Early childhood educators' self-efficacy, science perceptions, and professional development experiences in the Southeastern U.S. and Catalonia

Autoeficacia, percepciones sobre ciencia y experiencias de desarrollo profesional de las educadoras de educación infantil en el sudeste de EE.UU. y Cataluña

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ABSTRACT: Prior research has found relationships between science-based professional development (PD) and early childhood educators' self-efficacy, perceptions of science education, and challenges they experience implementing activities. However, there is limited understanding of how these connections differ across international contexts. This study explored differences between early childhood educators from Catalonia, Spain, and the Southeastern U.S. regarding science perceptions, experiences, and engagement in PD. A total of 396 early childhood educators from Catalonia (Spain), and the Southeastern U.S. completed the P-TABS Questionnaire. T-test and Pearson's correlations found U.S. educators were more comfortable teaching science and Spain educators engaged in more PD. Across all participants, educators with more experience or those with more PD were more comfortable teaching science and had fewer challenges. Further, participants who engaged in more PD perceived more benefits to children. Implications for future research include examining these differences through qualitative methods.

KEYWORDS: early childhood educator, professional development, educator perception, science education, cross-cultural perspective

RESUMEN: Investigaciones anteriores han encontrado conexiones entre el desarrollo profesional (DP) basado en la ciencia y la autoeficacia de las educadoras de educación infantil, los beneficios percibidos de la educación científica y los desafíos con los que se encuentran. Sin embargo, existe una comprensión limitada de cómo estas conexiones difieren a través de contextos internacionales. Este estudio exploró las diferencias entre las educadoras de educación infantil de España y del sudeste de Estados Unidos con respecto a las percepciones científicas, las experiencias y la participación en el DP. Un total de 396 docentes de educación infantil de Cataluña (España) y el sureste de Estados Unidos completaron el cuestionario P-TABS. La prueba T y las correlaciones de Pearson revelaron que las educadoras estadounidenses se sentían más cómodas enseñando ciencia mientras que las educadoras españolas participan más en el DP. Entre todas las participantes, las educadoras con más experiencia o aquellas con mayor DP se sentían más cómodas enseñando ciencia y percibían tener menos desafíos. Asimismo, las educadoras que participaron en más DP percibieron más beneficios para sus estudiantes. Las implicaciones de este estudio en futuras investigaciones incluyen examinar estas diferencias a través de metodologías cualitativas.

PALABRAS CLAVE: educadoras de educación infantil, desarrollo profesional, percepción de la educadora, educación científica, perspectiva transcultural

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1. INTRODUCTION

There is a growing increase in career paths for individuals with expertise in science-related fields, which has implications for early childhood educational programs. Countries around the world have invested in science education and 21st-century learning in order to meet this demand (OECD, 2016; Sahin, 2009), yet most of this investment has been for children ages 8+. Teaching science to young children fosters curiosity, problem-solving, and a foundational understanding of the natural world (Alam, 2022; Jirout, 2022; Lindholm, 2018). Effective science education for young children involves hands-on experiences, exploration, and inquiry-based learning (Jirout & Zimmerman, 2015; Suleeman & Widastuti, 2018). Teaching science curricula and activities in early childhood educational contexts is dependent on societal expectations and goals, culture, educators' prior education, beliefs, pedagogical skills, and prior experiences, and required standards (Edwards & Loveridge, 2011; Pendergast et al., 2017). Research consistently shows teachers' attitudes and beliefs about science significantly shape their instructional practices and the experiences of young children in their classrooms (Barenthien et al., 2019; Gerde et al., 2018; Pendergast et al., 2017). Studies suggest teachers who have positive attitudes toward science are more likely to engage in enthusiastic teaching practices and provide opportunities for children to explore and experiment (Casey et al., 2021; Maier et al., 2013; McDonald et al., 2020). Additionally, teachers who see value in science education are more likely to dedicate time and effort to teaching science concepts effectively (Lange et al., 2022; Park et al., 2017).

