Exploring Teachers' Attitudes and Self-efficacy towards AI Learning in Science Instruction

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Abstract. As teachers strive to adapt to the technologically evolving landscape of education, understanding the impact of Artificial Intelligence (AI) on pedagogical practices becomes increasingly crucial. This study explores the contribution of Artificial Intelligent Learning (AI Learning) model to teachers' attitudes and self-efficacy in teaching science. As such, an educational intervention based on AI Learning was conducted with a sample of 13 primary school teachers. The teachers were asked to answer a Dimensions of Attitude toward Science (DAS) questionnaire designed for this study, before and after the intervention. Before the intervention, a significant percentage of teachers expressed disagreement about the importance of physics in primary education (53.8%) and had a negative attitude towards its introduction (46.2%). However, after the intervention, there was a substantial shift towards positive attitudes: 38.5% acknowledged the importance of physics and 38.5% expressed a positive intention towards its introduction. The intervention also positively impacted teachers' anxiety levels, enjoyment of teaching physics, and perceptions of their knowledge adequacy to support students. Additionally, there was a noticeable positive change in teachers' perceptions of their preparedness to provide help to students. The improvement of DAS score (mean 68.15 before intervention/mean 89.15 after intervention) indicates that the intervention led to a more positive attitude among teachers regarding the use of AI learning in teaching science.

Keywords: AI Learning, DAS-based questionnaire, technology acceptance, self-efficacy, teaching science, teacher attitude.

1 Introduction

Artificial Intelligence (AI) refers to computational technologies that allow machines to make decisions by mimicking human intelligence [1]. The advancements and innovations in AI have developed rapidly over the past years, and thus many organizations have integrated it into their daily activities [2, 3].

AI is an intersection of different sciences, since it makes use of ideas and tools from many scientific fields, such as psychology, computer philosophy, mathematics, neuroscience, linguistics, cognitive science, aiming to synthesize intelligent behavior with elements of adaptation to the environment and reasoning learning [4]. The primary advantage of AI lies in its utilization of algorithms—mathematical formulas—that enable systems to analyze data, identify patterns, and derive the most suitable solutions [5, 6].

AI in Education enhances personalized learning experiences, automates administrative tasks, and provides learning analytics to support student knowledge and skills acquisition and teacher effectiveness. [7, 8]. The turn of the century found educational stakeholders engaged in an intense debate about what skills and competences teachers need to possess to effectively implement AI in the classroom [9]. Many researches have highlighted the role of AI in teaching science, supporting that AI enhances the teaching and learning of science by providing personalized experiences, facilitating hands-on experimentation, and offering interactive learning [10, 11]. AI-powered simulations can create virtual labs where students can explore physical phenomena in a safe and interactive environment, assisting with data analysis in physics experiments, and empowering teachers [12, 13]. However, it is important to recognize that teachers need proper training to effectively integrate AI tools into their lessons, and to ensure they are used appropriately [14, 15, 16].

Considering the potential benefits of AI for education, this paper aims to investigate its effect to primary school teachers' attitudes and self-efficacy in teaching science.

2 Research Methodology

In order to explore the effect of AI Learning on teachers' attitudes and self-efficacy beliefs, an educational intervention was designed and a pre/posttest was carried out. As such, a Dimensions of Attitude toward Science (DAS) questionnaire was developed and distributed before and after the intervention. This questionnaire includes the following dimensions: science value, subjective difficulty, pleasure, anxiety, self-efficacy, context dependence, and intention to use. The 5-level Likert scale was used for assessing the survey questions, providing the following answers, except from intention to use dimension: strongly disagree, disagree, neutral, agree, and strongly agree. The 5-level Likert scale used for intention to use dimension is related to frequency, namely rarely, 1-2 times per year, 1-3 times per month, once a week, and every day. Table 1 illustrates the question items.

Table 1. DAS-based questionnaire.

Question Items
Dimension 1: Science value
Teaching Physics in the Primary Education is important for children's development.
Physics needs to be embedded in Primary Education as early as possible.
Teaching physics is essential in making primary school students involved in problems related to technology and society.
Teaching physics in primary education is so important that non-experienced teachers should receive additional training in this field.

