



Early Childhood Science Education in Bedouin Communities: An Exploratory Collaborative Intervention in the Negev

Saleem Abu Jaber

Achva Academic College; Kaye Academic College of Education, Israel

<https://orcid.org/0000-0001-7059-0278>

ABSTRACT

This qualitative pilot examined the feasibility and professional value of an interdisciplinary science-education intervention in three Bedouin kindergartens in Rahat, Israel. Eight preservice early-childhood teachers and eight preservice elementary-science teachers worked in interdisciplinary pairs during eight inquiry-oriented sessions and a 30-hour professional learning community. The study asked how participants described confidence, collaboration, and culturally contextualized science teaching. Reflexive thematic analysis of open-ended responses, discussions, field notes, and final reflections identified perceived growth in confidence, reciprocal disciplinary learning, and value in connecting inquiry to children's environment. Children's outcomes were not measured, and no causal or population-level claims are made. The study offers a contextually grounded model for teacher preparation and identifies requirements for larger prospective research in comparable underserved educational contexts.

Keywords: Bedouin education, culturally responsive pedagogy, early childhood science, interdisciplinary teacher education, professional learning community, teacher self-efficacy

© Author(s), 2026. Published by Star Scholars Press.

This article is distributed under the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are

INTRODUCTION

Early childhood is a consequential period for the development of curiosity, explanatory language, problem solving, and habits of evidence-based inquiry. Young children do not encounter science only through formal lessons; they investigate materials, living things, weather, movement, and change in everyday activity. The educational question is therefore not whether young children engage with scientific phenomena, but whether early-childhood settings provide the language, materials, guidance, and social conditions needed to turn curiosity into sustained inquiry (Gelman & Brenneman, 2004; National Research Council [NRC], 2007).

Access to such opportunities is socially uneven. International research shows that the presence of a science corner or set of materials does not by itself produce meaningful engagement. Teachers' content knowledge, confidence, intentional facilitation, and capacity to connect inquiry with children's experiences are decisive (Nayfeld et al., 2011; Tu, 2006). More recent scholarship similarly emphasizes that early-childhood STEM improvement depends on sustained professional learning rather than isolated workshops, while also noting that the evidence base remains comparatively small and methodologically uneven (MacDonald et al., 2024).

These concerns are acute in Bedouin communities in the Negev. Bedouin education is shaped by long-standing disparities in infrastructure, public investment, professional preparation, and access to culturally and linguistically relevant curricula (Abu-Saad, 2023; Agbaria & Jabareen, 2013). Earlier work also documents limited confidence and preparation for early-childhood science among educators in Bedouin localities (Kasner-Baruch, 2015). Arabic-speaking children encounter formal systems in which Hebrew becomes increasingly consequential, while educational resources and institutional continuity differ markedly across localities. Science instruction in such a context cannot be treated as a culturally neutral curricular addition. It requires attention to language, local environmental knowledge, teachers' professional confidence, and the unequal institutional conditions under which teaching takes place.

This article reports an exploratory collaborative intervention that paired preservice early-childhood teachers with preservice elementary-science teachers in three kindergartens in Rahat. Rather than claiming a novel theory, the study examines a contextually original application of established ideas: socio-constructivist learning, teacher self-efficacy, culturally responsive pedagogy, and practice-embedded professional learning. Its co-planning and guided-inquiry

structure reflects the socio-constructivist view that professional knowledge is developed through active inquiry, interaction, and reflection (Brooks & Brooks, 1993). Its contribution is applied and contextual. It asks whether an interdisciplinary, field-based structure is feasible in this setting, what participants perceived they learned, and what design limitations must be addressed before the model can be evaluated at scale.

LITERATURE REVIEW

Early Childhood Science and the Role of the Educator

Inquiry in early childhood is most productive when children's exploration is combined with purposeful adult mediation. Tu (2006) found that science-related activity occupied a small proportion of observed preschool practice even when classrooms possessed relevant materials. Nayfeld et al. (2011) likewise showed the importance of balancing autonomous exploration with teacher-led support. Together, these studies shift attention from equipment alone to the pedagogical work of asking questions, eliciting predictions, supporting observation, introducing vocabulary, and revisiting explanations.