Professional development (PD) experiences have been found to increase teachers' self-efficacy, their views of science education, and their ability to effectively teach science (Barenthien et al., 2020; Duran et al., 2009). Research conducted in Spain, Mexico, and the U.S. has shown children's attitudes toward science are influenced by teachers' attitudes and instructional strategies (see Cézar & Pinto, 2017; Gerde et al., 2018), thus demonstrating the strong influence teachers have on children's experiences. In the early childhood sector, some research has found not only teachers' attitudes toward science but also their comfort with the subject and belief in the importance of early science education impact how they approach teaching (van Aalderen-Smeets & Walma van der Molen, 2015). While attitudes, beliefs, and PD impact science education, literature exploring these relationships in early education is limited, particularly when considering cross-cultural settings. There is a need to understand the impact of early childhood educators' perspectives and attitudes about science education and themselves as science educators across cultural contexts. Further, the influence of science-based PD has important implications for early childhood workforce development.

1.1. Science Education in the U.S. and Spain

In 2000, the U.S. spent significant effort in curriculum reform and began paying closer attention to how math and science standards compared to those in high-achieving countries (Valverde & Schmidt, 2000). At this same time, the No Child Left Behind (NCLB) Act was established, which included a heavy push for all children to be reading on grade level by third grade. These efforts expanded into Race to the Top (RTT) during the Obama administration, ultimately re-establishing the culture of school achievement with more comparison to student outcomes in other countries. RTT focused on the need to get children, preschool-age through twelfth grade, ready for the workforce and sought to make up for the perceived failings of NCLB (McGuinn, 2012). RTT had intentions to develop better standards, assessment practices, and strategies to improve teacher effectiveness and uplift struggling, underperforming schools. These policy initiatives led to increased accountability and pressure for teachers and administrators, ultimately steering many school districts into adopting scripted curricula (Vaughn et al., 2021). Also, NCLB resulted in the removal of valuable science instruction to include more time for math and reading (Griffith & Scharmann, 2008).

In the early 2000s, the European Commission became concerned about the lack of interest in science studies among young people. Recommendations were made to transform science education by shifting instructional strategies to be less didactic and more inquiry-based (European Commission, 2007). As a result, the Spanish primary school curriculum evolved to include more focus on competencies and application, providing room for improvement in the quality of science education if teacher education and PD are aligned to these changes (Balbas-Martinez, 2022). However, some research suggests the recommendations for Spanish early childhood educators to incorporate comprehension strategies to promote observation, experimentation, and reflection are not evidenced in pedagogy (Cézar & Pinto, 2017).

As of 2006, the Spanish national government implemented a new educational reform mandating communities to offer free, voluntary preschool for children ages three to five. This early childhood education, or la educación infantil, reform included increasing childcare spaces available for children under the age of three to match the growing needs and other European nations. According to this reform, early childhood teachers should have at least their bachelor's degree to be in the classroom; even more credentials are needed for teachers in public programs. This was part of an educational reform to bolster the workforce and improve academic achievement from birth through university level (Sandstrom, 2012). In the U.S., preschool availability varies across states and as of 2022, while 45 states offered public preschool, most of these programs did not provide universal access for all children (NIEER, 2023).

Globally, there is a universal need to foster the development of 21st-century skills, which can be prioritized in science education. To improve children's development of 21st-century skills and ensure they are prepared to be successful within all fields of study, they need ongoing opportunities to collaborate, problem-solve, and engage in critical thinking from a young age. Overall, to ultimately guarantee a strong trajectory of STEM learning, early science experiences need to embrace curiosity, children's interests, access, and exploration of natural environments while also integrating 21st century learning opportunities (Reinoso et al., 2019).

1.2. Teacher Knowledge, Attitudes, and Beliefs

Teacher knowledge, attitudes, and beliefs about science are key to educators' and childrens' motivation to engage in science activities (Gerde et al., 2018; OECD, 2016). According to Jiménez-Tejada et al. (2016), Spanish early childhood educators have similar perceptions of science and science activity implementation to U.S. educators. Ortiz-Revilla et al. (2023) found a number of Spanish early childhood teachers have a conceptual understanding of science concepts, including STEAM, and that early science experiences are linked to real-world experiences. Many Spanish teachers also recognize that science inquiry develops at an early age, but they often feel uncertain about teaching science to young children (Jiménez-Tejada et al., 2016). They also appreciate how early science allows young children to understand the world around them and interact with advancing scientific reasoning and technological development (Reinoso et al., 2019; García-Carmona et al., 2014). Educators' self-efficacy in science has also been previously linked to children's science motivation (Opperman et al., 2019). Educators who express a strong interest in science learning positively influence children's persistence in science at all levels of education (Modi et al., 2012; Wang & Moghadam, 2017).