I believe that teaching physics in primary education is essential so that students can make good choices about their studies.
Dimension 2: Subjective difficulty
I find the topics of the physics course complex. I encounter difficulties when teaching physics. I find that physics is a difficult subject to teach in terms of content.
Dimension 3: Pleasure
Teaching physics is a pleasure for me. I particularly enjoy teaching physics. I feel happy when I teach physics. Teaching physics makes me happy.
Dimension 4: Anxiety
Teaching Physics causes me stress. I am stressed when I have to teach the physics lesson. I feel nervous while teaching the physics lesson. I feel tense when I teach the physics lesson.
Dimension 5: Self-efficacy
I know enough about the content of physics to teach this subject well. I can deal with my students' questions about the physics lesson. I have sufficient knowledge of the material to effectively support students well in physics lesson. If students cannot find a solution during an assignment on Physics, I can help them.
Dimension 6: Context dependence
What teaching method is applied is crucial to whether or not I teach physics in the class. The availability of an existing package of materials, ready to use, is essential for me to teach Physics. The support of colleagues and the school is crucial to whether or not I will teach the physics lesson.
Dimension 7: Intention to use
How often do you use activities where technology is used in relation to the physics lesson? How often do you plan and prepare your physics lesson? How often do you conduct research with your students? How often do you allow your students to actually conduct research or try to discover something without following a predetermined procedure?

The sample consists of 13 primary school teachers (male and female), selected based on the purposive sampling, using the following specific criteria: teaching experience, prior science knowledge, and grade level (primary school teachers). The demographical characteristics of the participants are shown in Table 2. In particular, 92,3% of the sample are women while 7,7% are men. 92.3% are between 24 and 30 years old while the remaining 7.7% are between 31 and 40 years old. Most of them (84.6%) have between 1 and 3 years of experience in science instruction, while 15.4% have between 4 and 6 years.

Table 2. Demographical characteristics.

		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Gender	Men	1	7,7	7,7	7,7
	Woman	12	92,3	92,3	100,0
Age	24-30 years	12	92,3	92,3	92,3
	31-40 years	1	7,7	7,7	100,0
Years of experience	1-3	11	84,6	84,6	84,6
	4-6	2	15,4	15,4	100,0

3 Intervention Process

The study employed a three-session intervention designed to investigate the potential of chatbot technology within the context of teaching science. The intervention was conducted within the Information Technology (IT) room of the participating school, having a space equipped with modern technological resources, including internet access and thirteen computers with projector capabilities. The duration of the intervention was over a fifteen-day period.

Session 1 (50 minutes)

Pre-Intervention Assessment: A questionnaire, disseminated via Internet, was completed by the thirteen participants involved in the study. This instrument aimed to gather baseline data on the participants' pre-existing views regarding the influence of technology on physics pedagogy, their understanding of AI, and its potential application within the educational domain.
Interactive Discussion: Following the completion of the questionnaire, a facilitated discussion was initiated. This discussion centered around the participants' perspectives on the impact of technology on physics instruction, exploring the definition of AI and its potential integration within the educational landscape.

Session 2 (45 minutes):

Chatbot Technology Introduction: A concise presentation was delivered to introduce the concept of chatbot technology. The presentation explored the core functionalities of chatbots and their potential applications within the educational process. Specific focus was placed on the advantages associated with chatbot technology, including reduced preparation time and enhanced accessibility.
Interactive Exploration: Following the presentation, participants had the opportunity to raise questions concerning the future implementation and reliability of AI tools within the educational sphere.
Hands-on Experience: Each participant was provided with access to the specific chatbot tool employed in the study. An email containing the tool link (https://www.aichatting.net/) was distributed, and participants were granted unrestricted access to explore and experiment with the functionalities of the chatbot for educational purposes.

Session 3 (40 minutes):

Chatbot-Aided Lesson Planning: With the chatbot interface displayed on their screens, participants were tasked with utilizing the tool to identify activities pertinent to organizing physics lessons. Engaging in collaborative dialogue, participants constructed a sample physics lesson plan, utilizing the information retrieved from the chatbot tool. Discussions ensued, focusing on the extracted information and its potential applications in future lesson planning endeavors.

Post-Intervention Assessment:

A post-intervention questionnaire was distributed via email. This instrument aimed to gather data on the participants' experiences with the intervention.

