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SCAFFOLDING IN-SERVICE SCIENCE TEACHERS FOR DEVELOPING EPISTEMIC EMPATHY

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Abstract

Epistemic empathy refers to understanding and appreciating someone's cognitive and emotional experiences during an epistemic activity that involves constructing, communicating, and critiquing knowledge (Jaber et al. 2018). To foster a greater understanding of epistemic empathy among primary and lower secondary education teachers, a training program was implemented during the past schooling year 2023/2024. The program was designed to develop new habits in teaching practices by encouraging educators to adopt the Investigative Science Learning Environment (ISLE) approach, in their science classrooms. This initiative, supported by research from Etkina et al. (2017; 2023) and Brookes et al. (2020), aims to create effective and engaging inquiry-based learning experiences for students in the field of science. In this research, we aimed to achieve two key objectives. First, we sought to highlight the connection between the development of new habits and the concept of epistemic empathy, aligning the two frameworks. Second, we explored the degree to which the teachers participating in our training program became aware of these developments. We examined their reflections and insights regarding the relationship between habit development and empathetic understanding in their teaching practices. To accomplish our objectives, we conducted a comprehensive survey at the conclusion of the program. We meticulously analyzed the responses provided by the teachers, carefully examining how the various activities they engaged in aligned with and contributed to the attainment of the training program's goals. This in-depth analysis allowed us to draw meaningful connections between their experiences and the overall effectiveness of the training initiatives. Here we present the key findings of our analysis and how they reflect the alignment of the two frameworks for the professional training of in-service science teachers. We eventually turned our attention to how a program centered on epistemic activities can positively contribute to teachers' development of new and effective habits.

Keywords: *Epistemic empathy, inquiry-based learning, teacher professional development, habits of practices.*

1. Introduction

The concept of Epistemic Empathy refers to a teaching approach that requires educators to value the cultural, emotional, and linguistic resources and experiences of students in science and mathematics education, promoting inquiry and problem-solving (Warren et al., 2001).

Responsive teaching promotes autonomy, equitable participation, and active student engagement through an instructional approach that values and understands students' cognitive and emotional experiences in the learning process (Jaber et al., 2018; Jaber, 2021), fostering a more inclusive and equitable STEM education (Gutiérrez & Rogoff, 2003).

The main challenge of responsive teaching is recognizing and valuing students' unconventional insights, even when they deviate from accepted knowledge (Warren & Rosebery, 1996). This process requires teachers not only to have disciplinary expertise but also to actively listen and interpret students' thinking without forcing it into predefined frameworks (Hammer et al., 2005). In this context, epistemic empathy emerges as a crucial resource, helping teachers step outside their own perspectives to understand students' cognitive and emotional experiences and support authentic learning (Jaber et al., 202). Epistemic empathy is fundamental to this process as it involves not just recognizing students' ideas but also understanding how they make sense of them, both intellectually and emotionally (Jaber et al., 2018).

Empathy in education is often considered crucial for teacher-student relationships and awareness of students' cultural and social experiences (McAllister & Irvine, 2002; Tettegah & Anderson, 2007). However, research has overlooked its epistemic dimension, i.e., how teachers empathize with students'

cognitive experiences when formulating and discussing ideas. Epistemic empathy helps teachers value students' reasoning, even when it deviates from expectations, and recognize emotions related to the learning process (Sikorski, 2016).

This perspective promotes an approach based on students' strengths, treating them as competent thinkers and valuing their contributions (Gutiérrez, 2013). Additionally, epistemic empathy can foster more equitable learning environments by distributing power and authority, so that students feel actively involved in constructing knowledge (Segal & Wagaman, 2017).

With the present study, we aim to contribute to theoretically aligning the framework of epistemic empathy (Jaber et al., 2024) with one for developing new habits (Etkina et al., 2017) and to conduct an investigation utilizing a mixed-method research approach aimed at assessing the effectiveness of our training program in enabling teachers to achieve this objective.

2. Responsive teaching from a socio-constructivist perspective

Rather than viewing the body of canonical knowledge as the sole goal, responsive teaching starts from students' reasoning and values it, while also nurturing the disciplinary practices of learning (Hammer et al., 2012).

The socio-constructivist approach views learning as an active process in which students are actively involved in constructing knowledge, acting as epistemic agents who take responsibility for disciplinary norms and dispositions (Bruner, 1992; Fleer, 2015; Fragkiadaki et al., 2021; Stroupe, 2014). The learning context becomes the site of knowledge construction, where students do not simply learn things because information is transmitted to them, but they learn through observation, inquiry, and discovery (Scardamalia & Bereiter, 2014). Teaching practices must therefore evolve in this direction to facilitate students in this process and embrace ideas and initiatives that emerge from the group.