Teacher confidence is central to this work but should not be equated automatically with instructional quality. Research on early-childhood educators shows that mastery experiences, collegial encouragement, and engagement with educational knowledge can strengthen self-efficacy and support pedagogical planning and implementation (Pitkaniemi et al., 2025). At the same time, recent studies caution that self-reported beliefs and observed practices may not align; rigorous evaluation should therefore combine perception measures with observation and direct evidence of children's learning (Chen et al., 2025). The present pilot treats confidence as a professional perception, not as a proxy for child outcomes. Recent intervention evidence likewise indicates that structured, practice-oriented professional learning can strengthen preschool teachers' science-teaching self-efficacy and support more systematic classroom enactment (Uyanik et al., 2026).

Professional Learning and Interdisciplinary Preparation

Professional development is more likely to influence practice when it is sustained, collaborative, content-focused, and connected to teachers' work (Darling-Hammond et al., 2017). A scoping review of early-childhood STEM professional learning found generally positive reported outcomes but only a limited number of studies, wide variation in how STEM was defined, and a need for stronger evidence about impact (MacDonald et al., 2024). Evagorou's (2024) study of kindergarten preservice teachers further shows that teacher candidates

need supported opportunities not only to learn what integrated STEM means, but also to design, enact, and reflect on lessons with mentors. Recent evidence further shows that preschool STEM professional learning can change observed teaching practice, while professional learning communities foster ownership, collaboration, and reflective inquiry when adequate time and organizational support are available (Lange et al., 2026; van Rossum et al., 2026).

The pairing used in the present study responds to this preparation problem. Early-childhood candidates brought knowledge of young children, routines, play, and developmental pedagogy; science-education candidates brought greater familiarity with disciplinary concepts and inquiry activities. The intervention was designed to make these forms of expertise mutually accessible rather than to position one group as permanently expert and the other as deficient. This emphasis on repeated enactment and reflection is also consistent with recent work on helping preservice early-childhood teachers bridge the theory-practice divide (Yapar et al., 2026).

Culture, Language and STEM Equity

Equity-oriented science education requires more than including underrepresented learners in unchanged programs. It requires professional conditions that enable teachers to recognize learners' cultural and linguistic resources, connect curriculum to lived experience, and examine how institutional arrangements shape opportunity (Adah Miller et al., 2024; Hypolite & Rogers, 2023). In the Negev, this means attending simultaneously to Arabic language use, Bedouin community knowledge, local environmental phenomena, and unequal access to materials and professional support. Culturally responsive pedagogy is therefore understood here as a design orientation—not a claim that every activity was fully culturally sustaining.

These strands of scholarship converge on a common design problem. Inquiry-oriented materials are unlikely to change early-childhood practice without educators who possess sufficient science understanding, developmental knowledge, confidence, and institutional support. Conversely, teacher confidence alone is not evidence of effective inquiry or children's learning. A defensible preparation model must therefore connect content knowledge with developmentally appropriate enactment, provide repeated opportunities for supported practice, and evaluate perceptions separately from observed teaching and child outcomes. This distinction informs both the intervention and the deliberately bounded claims made in the present study.

Interdisciplinary preparation may be particularly useful where expertise is unevenly distributed across teacher-education programs. Early-childhood candidates often have stronger preparation in play, language, classroom routines, and developmental responsiveness, whereas science-education candidates may

have greater familiarity with disciplinary explanations and inquiry sequences. Bringing these resources together can create productive interdependence, but collaboration cannot be assumed merely because participants are placed in the same setting. It requires explicit role negotiation, shared planning time, mentor support, and opportunities to revise practice. These design conditions provide the analytical bridge between the international literature and the local Rahat intervention.