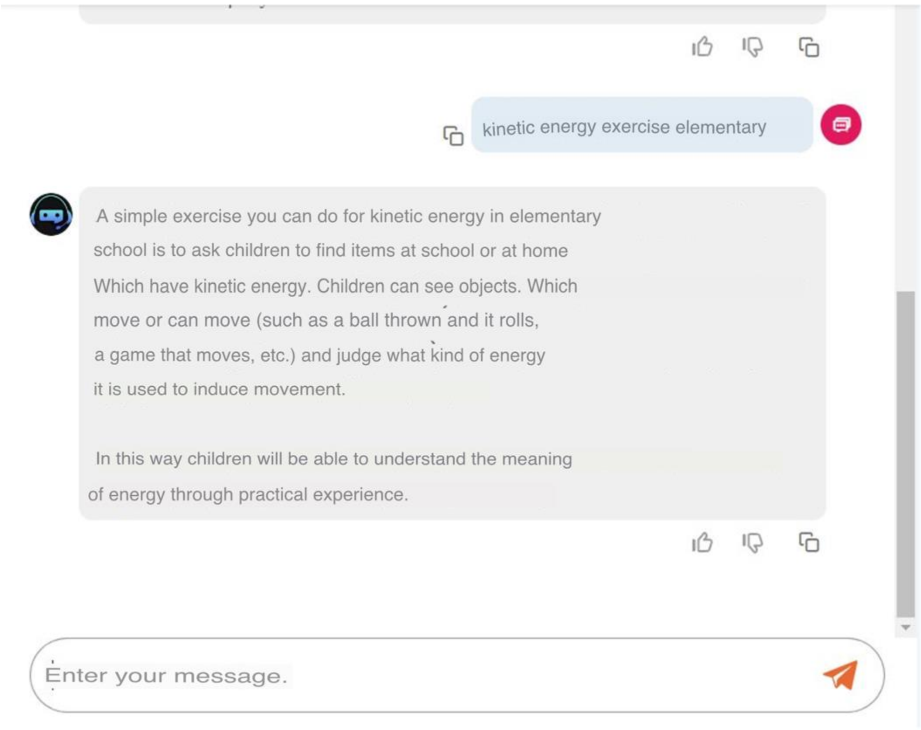

Fig. 1. Example of operation.

4 Evaluation Results and Discussion

4.1 Value of Sciences

Regarding the value of sciences, it should be noted that before the intervention, all of the teachers disagreed with the statement "*Teaching physics is essential in getting primary school students involved in problems related to technology and society*". While, after the intervention, there was a significant change, as the majority of them agreed with the statement (Table 3). This change shows that teachers gained a better understanding of the connections between physics, technology, and societal issues.

Moreover, the intervention provided teachers with effective strategies to integrate these concepts into their lessons.

Table 3. Teaching physics is essential in getting primary school students involved in problems related to technology and society.

Answers	Before Intervention		After Intervention	
	Frequency	Percent	Frequency	Percent
Totally disagree	5	38,5	1	7,7
Disagree	8	61,5	4	30,8
Neutral	0	0	1	7,7
Agree	0	0	6	46,2
Totally agree	0	0	1	7,7
Total	13	100,0	13	100,0

Before the intervention, teachers either disagreed with or had a neutral attitude toward the statement, "Teaching physics in primary education is so important that non-experienced teachers should receive further training in this field." However, after the intervention, 23.1% of the teachers agreed with this statement, significantly reducing the percentage of disagreement (Table 4). This shift in attitude may have occurred because by understanding how AI tools, like chatbots, can enhance lesson planning and delivery, teachers recognized the value of specialized training for non-experienced teachers.

Table 4. Teaching physics in primary education is so important that non-experienced teachers should receive further training in this field.

Answers	Before Intervention		After Intervention	
	Frequency	Percent	Frequency	Percent
Totally disagree	2	15,4	1	7,7
Disagree	6	46,2	4	30,8
Neutral	5	38,5	5	38,5
Agree	0	0	2	15,4
Totally agree	0	0	1	7,7
Total	13	100,0	13	100,0

4.2 Subjective Difficulty

A substantial portion of teachers (38.5%) maintain a neutral stance regarding the challenges they face while teaching physics, both before and after the intervention (Table 5). A possible reason why this neutrality was observed is why teachers might still be uncertain about the effectiveness of AI tools like chatbots in addressing the specific challenges they encounter in teaching physics

Table 5. I encounter difficulties when teaching physics.