Students are seen as bearers of resources, and the teacher's task is to explore and provide space for these resources, supporting students' curiosity and initiative. Disciplinary knowledge is not evaluated based on conformity to a predetermined learning goal but is gradually built starting from students' initial ideas and progressively enriched and supported by the teacher in a responsive manner (Richards & Robertson, 2016).

Research shows that responsive teaching can support disciplinary learning: it values the contribution of all students by recognizing that everyone is capable of constructing meaning while also giving students responsibility and placing them at the center of their learning journey (Scardamalia, 2000; Coffey et al., 2016).

3. Professional development of teachers

Promoting a responsive teaching approach requires teacher training that starts by considering teachers' initial conceptions about teaching scientific disciplines (Robertson & Richards, 2017). Shifting from a traditional knowledge transmission-based pedagogy to an approach based on the active construction of knowledge by students undoubtedly requires a significant shift in perspective, as well as a space for reflection and experimentation that allows teachers to reflect on their practices and find guidance in experimenting with different approaches (Radoff et al., 2018).

Training pathways should be designed to provide teachers with both conceptual knowledge about innovative teaching and experiential learning paths, where they can test practices that equip them with tools to manage classroom activities (Kennedy, 2006; Thompson et al., 2013; Cartier et al., 2013; O'Connor & Michaels, 2019).

Literature highlights that one of the effective strategies for teacher training involves experiential learning, where teachers are directly involved in scientific inquiry, experiencing the teaching activity as if they were students, while trainers model responsive teaching, encouraging teachers to develop activities based on their own questions and explorations (Atkins & Frank, 2016; Dini et al., 2021; Hammer & Van Zee, 2006). This approach helps teachers recognize and value the emerging scientific thinking of students (Watkins et al., 2017, 2020).

The Development of Habits through Cognitive Apprenticeship (DHAC) framework effectively includes the features mentioned earlier (Etkina et al., 2017; Etkina & Planinsic, 2024). It has been well-tested in both in-service and pre-service teacher training programs focused on incorporating the ISLE approach into teaching practices.

In this study, we aimed to theoretically understand the alignment between the Epistemic Empathy teaching approach and the implementation of ISLE. The tasks of teaching (Ball et al., 2008; Etkina et al., 2017) involved when adopting this approach in classrooms are intertwined with the one emphasized in the epistemic empathy framework. Table 1 summarizes the connections between the two frameworks. This

connection prompted us to adopt the DHAC framework for the professional development of in-service science teachers, focusing on enhancing their epistemic empathy in relation to the ISLE teaching adoption.

Table 1. Epistemic empathy and DHAC frameworks alignments.

Epistemic Empathy (Jaber et al., 2024)	**Tasks of Teaching adopting the ISLE approach** (Etkina et al., 2018; Etkina & Planinsic, 2024)
Noticing and appreciating students' epistemic affect *(Recognizing students' intellectual and emotional engagement in learning, such as excitement, frustration, or curiosity)*	Recognising student interest and motivation around particular science content and practices
	Engaging all students to express their thinking about key science ideas and encourage students to take responsibility for building their understanding, including knowing how they know
	Developing a climate of respect for scientific inquiry and encourage students' productive deep questions and rich student discourse
	Encouraging broad participation to ensure that no individual students or groups are marginalised in the classroom
	Engaging students in meta-cognition and epistemic cognition
Explaining and justifying students' lines of reasoning *(Seeking to understand and clarify why students think in a certain way, even if their reasoning is unconventional or incomplete)*	Helping students consider multiple alternative approaches or solutions, including those that could be considered to be incorrect
	Encouraging students to explain features of representations and models (their own and others') and to identify/evaluate both strengths and limitations
	Encouraging students to create, critique, and shift between representations and models with the goal of seeking consistency between and among different representations and models
	Modelling scientific approaches to explanation, argument, and mathematical derivation and explain how they know what they know
Identifying merits in students' ideas *(Finding the productive beginnings in students' thinking, even if it's not fully correct yet)*	Eliciting student understanding and help them express their thinking via multiple modes of representation
	Employing multiple strategies and tools to make student thinking visible
	Interpreting productive and problematic aspects of student thinking and mathematical reasoning
	Providing students with descriptive feedback
Anticipating students' ideas or feelings *(Predicting common misconceptions or struggles students might have and preparing ways to support them)*	Anticipating specific student challenges related to constructing scientific concepts, conceptual and quantitative reasoning, experimentation, and the application of science processes
	Addressing learners' actual learning trajectories by building on productive elements and addressing problematic ones
	Designing or selecting and sequencing learning experiences that focus on sense-making around important science concepts and practices, including productive representations, mathematical models, and experiments in science that are connected to students' initial and developing ideas
	Using interpretations of student thinking to support instructional choices both in lesson design and during the course of classroom instruction
Expressing curiosity and interest in students' reasoning *(Demonstrating genuine interest in how students think rather than just whether they are "correct")*	Prompting students to collectively generate and validate knowledge with others
	Encouraging broad participation to ensure that no individual students or groups are marginalised in the classroom
	Scaffolding learner flexibility and the development of independence
	Promoting negotiation of shared understanding of forms, concepts, mathematical models, experiments, etc., within the class
Channeling personal experiences to connect with students' intellectual and emotional experiences *(Reflecting on one's own learning struggles and using them to empathize with students)*	Creating opportunities for students to use science ideas and practices to engage real-world problems in their own contexts
	Helping students make connections between their collective thinking and that of scientists and science communities
	Making explicit distinctions between science practices and those of everyday informal reasoning as well as between scientific expression and everyday language and terms
	Providing opportunities for students to pose their own questions and investigate them experimentally

