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STEM IN THE MARGINS: EXPLORING PRESCHOOL TEACHERS' UNDERSTANDING, CHALLENGES, AND PRACTICES IN RURAL SABAH

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Abstract

Implementing STEM in rural preschools requires teachers to relate disciplinary concepts to young children's learning within resource-constrained contexts. However, how teachers interpret and implement STEM in these settings remains underexplored. This qualitative case study examined preschool teachers' understanding of STEM, implementation challenges, and integration strategies in rural Sabah, Malaysia. Three experienced preschool teachers participated in the study. Data were collected through structured interviews and classroom observations documented in field notes and were analysed thematically. Three themes emerged: teachers' understanding of STEM, implementation challenges, and classroom integration strategies. Teachers perceived STEM as involving questioning, everyday exploration, simple experimentation, and building and construction play. They reported challenges related to teaching materials, pupils' engagement, administrative demands, and limited preparation time. Teachers also described using hands-on learning, play-based activities, recycled and locally available materials, as well as pictures and real objects when digital resources were unavailable. These findings situate early STEM implementation within teachers' pedagogical perspectives, professional preparation, and experiences in facilitating learning. The study provides a context-specific understanding of how experienced teachers create STEM-related learning opportunities in rural preschool settings and how these opportunities are shaped by local classroom conditions and available resources. The findings suggest that early childhood STEM education should be supported by appropriate resources and sufficient time for professional learning, while teachers should be encouraged to develop inquiry-based experiences that are relevant to young children's engagement and responsive to the local classroom context.

Kata kunci:
Pendidikan STEM, pendidikan awal kanak-kanak, guru prasekolah luar bandar

Apabila menerapkan STEM di prasekolah luar bandar, guru perlu mengaitkan konsep disiplin ilmu dengan pembelajaran kanak-kanak dalam keadaan yang serba kekurangan. Walau bagaimanapun, cara guru mentafsir dan melaksanakan STEM dalam persekitaran sebegini masih belum difahami sepenuhnya. Kajian kes kualitatif ini meneliti kefahaman guru prasekolah mengenai STEM, masalah pelaksanaan, dan strategi integrasi di kawasan luar bandar Sabah, Malaysia. Tiga orang guru prasekolah yang berpengalaman telah dipilih untuk kajian ini. Data dikumpul melalui temu bual berstruktur dan pemerhatian bilik darjah (berdasarkan nota lapangan) serta dianalisis secara tematik. Tiga tema dikenal pasti: kefahaman guru tentang STEM, cabaran pelaksanaan, dan strategi integrasi dalam bilik darjah. Guru menganggap STEM sebagai proses penyoalan, penerokaan kehidupan seharian, eksperimen mudah, serta aktiviti permainan membina dan menghasilkan binaan. Dalam perkongsian mereka, guru menyentuh tentang kesukaran berkaitan bahan pengajaran, penglibatan murid, aspek pentadbiran, dan masa persediaan yang tidak mencukupi. Mereka melaporkan penggunaan kaedah pembelajaran secara praktikal (hands-on), aktiviti berasaskan permainan, bahan kitar semula dan bahan tempatan, serta penggunaan gambar dan objek sebenar sebagai ganti apabila sumber digital tidak tersedia. Dapatan ini membantu meletakkan pelaksanaan awal STEM dalam kerangka pandangan pedagogi guru serta pengalaman latihan dan pembelajaran mereka dalam menyediakan dan memudah cara pembelajaran. Kajian ini memberikan gambaran khusus konteks tentang bagaimana guru berpengalaman mewujudkan peluang berkaitan STEM di prasekolah luar bandar, serta bagaimana peluang ini berbeza daripada kejayaan pembelajaran atau pengajaran antara disiplin mereka. Kajian ini mencadangkan agar STEM untuk kanak-kanak awal usia disokong dengan sumber dan masa yang sesuai untuk pembelajaran profesional, dan guru perlu membangunkan pengalaman inkuiri yang relevan dengan penglibatan kanak-kanak dalam bidang tersebut di persekitaran bilik darjah tempatan.

1.0 Introduction

STEM education (Science, Technology, Engineering, and Mathematics) is being much more emphasized in Malaysia's education system as it is perceived as an important factor of the country's future development (Marzuki et al., 2026). When it comes to early childhood education, STEM is essential in establishing a scientific, logical, creative, and innovative thinking base from the preschool level (Ghazali et al., 2023). Early exposure to STEM can help kids develop 21st-century skills such as problem-solving, communication, and collaboration (AlAli, 2024; Nasir et al., 2025; Tan & Kidman, 2025; National Research Council, 2011). Nevertheless, the implementation of STEM education is not as straightforward as expected. Various issues and challenges often arise, particularly in rural schools that face limitations in infrastructure, teaching materials, and teacher expertise (Joseph & Uzondu, 2024; Selwyn, 2004).

