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Self-Efficacy of PCK: An Exploration of Indonesian Prospective Physics Teacher Perspectives

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Abstract

As physics is considered difficult to understand, prospective physics teacher programs face the challenges of providing adequate Pedagogical Content Knowledge (PCK). Future teachers' self-efficacy is an essential factor affecting their teaching performance in the classroom. This study aimed to explore the self-efficacy of prospective physics teachers in Indonesia. Data were collected through a questionnaire with a Likert scale consisting of 18 statements and reasons for scoring. The questionnaire on self-efficacy was divided into the self-efficacy domain Content Knowledge (CK), Pedagogical Knowledge (PK), and PCK. The participants were 71 final-year students from 5 Physics Education Study Programs in Indonesia. According to the results, the total self-efficacy score of prospective teachers in physics was 6.98, which falls into the high category. In the CK, PK, and PCK domains, self-efficacy was 6.91, 7.06, and 6.93, respectively, in the high category. An in-depth analysis of students who responded in the low category showed that prospective teachers with low self-efficacy tend to be unsure that they have taught well. They believe that they have not fully mastered physics material and the characteristics of diverse students. Also, they have not gained significant teaching experience. According to these results, teacher education institutions must re-evaluate what learning activities can increase prospective teachers' self-efficacy in teaching and their teaching opportunities.

Keywords: Self-Efficacy, Prospective Teachers, Physics, PCK

INTRODUCTION

Many changes in the educational system mark the twenty-first century, the role of schools and teachers' function (Arcoverde et al., 2022). Teacher qualifications are expected to be much higher than before (Kiray, 2016). Teachers are crucial in implementing reform-based science teaching practices in the classroom (Kahveci et al., 2018). Educational institutions must organize teaching that equips prospective teachers to become independent learners (Shawer, 2013). Teacher education programs should have one goal toward promoting self-regulation skills for learning among students who aspire to become teachers to lead in their student's learning and skills development (Arcoverde et al., 2022).

One of the essential factors in developing these skills is self-efficacy (Bandura, 1993). Self-efficacy is a person's belief about their ability to perform a particular performance (Bandura, 1984; Mesci et al., 2020; Shawer, 2013; Thomson et al., 2021). Self-efficacy is also integral to self-regulated learning (SRL), crucial to developing lifelong independent learning skills (Shawer, 2013). Someone with high self-efficacy believes they can control various situations in completing the work until the job is finished (Bandura, 1994). Self-efficacy will affect one's planning, motivation, strategies, actions, and achievements (Shawer, 2013).

Several studies have shown that self-efficacy is not affected by gender differences (Hernández-Barco et al., 2021; Özdemir & Hastürk, 2021; Shahat et al., 2022). Self-efficacy increases with age and length of teaching experience (Kahveci et al., 2018), besides that it can also be improved through specific learning approaches (González-Gómez et al., 2022; Mukhtar et al., 2021). Differences in a person's level of self-efficacy will have a different impact on their learning and behavior. A person's experience of success and failure in completing a job will affect their self-efficacy. It can increase when students complete the task but decrease if they fail to fulfill it (Shawer, 2013). Self-efficacy positively correlates with the attitude of scientific inquiry and the comfort level in carrying out these activities (Smit et al., 2017). Someone with high self-efficacy believes he can control various situations to do the job well (Bandura, 1994).

In addition to being an independent learner, there are many knowledge systems that teachers need to master. Teachers must be able to integrate knowledge in content and pedagogy in teaching, and this framework is named Pedagogical Content Knowledge (PCK) (Shulman, 1986). PCK is the pedagogical knowledge needed to teach specific content, for example, physics (Kiray, 2016). Mastery of Content Knowledge (CK) and Pedagogical Knowledge (PK) domains as two different entities is not enough to implement learning for students (Kavanoz et al., 2015). PCK includes knowledge of what makes an idea difficult or easy to learn, students prior knowledge, and epistemological theory (Kiray, 2016).