Research Gap and Questions

Existing scholarship supports inquiry-based early science, sustained professional learning, and culturally responsive teaching, but little empirical work has examined how these elements can be combined through interdisciplinary preservice preparation in Bedouin kindergartens. The study addressed three questions:

1. How did participants describe changes in their confidence and preparedness to facilitate early-childhood science inquiry?
2. How did the interdisciplinary model shape collaboration among preservice teachers and kindergarten teacher-instructors?
3. What features of the intervention supported or constrained culturally contextualized science teaching?

METHOD

Design and Epistemic Scope

The study used an exploratory, qualitative-dominant pilot design embedded in a one-semester educational intervention. The original project included brief pre- and post-intervention questionnaires containing Likert-type and open-ended items. Because the questionnaire was locally developed, was not psychometrically validated, and was administered to a very small bounded group, the closed-response items are not treated as a quantitative outcome measure in this article. No inferential statistics are reported. The analysis instead draws on the open-ended responses, reflective discussions, field notes, and summative reflections as a qualitative corpus. This decision aligns the evidentiary claims with the quality and scale of the available data.

Context, Sampling, and Participants

The intervention took place in three kindergartens in Rahat, a Bedouin city in the Negev, during the second semester of the 2022–2023 academic year. Sites were

selected purposively because they served as field-based practicum settings, their teacher-instructors agreed to host the initiative, and they could accommodate paired interdisciplinary placements. The participant group comprised eight female preservice early-childhood teachers, eight female preservice elementary-science teachers, and three kindergarten teacher-instructors. The three classrooms served approximately 90 children aged 4–5. Children participated in ordinary educational activities but were not research respondents, and no individual child data or learning assessments were collected.

Table 1
Participants, Intervention Components, and Analytic Evidence

Component	Description	Evidence used in this article
Preservice participants	8 early-childhood and 8 elementary-science candidates organized into 8 interdisciplinary pairs; purposive, practicum-based sample	Open-ended questionnaire responses, PLC reflections, summative reflections
Kindergarten educators	3 teacher-instructors in three Rahat kindergartens	Reflective comments and researcher field notes
Children	Approximately 90 children aged 4–5	No child-level outcome data; only non-identifying contextual observations
Field intervention	8 weekly sessions in each kindergarten	Observational field notes and end-of-day reflective discussions
Professional learning community	30 hours of guided planning, science content support, reflection, and feedback	Reflective discussions and seminar reflections

Note. The sample was bounded and purposive. Counts describe participation and are not a basis for population inference.

Intervention

Pairs consisting of one early-childhood candidate and one science-education candidate co-facilitated small-group activity within each kindergarten. The first session focused on orientation to the classroom, children, routines, and expectations. Subsequent sessions addressed age-appropriate topics such as plants, animals, weather, and the local environment through observation, hands-on

exploration, simple experiments, games, and modeling. The final session was a seminar for presentation and collective reflection.

A 30-hour professional learning community ran alongside field implementation. It provided science-content support, collaborative lesson planning, discussion of developmental appropriateness, reflection on classroom enactment, and feedback from pedagogical instructors and an external specialist in early-childhood science. The dual structure was intended to connect disciplinary knowledge with early-childhood pedagogy and to create repeated cycles of planning, enactment, and reflection.

The sixteen preservice participants were organized into eight interdisciplinary pairs, each comprising one early-childhood candidate and one elementary-science candidate. The pairs were distributed across the three practicum sites in coordination with the teacher-instructors and worked with small groups within the ordinary kindergarten schedule. The eight-session sequence combined initial orientation, collaborative planning, repeated inquiry enactment, feedback, and final synthesis. The intervention was not standardized as an experimental treatment; activities were adapted to classroom routines, available materials, and the interests and developmental needs observed at each site.

This flexible implementation was appropriate to an exploratory field-based pilot, but it also limits claims about fidelity and comparative effectiveness. No formal implementation-fidelity instrument was used, and the number, duration, and content of small-group interactions could vary within the shared eight-session framework. Accordingly, the study examines feasibility, participant experience, and recurring professional-practice patterns rather than estimating the effect of a uniform program. This distinction is maintained in the analysis and in the evidence-to-claim matrix.