Answers	Before Intervention		After Intervention	
	Frequency	Percent	Frequency	Percent
Totally disagree	3	23,1	2	15,4

Disagree	2	15,4	0	0
Neutral	5	38,5	5	38,5
Agree	3	23,1	3	23,1
Totally agree	0	0	3	23,1
Total	13	100,0	13	100,0

Before the intervention, 30.8% of teachers acknowledged physics as a challenging subject to teach in terms of its content. However, following the intervention, the majority (53.8%) expressed disagreement with the notion that physics is difficult to teach (Table 6). This change in attitudes may be due to the fact that by learning how to use AI tools like chatbots for lesson planning, teachers could leverage technology to simplify complex physics topics, making them easier to teach.

Table 6. I think physics is a difficult subject to teach in terms of content.

	Before Intervention		After Intervention	
Answers	Frequency	Percent	Frequency	Percent
Totally disagree	3	23,1	3	23,1
Disagree	3	23,1	7	53,8
Neutral	3	23,1	2	15,4
Agree	4	30,8	1	7,7
Totally agree	0	0	0	0
Total	13	100,0	13	100,0

4.3 Pleasure and Anxiety

Before the intervention, 46.2% of teachers disagreed with experiencing pleasure while teaching physics. However, after the intervention, 53.8% of teachers reported feeling joy associated with teaching physics (Table 7). This positive shift in teachers' attitudes can be because the use of AI Learning likely made the teaching process more interactive and engaging. By simplifying lesson planning and offering dynamic teaching aids, the AI tools helped teachers create more enjoyable and effective lessons.

Table 7. Teaching physics is a pleasure for me.

	Before Intervention		**After Intervention**	
Answers	Frequency	Percent	Frequency	Percent
Totally disagree	3	23,1	1	7,7
Disagree	6	46,2	3	23,1
Neutral	4	30,8	1	7,7
Agree	0	0	7	53,8
Totally agree	0	0	1	7,7
Total	13	100,0	13	100,0

Before the intervention, 38.5% of the teachers expressed a neutral stance regarding the stress induced by teaching physics. However, after the intervention, 38.5% of teachers disagreed with experiencing stress while teaching physics (Table 8). It seems that the use of AI tools helped teachers reduce the time and effort required to prepare engaging physics lessons, as well as have access to further resources, reducing the stress associated with feeling unprepared or inadequate.

Table 8. Teaching Physics causes me stress.

Answers	Before Intervention Frequency	Before Intervention Percent	After Intervention Frequency	After Intervention Percent
Totally disagree	2	15,4	3	23,1
Disagree	3	23,1	5	38,5
Neutral	5	38,5	4	30,8
Agree	3	23,1	1	7,7
Totally agree	0	0	0	0
Total	13	100,0	13	100,0

4.4 Self-efficacy of teachers

Prior to the intervention, a significant majority of participants asserted confidence in their knowledge of physics lesson content, believing it to be sufficient for effective classroom instruction. Following the implementation of the intervention, this conviction was further reinforced (Table 9).

Table 9. I know enough about the content of physics to teach this subject well.

Answers	Before Intervention Frequency	Before Intervention Percent	After Intervention Frequency	After Intervention Percent
Totally disagree	1	7,7	0	0
Disagree	1	7,7	0	0
Neutral	3	23,1	1	7,7
Agree	6	46,2	6	46,2
Totally agree	2	15,4	6	46,2
Total	13	100,0	13	100,0

Moreover, after the intervention, there is a perceptible improvement in teachers' readiness to support children within the classroom setting (Table 10). It seems that the intervention provided teachers with deeper knowledge and improved skills, particularly in using AI tools, which increased their overall readiness and confidence in supporting students.

Table 10. I can deal with my students' questions about the physics lesson.

Answers	Before Intervention Frequency	Before Intervention Percent	After Intervention Frequency	After Intervention Percent
Totally disagree	2	15,4	1	7,7
Disagree	3	23,1	0	0
Neutral	7	53,8	5	38,5
Agree	1	7,7	6	46,2
Totally agree	0	0	1	7,7
Total	13	100,0	13	100,0

Prior to the intervention, 46.2% of teachers expressed disagreement regarding their capacity to offer assistance to their students. However, following the intervention, there was a notable shift towards a more positive attitude, with 30.8% indicating confidence in their ability to address children's needs and provide effective support (Table 11).

Table 11. If students cannot find a solution during an assignment on Physics, I can help them.