Researchers in the PCK field argue that PCK is essential because teachers with better PCK will be more competent in supporting student learning (Kirschner et al., 2015). Teacher self-efficacy in teaching has a mutually influencing relationship with PCK. Increasing PCK will also increase teacher self-efficacy, which will be very helpful in the success of the implemented learning strategies (Thomson et al., 2021).

There have been many studies related to PCK that have been carried out in recent years, including the role of CK in teachers' PCK (Rollnick, 2017), the development of PCK science teachers in elementary schools (Bradbury et al., 2018), and the relationship between teacher PCK and practice (Barendsen & Henze, 2019). In addition to PCK research on teachers, research on PCK is also widely carried out on prospective teachers. For example, a study by Efwinda and Mannan (Efwinda & Mannan, 2020) on future physics teacher PCK in reflecting project-based learning activities, Coetzee (Coetzee et al., 2022), who conducted a case study of prospective teacher PCK teaching for the first time, and Putri et al. (Putri et al., 2021) that explored the pandemic context to this issue. However, these studies focus on the knowledge and skills aspects of PCK. No research has examined the PCK self-efficacy of prospective teachers, especially future physics teachers. Research related to this is essential because

prospective teachers' self-efficacy significantly affects PCK (Thomson et al., 2021) and the quality of their teaching (Kulgemeyer & Riese, 2018; Mesci et al., 2020). Based on these considerations, researchers explored the self-efficacy of PCK for prospective physics teachers in Indonesia.

The following research questions were asked:

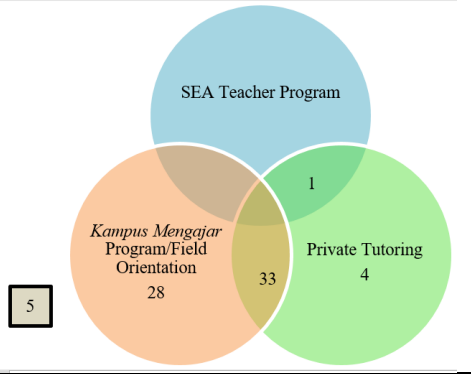
1. What is the PCK self-efficacy of prospective physics teachers in general?
2. What is the PCK self-efficacy of prospective physics teachers in PK, CK, and PCK?

METHOD

This study is exploratory research conducted to obtain an overview of the PCK self-efficacy of prospective physics teachers in Indonesia. The participants were 71 final-year students from 5 physics education study programs in Indonesia. The information regarding participants' gender and teaching experience is displayed in Table 1.

Table 1. The Details of Participants

Gender	Number of Participants				
	Duration of Teaching Experience				Types of Teaching Experience
	Have no experience	< 1 year	1-2 year	>2 year	Total
Male	1	17	1	1	20
Female	4	32	9	6	51
Total	5	49	10	7	71



Data were collected through a self-efficacy questionnaire with a Likert scale of 1-9, divided into content knowledge (CK), Pedagogical Knowledge (PK), and PCK domain. The questionnaire consists of 18 statements and reasons for giving the score accompanied by three (representing a CK, PK, and PCK domain). The questionnaire was adapted from Arsal (Arsal, 2014).

The participants' questionnaires are scored and input into the Microsoft Excel program to obtain an average score. After getting the average score of answers from the questionnaire, students are grouped using a criteria-referenced approach (Kaplan & Saccuzzo, 2017). Categorization is divided into five groups adapted from (Haryanto et al., 2023), as shown in Table 2.

Table 2. The Category of PCK Self-Efficacy

No	Category	Average Score
1	Very Low	$1 \leq x \leq 2,6$
2	Low	$2,6 < x \leq 4,2$
3	Moderate	$4,2 < x \leq 5,8$
4	High	$5,8 < x \leq 7,4$
5	Very High	$7,4 < x \leq 9$

RESULTS AND DISCUSSION

The prospective physics teachers' PCK self-efficacy, generally, and in each domain presented in this section. The data were analyzed by calculating the average score future teachers gave on the 18 statements in the questionnaire. Further analysis was carried out by exploring the reasons for scoring by prospective physics teachers on three ideas representing the CK, PK, and PCK domains.