4. Methodology

We engaged a group of 75 teachers from primary and low secondary education in a training program designed to familiarize them with the ISLE approach. The course was organized into three modules: a starting module, an intermediate module, and an advanced module, with each one lasting four hours. Then, teachers could adopt the ISLE activities in their classes, sometimes being tutored or coached by a trainer researcher. In total, approximately 80 classes participated in these activities- half tutored and half coached- resulting in 229 hours of teaching practice focused on ISLE.

We followed a structured procedure to evaluate the impact of the training program and its effect on teachers' development of new habits. We created a comprehensive survey aimed at capturing various aspects of the training program. This included questions on teachers' self-assessment of new habits, their engagement throughout the training, and perceived changes in their teaching practices. We identified a representative sample of teachers who participated in the training program (54 participants over 75). This ensured that our results would reflect a broad range of experiences and perspectives. The survey was distributed to the selected teachers through an online platform. We encouraged participation by emphasizing the importance of their feedback in shaping our research project. Once the responses were

collected, we conducted a thorough analysis to identify trends, patterns, and correlations. This included quantitative analysis of scaled questions and qualitative analysis of open-ended responses. The analysis was conducted using AILYZE software (www.ailyze.com, 2025, AILYZE Inc.), employing an inductive approach to identify themes across the entire dataset. This method avoids the limitations of traditional coding by capturing broader themes and complex discussions, ensuring consistent theme detection and speeding up the analysis process. Finally, we synthesized the data into a report that outlines the training program's effectiveness in facilitating new habits among teachers. This procedure ensures a systematic approach to evaluating the program and provides valuable insights into its effectiveness.

5. Discussion and conclusions

As a first insight, the key findings reveal significant changes in teaching practices among educators. A notable emphasis has been placed on encouraging conceptual construction grounded in observation, with 68.1% of respondents highlighting this approach. Additionally, the promotion and explicit formulation of hypotheses and the use of hypothetical-deductive reasoning have also been prioritized, with the same percentage of 68.1% reporting this shift.

This is aligned with the feature of epistemic empathy of recognizing students' intellectual and emotional engagement in learning, such as excitement, frustration, or curiosity (Jaber et al., 2024). Furthermore, the high adoption of supporting students' intuitive ideas (57.4%) reflects a commitment to understanding their reasoning, even when incomplete. This aligns with the idea that teachers should explore why students think a certain way, assisting them in refining and justifying their thought processes rather than dismissing unconventional reasoning.

A key change is the emphasis on experiment design to test hypotheses, identified as critical by 63.8% of educators. This highlight leveraging students' initial, albeit imperfect, thoughts to foster scientific inquiry, recognizing that their thinking holds valuable insights worth exploring. Interestingly, only 10.6% of teachers reported a stronger focus on anticipating students' difficulties.

The ISLE approach promotes responsive teaching, but there are gaps in anticipating students' struggles. Addressing this could enable teachers to offer better support for common misconceptions and emotional barriers to learning. The ISLE training appears to have strengthened teachers' ability to notice, validate, and build upon students' reasoning processes. However, there is room for growth in anticipating students' struggles and intuitive resources, which could further enhance their ability to provide targeted support..These preliminary results suggest that our training program effectively develops new habits and enhances teachers' epistemic empathy.

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