	Before Intervention		After Intervention	
Answers	Frequency	Percent	Frequency	Percent
Totally disagree	3	23,1	0	0
Disagree	6	46,2	2	15,4
Neutral	4	30,8	4	30,8
Agree	0	0	4	30,8
Totally agree	0	0	3	23,1
Total	13	100,0	13	100,0

4.5 Context dependence

Before the intervention, the majority of teachers (53.8%) were neutral about the role that the scientific method of teaching plays in the decision to teach physics. However, after the intervention, 53.8% of the teachers agreed on the importance of the scientific method, significantly changing their perspective (Table 12). The intervention likely provided teachers with a clearer understanding of how the scientific method can improve the effectiveness of teaching physics, making them more aware of its benefits.

Table 12. What teaching method is applied is crucial to whether or not I will teach Physics.

	Before Intervention		After Intervention	
Answers	Frequency	Percent	Frequency	Percent
Totally disagree	1	7,7	0	0
Disagree	3	23,1	0	0
Neutral	7	53,8	5	38,5
Agree	2	15,4	7	53,8
Totally agree	0	0	1	7,7
Total	13	100,0	13	100,0

Before the intervention, 38.5% of teachers agreed that having an existing, ready-to-use materials package is essential for teaching physics in the classroom. This statement was strengthened after the intervention (Table 13). The intervention likely demonstrated the benefits of having well-prepared materials, making teachers more aware of how these resources can enhance their teaching efficiency and effectiveness.

Table 13. The availability of an existing package of materials, ready to use, is essential for me to teach Physics.

	Before Intervention		After Intervention	

Answers	Frequency	Percent	Frequency	Percent
Totally disagree	1	7,7	0	0
Disagree	1	7,7	0	0
Neutral	3	23,1	2	15,4
Agree	5	38,5	6	46,2
Totally agree	3	23,1	5	38,5
Total	13	100,0	13	100,0

4.6 Intention to use

Concerning the frequency of incorporating technology-based activities into physics lessons, before the intervention the majority reported engaging in such practices either 1-2 times a year or 1-3 times a month. However, after the intervention, most teachers indicated that they intend to use technology-based activities more frequently (Table 14). It seems that teachers may have gained a deeper understanding of the benefits of technology-based activities, such as increased student engagement and improved understanding of complex concepts.

Table 14. How often do you use activities where technology is used in relation to the Physics lesson?

	Before Intervention		After Intervention	
Answers	Frequency	Percent	Frequency	Percent
Rarely or never	6	46,2	1	7,7
1-2 times a year	4	30,8	2	15,38
1-3 times a month	2	15,4	7	53,85
Weekly	1	7,7	3	23,1
Daily	0	0	0	0
Total	13	100,0	13	100,0

Before the intervention, the majority of teachers (84.6%) reported conducting research activities with their students rarely or never. However, after the intervention, the majority indicated their intention to conduct such activities 1-3 times a month (Table 15). The intervention likely highlighted the educational benefits of engaging students in research activities, such as developing critical thinking skills.

Table 15. How often do you conduct research with your students?

	Before Intervention		After Intervention	
Answers	Frequency	Percent	Frequency	Percent
Rarely or never	11	84,6	4	30,8
1-2 times a year	2	15,4	2	15,4
1-3 times a month	0	0	7	53,8
Weekly	0	0	0	0
Daily	0	0	0	0
Total	13	100,0	13	100,0

4.7 DAS score

The Dimensions of Attitude Toward Science (DAS) score is a measure used to evaluate individuals' attitudes towards science. This score is derived from responses to a questionnaire that covers several dimensions of attitude. The process for calculating the DAS score involves the following steps:

1. Define dimensions of attitudes toward science.
2. Define Likert scale responses.
3. Scoring individual items based on the Likert scale.
4. Reverse scoring for items being negatively worded.
5. Summing scores for each dimension of the attitude.
6. Calculating the overall DAS score based on the average score of all dimensions.

In this case, the DAS score recorded before the intervention was 68.15. After the intervention, the average score increased significantly to 89.15 (Table 16). This substantial improvement suggests that, before the intervention, the participants generally had a more negative attitude towards teaching physics. However, after the intervention, the increased mean score reflects a positive shift in their attitudes, indicating a greater appreciation and acceptance of the specific teaching practices introduced.