Preschool Teachers' Attitudes and Beliefs Towards Science Questionnaire (P-TABS)

A growing body of literature has not only examined relationships between early childhood educators' attitudes toward science teaching and self-efficacy (Ültay et al., 2020), but also comfort level educators feel about implementing science activities (Pendergast et al., 2017). Some researchers have evaluated these connections through a self-report rating scale developed by Maier et al. (2013)

called the *Preschool Teachers' Attitudes and Beliefs Towards Science Questionnaire* (P-TABS). The PTABS was created in response to a lack of reliable measures to assess early childhood teachers' beliefs and attitudes about science in the US. The P-TABS tool has been validated in other nations (Baruach et al., 2021; Oon et al., 2019), and has an established common framework for exploring early childhood educators' perspectives on science education. The P-TABS evaluates three key factors regarding attitudes and beliefs: comfort, child benefit, and challenges. Comfort gauges teachers' enjoyment and confidence in orchestrating science activities for young learners. Child benefit assesses teachers' beliefs in the significance and advantages of teaching science during early childhood. Meanwhile, the challenge factor examines teachers' perceptions of obstacles in teaching science, encompassing areas such as scientific knowledge, planning time, and execution skills (Maeir et al., 2013). Pendergast et al. (2015) discovered that preservice prekindergarten teachers displayed positive attitudes toward teaching science, felt comfortable in demonstrating science activities, and expressed interest in professional development related to science education. Addressing barriers, preservice teachers reported having adequate knowledge in the field of science and sufficient time to integrate science activities into their curriculum. Conversely, Kloos et al. (2018) observed that while early childhood educators acknowledged the benefits of teaching science activities to young children, they faced challenges. They also indicated a degree of comfort in teaching nature-based science activities. Nonetheless, when examining P-TABS results across different cultures, there appears to be some variability. Further cross-cultural research is crucial to deepen our understanding of teachers' attitudes toward science education, their perceived comfort levels, and the challenges they encounter.

1.3. Barriers to Early Science Education

High-quality science education in the early years supports children's use of inquiry, problem-solving, and design thinking (Lange et al., 2022), yet there are clear barriers that impact this type of pedagogy. Substantial research has found early childhood teachers' attitudes toward teaching and the implementation of early science in the classroom are associated with negative self-perception (Gerde et al., 2018). Barriers to successful science implementation (i.e., support, space, time, materials) and barriers to knowledge of science and science literacy (i.e., lack of higher education courses or PD opportunities) may also contribute to feelings of low efficacy and comfort when asked to teach science in the classroom (Edwards & Loveridge, 2011; Gerde et al., 2018; Greenfield et al., 2009; Yoon & Onchwari, 2006). It has been documented that early childhood teachers experience barriers, such as too little time to prepare, lack of resources, and lack of support from other teachers or staff while teaching science activities (Fridberg et al., 2023). Multiple studies have identified early educators in Spain as feeling insecure due to the lack of self-perceived knowledge around STEM and early science topics; also, barriers to implementation contribute to these insecurities (Fridberg et al., 2023; Ortiz-Revilla at el., 2023).

Consistent with U.S. studies, research demonstrates a need for early childhood educators in Spain to have more training and PD in order to successfully gather scientific knowledge and practical skills needed to implement scientific content and support young children in building their scientific literacy (Reinoso et al., 2019). It has been established that PD positively influences educators' perceptions of science and their ability to implement high-quality experiences for children (Brenneman et al., 2019). Studies have also shown engagement in science-based PD decreases challenges faced by educators when implementing science education (Barenthein et al., 2020). While there has been an overall increase in science-based PD for early childhood educators in the past decade (Johnson, 2012), access to these opportunities is not consistent across early childhood schools and programs. Further, the type of PD matters. Short, one-day workshops are found to be less effective than ongoing forms of engagement (Lange et al., 2022). Professional learning opportunities that emphasize collaboration, inquiry, and multilevel experiences connected to practice have a deeper effect (Lange et al., 2022).

