics)	Mastery of knowledge (Sharma et al., 2021), Training guidance (Haatainen et al., 2021) experience (Chen, Wu, & Hsin, 2022), Reflection on teaching experience (Menon & Azam, 2021; Sharma et al., 2021)
10	Discussion of Learning Flow Development (PCK Strengthening)	
11	Discussion and Assignment	
12	Development of student worksheets (PCK Strengthening)	
13	Discussion and Assignment Development of a Learning Implementation Plan	
14	(PCK Strengthening)	
15	(Reflect on teaching practices that have been carried out)	
16	Discussion on Scientific approach according to OECD PISA (PCK Strengthening)	

Participants

Participants in this study were 17 out of 51 preservice physics teachers with considerations including 1) some participants who had the highest increase in self-efficacy, 2) some participants who had the highest decrease in self-efficacy, 3) some participants who experienced an increase in Treatment 1 but decreased after Treatment 2.

Of the existing study participants, 10.3% were male, and 89.7% were female. 48.3% had no teaching experience, 37.92% had taught for one year, 13.78% had taught within 1-2 years, and none had teaching experience > 2 years.

Data Collection

The data collection technique was in the form of an interview technique using an interview sheet instrument. In this study, the interview sheet seeks to reconfirm the consistency of the scores given by preservice teachers in the questionnaire, the reasons for scoring them, and their views on how the treatment can increase or decrease their PCK self-efficacy. Experts have validated the interview sheet through FGD activities. The interview sheet consisted of seven questions.

Data Analysis

The answers from the research participants were then processed into data, grouped with the same answers, then summarized, and conclusions were drawn regarding how mastery of knowledge, teaching practice, and reflection could increase or decrease their PCK self-efficacy.

Findings

This section will present research results regarding: 1) increasing their self-efficacy after obtaining information related to PCK and after carrying out teaching practice activities and 2) decreasing their teaching self-efficacy after teaching reflection activities.

RQ 1: How does mastery of knowledge and teaching practice shape PCK self-efficacy?

The answers from the preservice physics teachers' interviews to answer research question 1 were analyzed by coding and grouping similar answers. Conclusions were drawn from all types of responses obtained. Examples of statements by preservice physics teachers regarding increasing PCK self-efficacy are presented in Table 2.

RQ2: How does teaching reflection shape the PCK self-efficacy of preservice physics teachers?

The answers from the physics teacher candidate interviews to answer research question number 2 were analyzed by coding and grouping similar answers. Conclusions were drawn from all the types of answers obtained. An example of interview answers for preservice teachers is presented in Table 3.

Discussion

RQ1: How does mastery of knowledge and teaching practice shape PCK self-efficacy?

Table 2: The answers of preservice teachers are related to increasing PCK self-efficacy.

Participant	*Preservice teachers answer*	*Keywords*
P1	In my opinion, practical teaching activities through microteaching courses by teaching directly in front of lecturers and peers have a role in increasing my self-efficacy in teaching. This opinion is because after practicing teaching, I get praise directly from the lecturer regarding the teaching that I do. Lecturers and other friends also provide input on what I can improve in teaching. The information from the lecturers and friends can increase my knowledge, so I am sure I can be even better at teaching in the future.	Succeed in teaching practice.
P5	Gaining new knowledge in theory and the opportunity to put these theories into practice directly increased my PCK self-efficacy. After practicing teaching, I also became increasingly aware that it is necessary to make initial observations to determine students' characteristics before teaching. It is also essential to discuss with those more experienced, such as teachers and lecturers—knowing what to prepare and what is needed to teach increases my self-efficacy.	Upgrading Mastery of Knowledge
P10	Lecturer activities that pay attention to preservice teachers in teaching and comment on what needs improvement have increased my PCK Self-efficacy.	Evaluation in Mastery of Knowledge
P14, P15, and P17	Through lecture activities, I have learned about PCK, how to make lesson plans, how to determine learning methods and models, and do teach practice, so I feel ready and confident that I can teach well.	Applying Mastery of Knowledge on Teaching Practice

Table 3: The answers of preservice teachers are related to increasing PCK self-efficacy.

Participant	*Preservice teachers' answer*	*Keywords*
P2	After the self-reflection activity, I realized that there were still many shortcomings in my teaching practice, thus reducing my self-confidence to teach well.	Many shortcomings
P4, P12	Observing teaching practice activities carried out by my friends makes me reflect that my friends have better teaching skills than me, and this causes my self-efficacy to decrease.	Comparing self to peer
P6, P8	During teaching reflection, I realized that what I had learned was still insufficient to teach well because many other factors in the field also had to be considered during teaching practice. After reflection, I am increasingly aware that effective lesson planning must also adapt to students' character.	"Reality Shock" and lack of preparation

Table 2 shows that the information related to PCK given by the lecturers can increase preservice teachers' understanding of teaching. Based on preservice teachers' opinions, mastery of knowledge about PCK gives them enough provisions to teach and boosts their confidence to teach well. Mastery of knowledge related to PCK makes them feel capable of creating lesson plans and determining appropriate learning methods and models; with that, they are ready to teach. This readiness makes PCK self-efficacy increase. This statement is consistent with Sulaeman et al. (2022), who stated that teaching implementation's success is influenced by teaching readiness.