Data Sources

Four sources informed the analysis: (a) open-ended responses accompanying locally developed pre- and post-intervention questionnaires; (b) structured reflective discussions within the professional learning community; (c) observational field notes documenting instructional interactions, participant roles, and implementation challenges; and (d) end-of-project seminar reflections. Questionnaire prompts addressed confidence in teaching science, perceived access to pedagogical tools, collaboration, and cultural appropriateness. Because neither a validated scale nor a complete analyzable numerical dataset was available, the Likert-type responses were excluded from claims of measurable change.

Qualitative Analysis and Trustworthiness

The author conducted a reflexive thematic analysis in four stages. First, all available narrative material was read repeatedly and organized by source and participant role. Second, initial codes were generated both deductively from the research questions (confidence, collaboration, and contextual responsiveness) and inductively from recurring descriptions in the corpus. Third, related codes were compared across sources and consolidated into candidate themes. Fourth, themes were checked against disconfirming or cautionary material, including early reluctance, uncertainty about disciplinary boundaries, and concerns about implementation. The unit of analysis was a meaning-bearing statement or observed episode rather than an isolated keyword.

The analysis was completed by one researcher who also initiated the intervention. Accordingly, no inter-rater reliability statistic is claimed. Trustworthiness was pursued through triangulation across four sources, role-based comparison, maintenance of reflexive notes, preservation of illustrative quotations, and explicit separation of participant perception from direct outcome evidence. The study did not seek thematic saturation in a population sense; it analyzed the complete bounded corpus generated by this pilot. Quotations are presented in English translation from Arabic and are anonymized; ellipses indicate omitted words that did not alter the intended meaning.

Coding remained close to the bounded corpus and was documented through a working code list and reflexive analytic notes. Candidate themes were retained only when they appeared across more than one source or participant role and could be illustrated with specific statements or observed episodes. Evidence that complicated favorable interpretations—including initial reluctance, uneven disciplinary confidence, and concerns about implementation—was used to define the boundary of each claim. This procedure did not substitute for independent coding, but it made the interpretive decisions more explicit and reduced the risk of treating isolated positive statements as general outcomes.

Table 2
Analytic Framework

Theme	Indicative codes	Confirming sources	Boundary on interpretation
Developing confidence for inquiry	Initial anxiety; mastery through enactment; growing independence; desire for further training	Open responses, reflections, field notes	Perceived confidence, not a validated self-efficacy effect

Theme	Indicative codes	Confirming sources	Boundary on interpretation
Reciprocal interdisciplinary learning	Developmental expertise; science-content support; co-planning; negotiated roles	PLC discussions, field notes, summative reflections	Collaboration quality was not measured with a standardized instrument
Contextualizing science	Local plants and weather; Arabic explanation; familiar materials; relevance to children's lives	Lesson reflections, field notes, teacher comments	No direct measure of cultural responsiveness or child learning

Ethical Considerations and Researcher Reflexivity

The intervention received administrative approval from the participating teacher-education institution and was conducted within the kindergartens' approved educational activities. Adult participants were informed that anonymized questionnaire responses, reflective discussions, and quotations could be used for research and publication; participation was voluntary, and reported quotations were anonymized. Kindergartens held routine parental permissions for children's educational participation, field trips, and photography. No identifiable images, names, or child-specific records are reported, and children were not assessed for research purposes.

Because the initiative began as an educational improvement project rather than as a prospectively designed research study, a separate institutional research-ethics approval number was not obtained at inception. This procedural limitation constrains the dataset and is disclosed explicitly. Any future effectiveness study should obtain prospective ethics approval, register its protocol, secure research-specific consent, and define child-level measures before data collection.