1.4. Purpose

There is a lack of research that identifies factors influencing early childhood educators' science beliefs and practices to better understand how to reduce challenges and increase high-quality science education. The importance of understanding differences in advancing early science education globally can improve instructional strategies and allow both children and adults to engage in scientific inquiry through means of higher order thinking and working to solve real-world issues (Sahin, 2009). The purpose of this international study was to explore differences between early childhood educators from Catalonia (Spain) and the Southeastern U.S. regarding science perceptions, experiences, and engagement in PD. The following research questions (RQ) were examined:

RQ 1: Are there differences between Spain and the U.S. in the number of science-based PD activities attended by teachers in the past five years?

RQ 2: Are there differences between Spain and U.S. teachers' perceptions regarding how science education benefits children, the challenges they face implementing science activities, and their comfort level as science educators?

RQ 3: Is there a relationship between years of experience, science-based PD activities attended, perceived benefits to children, challenges experienced, and comfort level?

2. METHODS

A quantitative cross-sectional study was implemented, approaching the research questions using a questionnaire applied to in-service teachers. For the purpose of this manuscript, in-service teachers include those working as educational assistants, certified teachers, and center directors from public and private early educational settings (birth-kindergarten). Through a nonprobabilistic and intentional sampling technique, participants included 396 early childhood educators from Catalonia, Spain, and the Southeastern U.S. Participants anonymously completed a questionnaire sent via email addresses through listservs. Among the participants, 206 were from Spain, 190 were from the U.S., 95.2% were female, .04% were male, and .0005% preferred not to answer, 62% were from urban schools and 38% were from rural schools. Participants' average age was 41.04 and the average years of experience was 15.40 years.

2.1. Instruments

Data were collected from demographic questions, the Preschool Teachers' Attitudes and Beliefs Towards Science Teaching (P-TABS) Questionnaire (Maier et al., 2013), and questions about science-based PD involvement in the last five years. The demographic questionnaire included questions to gather information about participants, such as country of residence, a region or county depending on the country, gender, age, current employment at an urban vs. rural school setting, years of experience in the education profession, and the number of science-related PD activities attended in the past five years.

The *Preschool Teachers Attitudes and Beliefs toward Science* (P-TABS; Maier et al. 2013) questionnaire was used to measure early childhood educators' attitudes and beliefs toward science. The PTABS includes a 5-item Likert scale (1= strongly agree to 5= strongly disagree). The questionnaire includes three factors: Comfort, Child Benefit, and Challenges teaching science with a total of 35 items. Cronbach's alpha for the Comfort factor =.89, Child Benefit =.85, and Challenges =.71 (Maier et al., 2013). The Comfort factor measures how comfortable a teacher is planning and providing examples of science activities to young children. The Child Benefit factor measures teachers' perceptions and attitudes toward the effects of promoting science education in the early childhood years (Pendergast et al., 2017). The Challenges factor assesses early educators' perceived

challenges with teaching science activities. Participants were also asked a series of questions about their experiences with science-related PD as part of the questionnaire, such as the number of PD activities attended in the past five years. Participants were also asked about the different types of PD attended, such as webinars, in-service training, conferences, coaching, professional learning communities, and teamwork sessions. Cronbach's alpha values were conducted on each factor, Comfort =.84, Child Benefit =.81, and Challenges=.71 for this sample. There was adequate internal consistency for this sample and it was similar to results obtained by Maiers et al. (2023).

2.2. Data Analysis

Analysis of the data included several phases. First, items were evaluated to determine trends and patterns. Descriptive statistics were conducted using SPSS v.23. Reliability was conducted on the PTABS (Comfort, Child Benefit, and Challenges) for the sample. T-test analysis was conducted between the U.S. and Spain to determine differences between the two countries. Pearson's correlations were conducted using SPSS v.23 to determine significant relationships between the three scales of the PTABS (Comfort, Child Benefit, and Challenges) and the number of science-related PD activities.

3. RESULTS

Comparisons were analyzed between participants from Spain and the U.S. to address the research questions. An independent t-test analysis was conducted to answer the first research question on participation in PD. There was a significant difference in participation in PD between Spain (M = .79, SD = .40) and the U.S. (M= .64, SD = .48); t(387) = 3.36, p = <.001. Overall, participants in Spain engaged in more PD in the areas of in-person and professional learning communities than participants in the U.S. Participants in the U.S. participated in more online and coaching PD than participants in Spain. (See Table 1 for means and standard deviations).