Teaching practice and mentoring activities by lecturers can increase the PCK Self-efficacy of future teachers in teaching. This statement follows Nikoçeviq-Kurti (2022), which states that mentor teachers' attributes can affect self-efficacy. Positive reactions and feedback from lecturers and peers have been considered to validate their teaching abilities. This validation from other people further strengthens or increases their self-confidence that they have succeeded in teaching, are good, and will be able to teach well in the future. Because of this praise, preservice teachers feel that they have experienced progress in teaching. Based on research, science teaching activities, especially those directly placed in schools or the field, will increase self-efficacy in teaching (Cavanagh, 2018). In essence, the preservice teachers must appreciate their experience, either succeeding or not (Park, 2022). Accordingly, preservice teachers stay broad-minded regarding mastery of knowledge and teaching practice training as the first step of the learning process.

Lectures with practice are also one of the efforts to increase the mastery of knowledge of preservice teachers. Mastery of knowledge is an aspect that plays a role in increasing PCK self-efficacy (Sharma et al., 2021). Following the results of research by Semilarski et al. (2022), increasing mastery of knowledge and involving students in learning can increase PCK Self-efficacy in Preservice Teachers. This explanation can state that the preservice teacher's mastery of knowledge must be accompanied by teaching practice to improve teaching skills to increase the Physics Preservice teacher's PCK Self-efficacy.

Moreover, based on the results of interviews with P5, a preservice teacher with high PCK self-efficacy can accept openness and enthusiasm for something new. Something new provides a challenge that can increase the preservice teacher's PCK self-efficacy. Apart from teaching and mentoring practices, adequate preparation regarding student characteristics by conducting discussions with experts such as teachers and lecturers will increase PCK self-efficacy. The preparation obtained from experts such as lecturers and teachers provides perceptions about students who will be more on target.

Experience in teaching practice is essential to teacher education in various countries (Vogelsang et al., 2022). Direct experience given in teaching institutions can increase self-efficacy (Handtke et al., 2022). Experience is necessary for teachers, both successful and unsuccessful experiences, and teaching experience is very influential in the mastery of knowledge. Field experience aims to bridge the gap between mastery of understanding and the ability to teach in PCK Self-efficacy. The more experience you have, the more solutions you can provide; the more solutions, the less failure. Thus, it will not reduce the self-efficacy of preservice physics teachers.

RQ2: How does teaching reflection shape the PCK self-efficacy of preservice physics teachers?

Table 3 shows that most preservice teachers have decreased self-efficacy after self-reflection activities. Self-reflection activities make them realize their teaching skills and experience are still lacking, and they feel they have failed in teaching practice. After the reflection activity, preservice teachers realize there are still many teaching activities they

do not know or practice; as a result, they feel they have failed. The failure, they think, is also caused by seeing friends or other preservice teachers who teach better than they have practiced. When teachers are successful in teaching, they will tend to be confident in their teaching abilities; likewise, when teachers are not successful in teaching, they will doubt their teaching abilities, and their self-efficacy will decrease (Gale et al., 2021).

The ability to reflect is described as a core teacher skill and has been investigated in many studies in general and physics teacher education (Kulgemeyer et al., 2021). Preservice physics teachers should have this ability because it is precious in developing PCK. Efwinda & Mannan (2020) shows that the ability of preservice teachers in Indonesia to reflect on learning is only in the sufficient category. Self-efficacy itself influences field experience and judgment from experts and peers. Self-reflection not obtained from peers or experts negatively impacted the development of preservice teacher PCK. The low PCK of preservice teachers affects their self-efficacy. Hence, reflection is the outside context of an experience that has not yet been experimented with. So, the preservice teacher did not quite conduct reflection properly. The research results also say that self-reflection does not produce positive developments during direct practice in the field (Pieper, Roelle, & Berthold, 2020). The reflection will positively impact if it is carried out with the correct procedures involving experts and peers. Reflecting without peers and experts can result in negative judgments about the PCK development of preservice PCK teachers. It can lead to a decrease in the self-efficacy of future teachers.

Conclusion

The results have fulfilled the research objective to dig deeper into how knowledge acquisition, teaching experience, and reflection activities can shape the PCK self-efficacy of preservice physics teachers. Based on the research results, it can be concluded that mastery of knowledge makes preservice physics teachers feel capable of creating lesson plans and determining appropriate learning methods and models; with that, they are ready to teach. This readiness makes PCK self-efficacy increase. Positive reactions and feedback from lecturers and peers also increase the PCK self-efficacy of preservice teachers as validation that their teaching abilities are indeed good. This validation from other people further strengthens or increases their self-confidence that they have succeeded in teaching, are good, and will be able to teach well in the future. Because of this praise, preservice teachers feel that they have experienced progress in teaching.

Interestingly, after the teaching reflection activities allegedly caused by the "reality shock" experienced. The decrease in self-efficacy is related to their metacognitive ability to realize that their teaching ability is still lacking. The more understanding the preservice teacher has, the deeper the teacher knows their shortcomings.

Suggestion

The results of this study can be applied not only to preservice physics teachers but to every preservice teacher from various fields. All preservice teachers, even from different areas, carry out teaching-related activities that form PCK self-efficacy, such as mastery of knowledge, teaching experience, and teaching reflection. The results of this study help stakeholders and lecturers in teacher education institutions to design lecture activities in preparing preservice teachers to have high teaching self-efficacy. With high teaching self-efficacy, it is hoped that preservice teachers can implement these beliefs so that as a teacher in the future, they can implement high-quality learning and optimal student learning outcomes. Other researchers may also conduct further research exploring the relationship between self-efficacy and the metacognitive skills of teachers and future teachers.

Limitation

0This study involved few research participants compared to the total number of preservice teachers in Indonesia. Therefore, it is also necessary to conduct this research involving research participants on a large and representative scale to describe all preservice physics teachers in Indonesia.

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