The author initiated, coordinated, observed, analyzed, and reported the project. This insider position provided contextual access but created risks of confirmation and social-desirability bias. Reflexive memo-writing, cross-source comparison, attention to reservations as well as favorable responses, and cautious claim language were used to reduce—but cannot eliminate—these risks.

FINDINGS

Three themes recurred across the bounded corpus. The findings describe participant perceptions and observed professional activity. They do not establish causal effects, psychometric change, or gains in children's science learning.

Developing Confidence Through Supported Enactment

Several preservice participants described initial apprehension about teaching science in kindergarten, followed by greater willingness to facilitate activities after repeated, supported practice. One science-education candidate recalled: "At first ... it scared us to think about going to kindergarten and teaching science. But when I arrived, received guidance, and slowly became part of the kindergarten, it became meaningful for me to give children new things that they enjoyed." An early-childhood candidate similarly reflected: "Through this project and the collaboration with the science students, I now feel able to teach science activities in my classroom ... I felt more confident managing the activity independently."

These statements suggest a movement from anticipatory anxiety toward perceived capability. Field notes also recorded increasing participation in planning and facilitation over the eight sessions. The interpretation remains bounded: the evidence documents perceived confidence and enacted participation within the project, not a validated increase in self-efficacy or enduring change beyond the intervention.

Teacher-instructors expressed a related need for content-focused professional support. One stated, "I am thirsty to learn, develop, and receive training in science teaching through this project." Another observed, "You exposed me to methods, tools, and skills that I did not know before in kindergarten science." Such comments illuminate the professional need that the intervention addressed, while also carrying a likely social-desirability effect because the researcher coordinated the project.

Reciprocal Learning Across Disciplinary Roles

The interdisciplinary pairing initially generated uncertainty. Science candidates were unfamiliar with kindergarten routines and developmental pacing, whereas early-childhood candidates reported less confidence with science content and experimentation. Across the sessions, these differences became resources for reciprocal learning: early-childhood candidates supported classroom management, play-based mediation, and adaptation to children's attention; science candidates contributed content explanations, materials, and inquiry sequences.

Pedagogical instructors also had to negotiate unfamiliar collaborative roles. Participants described co-guidance as exposing professional practice to colleagues, which produced early reluctance. Later reflections emphasized more sustained coordination and advocacy for continuing the model. The finding is therefore not that collaboration occurred automatically, but that repeated planning and a protected PLC structure helped participants negotiate disciplinary boundaries.

Contextualizing Inquiry in Children’s Familiar Environment

Activities centered on phenomena accessible in children’s immediate environment, including plants, animals, weather, materials, and observable change. Participants used Arabic explanation, familiar objects, and small-group exploration to reduce the distance between science terminology and everyday experience. Teacher reflections valued this practical connection because it enabled scientific questions to emerge from recognizable settings rather than from decontextualized textbook tasks.

The evidence supports a modest claim: participants intentionally sought local relevance and perceived it as pedagogically useful. The study did not employ an observation rubric for culturally responsive teaching, interview families, or assess children’s cultural identification. “Culturally responsive” therefore describes the intervention’s orientation and design choices, not a measured outcome.

Table 3
Evidence-to-Claim Matrix

Finding	Illustrative evidence	Warranted claim	Claim not warranted
Confidence	Participant accounts of reduced anxiety; more active facilitation in field notes	Participants perceived greater preparedness within the pilot	Statistically significant or durable self-efficacy gain
Collaboration	Co-planning, reciprocal mentoring, changing instructor attitudes	The model supported negotiated interdisciplinary practice	Superiority over another training model

Finding	Illustrative evidence	Warranted claim	Claim not warranted
Contextual relevance	Use of local themes, Arabic explanation, familiar materials	Participants enacted locally connected inquiry activities	Measured cultural responsiveness or improved child achievement

DISCUSSION

The pilot’s principal contribution is not evidence of a new theoretical mechanism; it is a contextually grounded demonstration of how established principles can be organized in an under-researched setting. The pairing of early-childhood and science-education candidates, combined with field enactment and a professional learning community, created repeated opportunities for mastery experience, social persuasion, disciplinary exchange, and reflection. These are plausible sources of developing teacher efficacy (Pitkäniemi et al., 2025), but the present evidence supports only a qualitative interpretation of perceived professional growth.