TABLE 1. Means and Standard Deviations for Professional Development

Professional Development	Spain		United States	
	M	SD	M	SD
Online	.302	.530	.563	.723
In-person	.961	.720	.605	.680
Learning Communities	.380	.620	.168	.375
Coaching	.040	.194	.150	.361
Not Applicable	.110	.316	.330	.470
Total Professional Development	.79	.40	.64	.48

For the second research question, an independent sample t-test was conducted to compare subscales from the PTABs Questionnaire between Spain and U.S. samples. There was not a significant difference in Child Benefit between Spain (M = 4.65, SD = .36) and the U.S. (M = 4.57, SD = .46); t(396) = 1.96, p = .051. There was also not a significant difference in Challenges between Spain (M = 2.67, SD = .72) and the U.S. (M = 2.57, SD = .77); t(396) = 1.36, p = .173. However, there was a significant difference in Comfort between Spain (M = 4.05, SD = .49) and the U.S. (M = 4.17, SD = .55); t(369) = -2.171, p = .031. Seventy-one percent of participants reported receiving some type of science-related PD in the past five years and on average, they had participated in 2.55 PD activities. (See Table 2 for means and standard deviations).

TABLE 2. Means and Standard Deviations for the PTABS

PTABS	Spain		United States	
	M	SD	M	SD
Comfort	4.05	.49	4.17	.55
Child Benefit	4.65	.36	4.57	.46
Challenges	2.67	.72	2.57	.77

Pearson's R correlations were conducted to answer the third research question. Variables in this analysis included: years of experience, number of science-related PD activities attended, Child benefits, Challenges, and Comfort. Mild, positive significant correlations were found between years of experience and the number of science-related PD activities attended and Child Benefit and Comfort. Years of experience were found to be significant and negatively correlated with Challenges. The number of science-related PD activities attended was mildly positively correlated with Child benefit and Comfort and negatively correlated with Challenges (see Table 3).

TABLE 3. Correlations Between Years of Experience, Number of PD Activities, and the P-TABs Questionnaire

	1	2	3	4	5
1. YEARS of EXPERIENCE	____	.209**	-.158**	.252**	.178**
2. NUMBER of PD ACTIVITIES	.209**	____	-.281**	.154**	.329**
3. CHALLENGES	-.158**	-.281**	____	-.296**	-.425**
4. CHILD BENEFIT	.252**	.154**	-.296**	____	.588**
5. COMFORT	.178**	.329**	-.425**	.588**	____

**. Correlation is significant at the 0.01 level (2-tailed).

4. DISCUSSION

This study examined the relationship between the number of PD experiences, years of experience, and educators' perceived comfort in teaching science. The first research question, differences between Spain and the U.S. in the number of science-based PD activities attended by teachers in the past five years, showed that Spanish educators attended more science PD activities than U.S. educators. However, it is not clear if this tendency is due to educators' need to further their skills to teach science, their eagerness to innovate different ways of teaching science, or because Spanish teachers do not receive as much science-based training in their higher education programs (Balbas-Martinez, 2022). Studies have also found a positive impact on pedagogy in general when teachers had access to high-quality PD, and meaningful PD activities led to more job satisfaction (OECD, 2018). A study with teachers in both Spain and the U.S. identified how PD activities attended in the previous 12 months had a positive impact on teaching practice (OECD, 2018). Relatedly, Maeng et al. (2020) found that teachers who attended PD had better understanding and confidence in teaching science and incorporated more science activities into their classrooms.

Regarding the second research question, differences between Spain and U.S. teachers' perceptions about how science education benefits children, the challenges they face implementing science activities, and their comfort level as science educators, there was a statistical difference found in educators' level of comfort when teaching science between Spain and the U.S. Early childhood teachers in the U.S. showed a higher level of comfort than educators from Spain. However, there was no significant difference found between Spain and the U.S. in early childhood educators' perceptions of child benefit and challenges in teaching science to young children. McDonald et al. (2021) found that early childhood educators in the U.S. reported having a positive attitude toward teaching science activities and it was appropriate to do so with young children, but expressed support was needed.