Prospective Physics Teachers' Self-Efficacy in General

The average self-efficacy score of prospective physics teachers is 6.98, which is in the high category. The percentage of the number of future physics teachers in each category is generally presented in Figure 1.

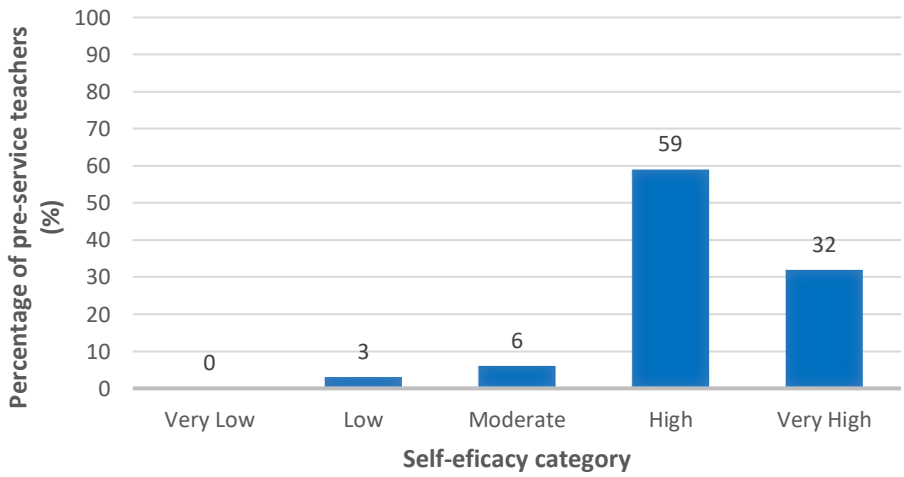


Figure 1. The Percentage of Prospective Physics Teachers in Each Self-Efficacy Category

Most prospective physics teachers have a high self-efficacy category, and none of them are in a very low one. The results obtained are good but still need to be improved. Their self-efficacy influences their motivation to make some effort to perform well (Lin, 2021). It can be considered that a person with high self-efficacy will also have a high level of motivation to make efforts to achieve the desired performance. High self-efficacy can make a person able to organize tasks properly and will mobilize all abilities they have to complete tasks (Latifah &

Ratnaningsih, 2022). Someone with high self-efficacy tends to dare to take and face challenges (Mon, 2022). This is supported by Sharp et al. (2022), which state that a teacher with high self-efficacy can better deal with pressure that may occur in the classroom. It is hoped that prospective physics teachers will also perform well in teaching physics with high self-efficacy.

Prospective Physics Teachers' Self-Efficacy in Each Domain

Data analysis of each domain PCK self-efficacy score was also carried out. The results are presented in Figure 2.