The findings also accord with research showing that preservice kindergarten teachers benefit from moving iteratively between STEM learning, lesson design, classroom implementation, and mentored reflection (Evagorou, 2024). The Rahat model adds a reciprocal interdisciplinary dimension: neither candidate group possessed all the knowledge required for strong early-childhood science teaching. This matters for program design because it replaces a deficit model with distributed expertise and structured interdependence. More recent experimental evidence similarly links structured early-childhood science workshops with increased teacher self-efficacy, while underscoring that measured child outcomes require validated instruments and a controlled design (Uyanık et al., 2026).

The PLC appears to have been a necessary mediating condition. Participants did not simply receive materials; they planned, enacted, discussed difficulties, and revised practice. This supports MacDonald et al.’s (2024) conclusion that early-childhood STEM professional learning requires a stronger evidence base while suggesting specific design elements for further testing: sustained duration, content focus, mentor involvement, collaborative enactment, and linkage to authentic classrooms. This interpretation is also consistent with 2026 studies showing that sustained preschool STEM professional learning can influence teaching practice and that PLCs are especially valuable for collaborative ownership and reflective inquiry (Lange et al., 2026; van Rossum et al., 2026).

Equity claims require particular restraint. The intervention took place within a system marked by unequal resources, and it deliberately connected science activities to children’s language and local environment. Those features align with calls to professionalize and support teachers as part of equity-centered science

reform (Adah Miller et al., 2024) and to address opportunity gaps through critical, culturally relevant approaches (Hypolite & Rogers, 2023). However, a small teacher-preparation pilot cannot demonstrate that educational inequalities were reduced. At most, it identifies a feasible professional-learning pathway that may contribute to more equitable opportunity if supported structurally and evaluated rigorously.

The model's practical significance lies in how its components were combined. Interdisciplinary pairing supplied complementary expertise; field placement created opportunities to enact ideas with children; teacher-instructors connected the work to classroom realities; and the professional learning community created protected time for preparation and reflection. The findings suggest that these components functioned as a connected design rather than as independent activities. Participants' reported confidence was associated with supported enactment, while reciprocal learning depended on repeated coordination across disciplinary roles. These interpretations remain provisional because the study did not isolate components or compare alternative models. The iterative movement between specialist input, enactment, and reflection also addresses the theory-practice gap highlighted in recent preservice early-childhood teacher education research (Yapar et al., 2026).

The study also illustrates why cultural responsiveness should be evaluated rather than inferred from location alone. Arabic explanation, familiar materials, local plants, weather, and everyday phenomena reduced curricular distance in the activities described by participants. Yet the project did not systematically examine family perspectives, children's interpretations, or the relationship between community knowledge and formal science concepts. Future research should therefore involve local educators and families in co-design, document how language is used during inquiry, and employ observation tools capable of distinguishing surface-level contextualization from sustained culturally responsive pedagogy.

LIMITATIONS

The study has substantial limitations. The sample was small, all preservice participants were women, sites were purposively selected, and the setting was limited to three kindergartens in one city. The questionnaire was locally developed and not validated; its closed-response data are therefore not presented as an outcome measure. The qualitative corpus relied heavily on self-report, and favorable responses may reflect social desirability. The author's dual role as initiator and analyst creates interpretive risk, and no independent coding or inter-rater reliability procedure was used. Prospective research ethics approval was not obtained because the initiative began as educational improvement. The duration was short, there was no comparison group, and the study measured neither

instructional quality with a validated observation tool nor children's scientific knowledge, inquiry skills, motivation, or longer-term trajectories. Consequently, the findings are exploratory, context-specific, and not statistically or analytically generalizable.