To address the third research question, the relationship between years of experience, science-based PD activities attended, perceived benefits to children, challenges experienced, and comfort level was analyzed, and results indicated that the number of years of experience an early childhood teacher has increased their perceived comfort in teaching science activities. For this sample, the more years of experience a participant had, the fewer challenges they seemed to face when teaching science, and the more comfortable they were with teaching science content to young children. In fact, participants experienced fewer challenges and perceived more benefits to children with regard to teaching science activities. Pendergast et al. (2017) found that early childhood teachers were most comfortable with teaching and demonstrating life science, earth science, and physical science activities, and located most of their resources on the internet. Interestingly, other studies did not find significance between educators' years of experience and confidence in teaching science in the early years (Sackes, 2014; Tao, 2019), however, PD and support made a difference for teachers in their ability to implement science activities (Maeng et al., 2020; McDonald, et al., 2021).

4.1. Future Directions for Research

This current study found early childhood educators in the U.S. perceived more comfort in teaching science to young children than educators in Spain. Further research is needed in this area to determine the factors contributing to this difference. It is important to gain a better understanding of what educators in each country receive in their training in higher education as preservice teachers. Further studies on this topic should also include the types of experiences preservice teachers receive in higher education programs, such as field experiences, knowledge of science curriculum, and scaffolded practice implementing science activities with young children. Based on this study's findings, future studies should also explore motivations and reasons behind attending science-related PD as well as assessments of the effectiveness of these science-related PD experiences. The connections between what is learned in PD and applied in the classroom, in other words, the transfer

of learning, has become an important area of investigation (see Villaseñor et al., 2023) that should be continued.

This study addressed the comparison of group means of the sample and relationships between variables. Therefore, causation cannot be determined. While the sample was adequate enough for the analysis conducted, a majority of the participants were female from both Spain and the U.S. Therefore, the results may not be generalizable to a population with a different gender, but currently, the field is dominated by early childhood professionals who are female.

4.2. Conclusions and Implications

In this study, several cross-cultural results were found between the relationship between the number of science-related PD experiences, years of teaching experience, and educators' perceived comfort in teaching science in the Southeastern U.S. and Catalonia. The correlation between science-related PD experiences, early childhood educators' years of experience, and their perceived comfort in teaching science resulted in a difference in the participation rates of science-related PD activities between Catalonia and the U.S., indicating a higher attendance by educators in Spain. However, the precise cause of this distinction remains unknown, whether pressed by the necessity to strengthen teaching skills, an inclination towards innovative teaching methods, or disparities in science training during their initial education. In addition, a direct relationship emerged between science-related PD attendance, early childhood educators' comfort in teaching science, and the integration of science activities into their classes. Differences were found in early childhood educators' perceptions of benefits to children, challenges in implementation, and comfort in teaching in Spain and the U.S. regarding science education. Although early childhood educators in the U.S. exhibited a higher comfort level in teaching science, no significant differences emerged in their perceptions of child benefits and challenges compared to their Spanish counterparts. The significant difference in comfort levels between Spain and the U.S. may be attributed to cultural variations in educational approaches and teacher training (Balbas-Martinez, 2022). The lack of significant differences in educators' perceptions of the benefits of science education for children and the challenges they face suggests a common understanding of the importance of early science education and shared difficulties encountered (McDonald et al., 2021).

Furthermore, the study investigated the relationship between years of experience, number of science-based PD activities attended, perceived benefits for children, challenges encountered, and comfort levels in early childhood educators. There was a positive correlation between years of experience and increased comfort in teaching science among early childhood educators. Intriguingly, a reduction in challenges faced and an augmented perception of children's benefits were observed as educators accumulated more experience. While some studies found no substantial correlation between years of teaching experience and confidence in teaching science in the early years (Sackes, 2014; Tao, 2019), the current research indicated that PD significantly influences educators' confidence in implementing science activities. This highlights the pivotal role of ongoing professional development and support mechanisms in enhancing educators' competence in teaching science to young learners. Higher education institutions should consider integrating more science-based professional learning elements into their teacher preparation programs. This can help address potential gaps in science training and better prepare future early childhood educators (Maeng et al., 2020). Educational institutions should also actively promote collaboration among educators, both locally and internationally, to create opportunities for sharing best practices and fostering professional growth (Ingersoll & Strong, 2011). These implications emphasize the need for culturally sensitive approaches to PD and the potential for cross-cultural learning to improve science education worldwide.

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