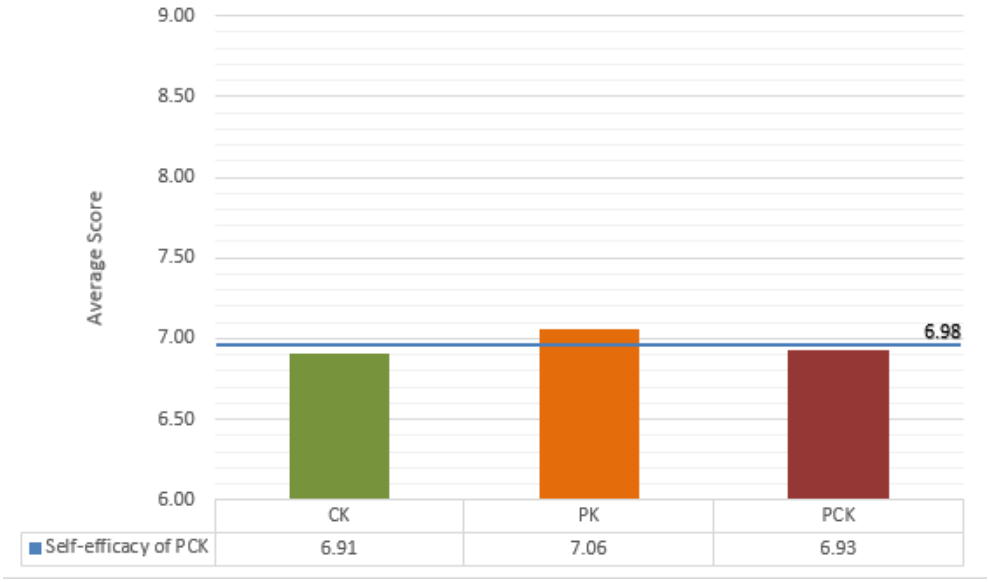


Figure 2. Average PCK Self-efficacy Score of Prospective Physics Teachers

Based on Figure 2, the PK has the highest average score among other self-efficacy domains. In addition, in this PK domain, the average score is above the average self-efficacy score. The CK and PCK domains' average score is below the average self-efficacy score.

Each category's percentage of self-efficacy data is also analyzed in each domain, as shown in Figure 3. In each component, most prospective physics teachers are in high self-efficacy. No future physics teacher is in the deficient self-efficacy category.

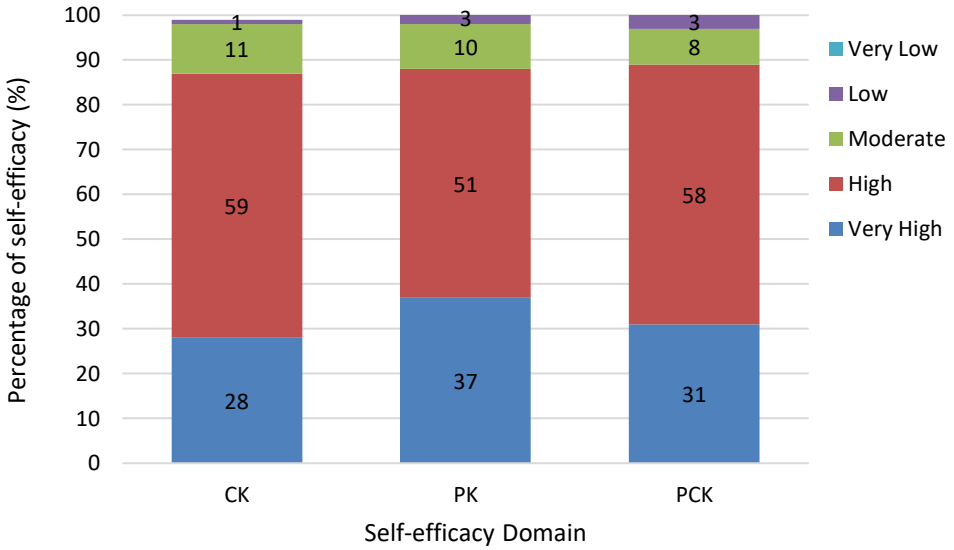


Figure 3. PCK Self-Efficacy Percentage in Each Category and Domain

Further analysis was carried out on three questionnaire statements accompanied by the reasons for giving the score. Table 3 presents several reasons for prospective physics teachers to score their self-efficacy in teaching, representing each score: lowest, neutral, and highest scores.

Table 3. Reasons for Scoring

No	Domain	Reason For Scoring		
		2	5	9
1	CK	*R41: For me, learning concepts in physics is quite difficult, so I am unsure about the proper delivery.*	*R69: Because the material being taught is still complex for students to understand, there is a possibility that misconceptions will arise; therefore I can not say I am sure about the learning that I give.*	*R67: Because I prepare the material before teaching, I have a principle that the teacher must first understand it before it is taught.*
2	PK	*R69: Due to the different characteristics of each student, I feel less sure that the learning I provide can match these characteristics.*	*R60: Because every student has different characteristics, so adjusting the learning management for each student is quite challenging to do.*	*R53: I have experience and have been mentored in managing learning.*
3	PCK	*R34: I only teach the material with the lecture method or*	*R26: I chose neutral because I have confidence in my*	*R2: Before teaching, I try to adapt first to understand the*

	write it on the blackboard	*readiness, but I can not plan learning activities according to the character of the students*	*students' character and finally find the right design.* *R31: Sure, because I have prepared everything as well as possible before the lesson. From teaching materials, materials, methods, etc.*