IMPLICATIONS FOR RESEARCH AND PRACTICE

For practice, teacher-education programs may consider pairing complementary specializations, locating professional learning within field placements, and protecting time for collaborative planning and reflection. Such models should recognize early-childhood pedagogy and science-content knowledge as mutually necessary forms of expertise. In Bedouin settings, program design should also involve local educators and families more directly, incorporate Arabic scientific discourse and community knowledge, and ensure reliable access to materials rather than placing responsibility solely on individual teachers.

For research, the next phase should use a prospectively approved and pre-specified protocol across multiple localities. A larger sample would permit the use of validated teacher-efficacy measures, systematic classroom observation, fidelity documentation, and an appropriate comparison condition. Direct child assessments should be developmentally and linguistically appropriate and should distinguish inquiry skills, conceptual learning, engagement, and language outcomes. Qualitative interviews with teachers, families, and mentors would clarify how cultural relevance is experienced rather than merely intended. Independent coding and an accessible analytic audit trail would further strengthen credibility.

CONCLUSION

This exploratory pilot shows that an interdisciplinary, practice-embedded model of early-childhood science preparation was feasible in three Bedouin kindergartens in Rahat and was experienced by participants as professionally valuable. Supported enactment, reciprocal expertise, and a structured professional learning community were the model's most salient features. The study does not demonstrate changes in children's learning or reductions in educational inequality, and it does not provide a validated quantitative test of teacher self-efficacy. Its contribution is narrower but important: it offers a transparent account of an applied intervention in an underrepresented context, identifies plausible mechanisms and implementation conditions, and establishes a disciplined agenda for a larger evaluation. In settings where structural inequality and curriculum–culture distance constrain science opportunity, such careful, collaborative teacher preparation is a necessary beginning—not evidence that the gap has already been closed.

ACKNOWLEDGMENTS AND AI USE STATEMENT

During the preparation and revision of this manuscript, the author used ChatGPT (OpenAI) solely to assist with English-language editing, clarity, organization, readability, and formatting. The AI tool was not used to generate or alter empirical data, fabricate sources, manipulate results, or determine the study's findings or conclusions. The author independently reviewed and verified the entire manuscript, including all citations, references, interpretations, and conclusions, and assumes full responsibility for the accuracy, originality, ethical integrity, and intellectual content of the work.

DECLARATIONS

Funding. No external funding was received for this study.

Conflict of interest. The author declares no conflict of interest.

Data availability. The qualitative materials contain context-sensitive participant information and are not publicly deposited. De-identified excerpts may be considered subject to institutional and participant-permission constraints.

REFERENCES

- Abu-Saad, I. (2023). *The Bedouin-Arab education system in the Negev from a local perspective: Current situation and needs* (Policy Study No. 186). Israel Democracy Institute. [Hebrew]
- Adah Miller, E., Berland, L., & Campbell, T. (2024). Equity for students requires equity for teachers: The inextricable link between teacher professionalization and equity-centered science classrooms. *Journal of Science Teacher Education*, 35(1), 24–43. <https://doi.org/10.1080/1046560X.2023.2170793>
- Agbaria, A., & Jabareen, Y. (2013). Buried reports: The implications of the politics of contempt for Arab education in Israel. In D. Avnon (Ed.), *Civic education in Israel* (pp. 106–146). Am Oved. [Hebrew]
- Brooks, J. G., & Brooks, M. G. (1993). *In search of understanding: The case for constructivist classrooms*. Association for Supervision and Curriculum Development.
- Chen, S., Sermenio, R., Hodge, K. N., Geesa, R. L., Song, H. S., Izci, B., Froh, Z., & Murphy, S. (2025). Aligning early childhood science teaching beliefs, practices, and children's learning outcomes: The impact of a professional development program. *Frontiers in Psychology*, 16, Article 1580018. <https://doi.org/10.3389/fpsyg.2025.1580018>

- Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute.
- Evagorou, M. (2024). Engaging kindergarten pre-service teachers in the design and implementation of STEM lessons. *Frontiers in Education*, 9, Article 1277835. <https://doi.org/10.3389/educ.2024.1277835>
- Gelman, R., & Brenneman, K. (2004). Science learning pathways for young children. *Early Childhood Research Quarterly*, 19(1), 150–158. <https://doi.org/10.1016/j.ecresq.2004.01.009>
- Hypolite, L. I., & Rogers, K. D. (2023). Closing STEM opportunity gaps through critical approaches to teaching and learning for Black youth. *Theory Into Practice*, 62(4), 431–447. <https://doi.org/10.1080/00405841.2023.2278972>
- Kasner-Baruch, Y. (2015). *Young scientists: Affective and cognitive aspects among kindergarten teachers and children with respect to dealing with science in early childhood education* [Unpublished doctoral dissertation]. Bar-Ilan University. [Hebrew]
- Lange, A. A., Musgrove, M. C., Facun-Granadozo, R., & Alshahrani, W. (2026). Impacts of a preschool STEM professional learning approach on teaching practice in math, science, and integrated STEM. *Journal of Research in Childhood Education*. Advance online publication. <https://doi.org/10.1080/02568543.2026.2648182>
- MacDonald, A., Danaia, L., Deehan, J., & Hall, A. (2024). STEM professional learning in early childhood education: A scoping review. *Journal of Early Childhood Teacher Education*, 45(1), 79–95. <https://doi.org/10.1080/10901027.2023.2224251>
- National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K–8*. National Academies Press. <https://doi.org/10.17226/11625>
- Nayfeld, I., Brenneman, K., & Gelman, R. (2011). Science in the classroom: Finding a balance between autonomous exploration and teacher-led instruction in preschool settings. *Early Education and Development*, 22(6), 970–988. <https://doi.org/10.1080/10409289.2010.507496>
- Pitkäniemi, H., Hirvonen, R., Heikka, J., & Suhonen, K. (2025). Teacher efficacy, its sources, and implementation in early childhood education. *Early Childhood Education Journal*, 53, 1705–1715. <https://doi.org/10.1007/s10643-024-01713-w>
- Tu, T. (2006). Preschool science environment: What is available in a preschool classroom? *Early Childhood Education Journal*, 33(4), 245–251. <https://doi.org/10.1007/s10643-005-0049-8>
- Uyanık, G., Günşen, G., Konaş Azaklı, T., Değirmenci, Ş., Çelik, B., Aydın, D., & Kaçira, A. B. (2026). Exploring science through stories: Investigating

effects on teachers' self-efficacy and preschoolers' scientific skills and curiosity. *Early Childhood Education Journal*, 54, 5333–5346.

<https://doi.org/10.1007/s10643-026-02234-4>

van Rossum, E., de Schipper, J. C., van der Veen, C., & Dobber, M. (2026). The suitability of training and professional learning communities for professional development in early childhood education. *Journal of Early Childhood Teacher Education*. Advance online publication.

<https://doi.org/10.1080/10901027.2026.2654436>

Yapar, N. B., Üzümlü, S., & Demircan, H. Ö. (2026). Pre-service early childhood teachers' reflections on specialist teaching methods and their experiences regarding the transfer of knowledge from theory to practice. *European Journal of Teacher Education*. Advance online publication.

<https://doi.org/10.1080/02619768.2026.2655983>

Bio

SALEEM ABU JABER, PhD, is a Senior Lecturer and Head of the Department of Arabic Language and Literature at Achva Academic College, Israel, and a lecturer at Kaye Academic College of Education. His research focuses on modern and classical Arabic literature, Palestinian literature, cultural memory, Ottoman intellectual history, Qur'anic exegesis, Arabic manuscript studies, and teacher education. He received his PhD from Tel Aviv University and completed postdoctoral research at SOAS University of London and the University of Westminster. He has published widely on Palestinian literary identity, Arabic-Islamic intellectual history, and teacher education, and has held academic leadership positions advancing Arabic-language education and access to higher education for Arabic-speaking students. Email: saleemabujaber@gmail.com