Table 16. Paired Samples Statistics of Teachers' Attitudes Before and After the intervention

Paired Samples Statistics				
	Mean	N	Std. Deviation	Std. Error Mean
Attitudes of teachers before the intervention	68,15	13	7,414	2,056
Attitudes of teachers after the intervention	89,15	13	5,080	1,409

In order to evaluate the significance of DAS score, a paired samples t-Test was conducted. If the significance value (sig = p-value) of 0.000 is less than 0.05, leading to the rejection of the null hypothesis at a significance level of 0.005. The null hypothesis was stated as follows: "There is a statistically significant difference at the 0.05 significance level in the mean DAS score after the intervention compared to the mean score before the intervention.". Table 17 illustrates the t-Test results. The p-value of 0.000 (<0.05) indicates the existence of statistically significant differences in the mean DAS scores recorded before and after the intervention.

In particular, it demonstrates that the intervention significantly improved the participants' positive attitudes, leading to a reduction in the negative feelings and thoughts that existed before the intervention. This improvement can be attributed to several factors introduced by the intervention, such as enhanced teaching methods, increased confidence in using innovative tools, and positive feedback from student engagement.

Table 17. Paired Samples t-Test of Teachers' Attitudes Before and After the intervention

Paired Samples Test
Paired Differences

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Attitudes of teachers before the intervention - Attitudes of teachers after the intervention	- 21,000	7,767	2,154	- 25,694	- 16,306	- 9,748	12	,000

5 Discussion and Conclusions

The paper investigated AI contribution to teachers' attitudes and self-efficacy in teaching science. The intervention program resulted in a significant positive shift in the attitudes of teachers towards AI Learning in science. Teachers became more receptive to introducing AI tools in science instruction after the intervention. A significant number of teachers shifted towards supporting the integration of physics with real-world problems and technology after the intervention. The intervention likely provided comprehensive training on the benefits and applications of AI tools, enhancing teachers' understanding and confidence in using these technologies. Moreover, most teachers came to recognize the usefulness of chatbots in understanding complex physics concepts, since they were given hands-on experience with such tools, which demonstrated their practical benefits in simplifying complex concepts and engaging students.

The perception of physics as a difficult subject to teach decreased significantly after the intervention. Teachers reported a greater sense of enjoyment associated with teaching physics after the program. There was also a notable decrease in teacher-reported stress related to teaching physics. The intervention provided teachers with a deeper understanding of physics concepts and effective teaching strategies, which made the subject matter more approachable and easier to teach.

Teachers reported increased preparation for physics lessons following the intervention. These findings suggest that the intervention successfully addressed potential concerns teachers had about AI tools. The intervention appears to have fostered a more positive and confident approach to integrating such tools into science curriculum. The intervention likely included extensive training on how to effectively incorporate AI tools into lesson planning, giving teachers the skills and confidence needed to prepare more thoroughly.

The intervention program also yielded positive results in terms of teachers' self-efficacy. Most teachers reported feeling more confident in addressing student questions related to physics lessons after the intervention. Besides, teachers expressed a greater sense of preparedness to support student investigations and classroom planning related to physics concepts after the intervention. Overall, there was a significant increase in the average score on DAS scale which measures teacher self-efficacy. This suggests a shift from a generally negative attitude towards physics instruction (before) to a more positive and confident outlook (after) when using specific tools and practices.

These findings indicate that AI learning not only fostered a more positive attitude towards science education but also equipped teachers with the confidence and skills they need to effectively deliver science lessons to their students. The observed positive changes in teacher attitudes and self-efficacy following the intervention underscore the critical role of continuous professional development programs. The implementation of ongoing training sessions, and workshops, can serve to further enhance educators' pedagogical skills and confidence in delivering effective science teaching.

This study, while offering valuable insights, has some limitations to consider. The sample size of 13 primary school teachers is relatively small. This limits the generalizability of the findings to a wider population of teachers. In addition, using purposive sampling, participants are chosen based on criteria, which helps gather focused data. However, this method might not capture the full range of perspectives and experiences found among all primary school teachers. Finally, the study relies on self-reported data collected through questionnaires. While questionnaires can provide valuable information, they are susceptible to participant bias. Teachers may unconsciously answer in a way they perceive to be socially desirable.

To overcome these limitations, part of our future plans is monitoring teachers' attitudes over an extended period, which will provide valuable insights into the long-term efficacy of such programs. Complementing quantitative research with qualitative studies is crucial. Exploring teacher experiences and perceptions through in-depth interviews or focus groups can shed light on the factors that significantly influence their attitudes towards teaching science.

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