In the CK domain, prospective teachers with low confidence in teaching tend to think that physics is complex to understand. The daily life that we experience is closely related to Physics (Sari et al., 2023). In addition, many other sciences are integrated with physics (Haryadi & Pujiastuti, 2022). Their limitations in understanding physics material affect their confidence in correctly conveying it to students. Emotions toward Physics, such as fear or rejection of specific science topics, can also reduce self-efficacy in teaching (Hernández-Barco et al., 2021). Therefore, prospective physics teachers must have a high commitment to learning physics. This result follows Wong et al. (Wong et al., 2021), which state that students' increased commitment to learning science tends to make them have high self-efficacy.

In the PK domain, the factors that most concern prospective physics teachers and affect their self-efficacy in teaching are related to student characteristics. Future teachers who choose low scores on their self-efficacy tend to be unsure if the learning they implement is appropriate for each student with diverse aspects. Understanding the characteristics of diverse students requires expertise and rich experience in teaching and interacting with students. This result follows research conducted by Seidel et al. (Seidel et al., 2021), which shows that teachers who are experts compared to novice teachers have more accurate abilities in justifying the characteristics of their students. Therefore, in lectures, it is necessary to facilitate prospective teachers to enrich their experiences to understand the aspects of students.

Prospective physics teachers who choose the highest score (very high level of confidence in teaching) in the CK, PK, and PCK domains tend to be adequately prepared and experienced. Their preparations made them very confident that they could teach physics well, such as through experiences in the microteaching course (Haryanto et al., 2021). The experience they have in teaching also plays a role in increasing their self-confidence. This result follows Kahveci et al. (Kahveci et al., 2018), Shawer (Shawer, 2013), and Wong et al. (Wong et al., 2021), who stated that a person's experience of a particular performance affects their self-efficacy.

A teacher with high self-efficacy is confident that he can perform well (Dökme & Koyunlu Ünlü, 2023). Self-efficacy can affect self-motivation (Leonardo & Cha, 2021) and teacher success in teaching (Nugent et al., 2022) and ultimately impact student learning outcomes (Yadav et al., 2021) and the surrounding community (Zorlu & Zorlu, 2021). Self-efficacy affects the learning carried out by students (Wan, 2021). As shown in various studies, Self-efficacy plays a role in developing teaching skills (Kim, 2020).

According to the reasons prospective physics teachers give self-efficacy scores, lecturers' role in aiding in learning management makes them confident in their ability to teach well. It is better if efforts increase prospective teachers' self-efficacy (Boz & Cetin-Dindar, 2021). Self-efficacy interventions in the curriculum can be carried out to improve the quality of future teacher-teaching practices (Haryanto et al., 2023). Self-efficacy in teaching science has a positive relationship with attitudes toward teaching science (Ecevit & Kıngır, 2022). Teacher education institutions need to facilitate learning activities that can increase the self-efficacy of prospective teachers (Lewis et al., 2021). Practical experience in the field and reflection activities are essential to achieve new levels of self-efficacy (Menon & Azam, 2021).

CONCLUSION

The self-efficacy of Prospective physics teachers in Indonesia was 6.98 in the high category. In the CK, PK, and PCK domains, the self-efficacy was 6.91, 7.06, and 6.93, respectively, considered in the high category.

Further analysis of students who responded in the low category showed that Prospective teachers with low self-efficacy tend to be unsure that they have taught well. Their limitations in understanding physics material in the CK domain affect their confidence in correctly conveying it to students. In the PK domain, the factors that most concern Prospective physics teachers and affect their self-efficacy in teaching are related to student characteristics. The experience they have in teaching also plays a role in increasing their self-confidence. Therefore, courses related to teaching experience for Prospective physics teachers need more severe support.

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