Moreover, in a Fourth Industrial Revolution (IR 4.0) where STEM is no longer optional, it is now mandatory (Marzuki et al., 2026; MOSTI, 2021). In the modern world, we need a generation that can adapt to technology and think critically and analytically (UNESCO, 2025; Rusmin et al., 2024). Therefore, STEM education at the preschool level is a first step to prepare children for the future. However, in rural Sabah, preschool teachers can face various challenges (namely, lack of professional training, curriculum burden, and different student readiness) (Thibaut et al., 2018; Photo, 2026; Maja, 2023; Leung, 2023; Ling et al., 2020). Therefore, this research is

important as it not only assesses teachers' level of knowledge about STEM but also how they tackle the issues they face and how they are able to support STEM learning in their schools. The study regarding the implementation of STEM among preschool teachers in rural Sabah is highly significant as it would provide a true picture of the extent to which teachers are ready and able to implement this concept in the classroom. This study is hence hoped to open a broader space for discussion regarding the need for support, training, and creative approaches that can be used by teachers to ensure STEM education can be carried out comprehensively even in conditions of deficiency.

1.1 Research Objectives

1. To explore rural preschool teachers' understanding of STEM education in Sabah.
2. To identify the challenges faced by rural preschool teachers in implementing STEM education in Sabah.
3. To explore the strategies used by rural preschool teachers to integrate STEM into teaching and learning in Sabah.

1.2 Research Questions

1. How do rural preschool teachers in Sabah understand STEM education?
2. What challenges do rural preschool teachers in Sabah face when implementing STEM education?
3. What strategies do rural preschool teachers in Sabah use to integrate STEM into teaching and learning?

2.0 Literature Review

STEM is the practice of integrating Science, Technology, Engineering, and Math into cohesive, hands-on lessons. Rather than memorizing facts, children are encouraged to investigate their surroundings and tackle problems through critical thinking. In a preschool setting, this is achieved through "play with a purpose" activities tailored to a child's developmental stage that turn the environment into a living laboratory. According to Salahova (2023), experiential STEM labs (ages 5–9) strengthened components of scientific thinking including questioning, hypothesizing, experimenting, analyzing data, and drawing conclusions. Reviews and empirical work emphasize that early STEM builds a foundation for later STEM learning, literacy, and 21st-century skills such as communication and collaboration (Wan et al., 2020).

The Malaysian STEM literature also considers the psychological dimension of the involvement of the learner. Idris, Govindasamy, et al. (2023) discuss self-efficacy as an important factor in students' STEM engagement and career interest. Idris, Bacotang, et al. (2023) discuss field independence and field dependence as cognitive styles that may inform STEM learning and instructional choices. Together these conceptual perspectives suggest thinking about learners' confidence and processing information and how they are able to use information to the best of their ability as well as the resources available to them. They provide a more general context for teachers' views of children's engagement, although in the present study we did not

measure self-efficacy or categorize children by cognitive style. Research has demonstrated how preschool teachers have the key role to play in how STEM is put into practice: they create experiences, mediate children's inquiry and need the support to move away from traditional, teacher-centred education to a child-centered, teacher-centred learning model.

In teachers' hands, we are moving from "delivering" content to co-learning, guiding inquiry and co-creating knowledge with children, so that we're more able to solve problems and make real life applications (Leung, 2023; Aleksieva et al., 2021). STEM education in early childhood is also a much more important educational field worldwide as it can train kids to be creative, critical thinkers and problem solvers at an early age. STEM education is a major issue in Malaysia and STEM is a core element of the nation's education transformation program to prepare the future generation to meet the demands of the Fourth Industrial Revolution. However, the evidence for STEM education in preschool is mixed, especially in marginalized and poorer areas like Sabah. Research shows that preschool teachers generally have a positive attitude towards STEM education, but few are well aware of integrated STEM teaching (Abd. Halim et al., 2023).

Instead of looking at STEM as an interdisciplinary and inquiry-based learning process, teachers tend to view it as science experiments or math projects. In rural settings, teachers often get little exposure to STEM-focused professional development and have limited opportunities to engage with new pedagogical practices. Leung (2023) has argued that early childhood educators are often finding it harder to move away from teacher-focused approaches to child-centered STEM education because of the lack of pedagogical confidence and institutional support. So far, it is found in the literature that teachers' knowledge of STEM in rural preschools is influenced not only by the level of their competency but also by wider structural and contextual inequality.

Resources and opportunities for professional development are important aspects of rural STEM implementation. Research in Malaysian early childhood schools has demonstrated the value of integrated STEM and design thinking activities (Ho & Pang, 2024), and rural primary teachers are also shown to need professional support for lesson planning (Jiwarathnam & Karpudewan, 2026). These studies provide related perspectives, although their settings and participants should not be seen as evidence for all rural preschools in Sabah. In this study we investigate how teachers describe the resource and planning conditions in terms of STEM activities.

There are also pedagogical and professional readiness issues with preschool teachers beyond infrastructural limitations as noted in the literature. A large body of research indicates that most of the teachers are not comfortable integrating engineering design, technology, and inquiry-focused learning into preschool classrooms (Rethinam, 2024). Teachers tend to be uncomfortable about how STEM concepts are appropriate for young children while still being developmentally appropriate. Ghazali et al. (2024) described that good early childhood STEM implementation needs teachers who possess good pedagogical flexibility, creativity, and the ability to work in hands-on learning contexts. Rural teachers tend to be further isolated and have little access to mentors, which often inhibits their ability to develop these skills, so in preschools this is a particular concern because early childhood education is based on play-based and holistic learning methods, which might conflict with teachers' traditional understanding of formal education. International literature

also suggests that teachers' anxiety about STEM is generally a result of insufficient training and lack of training in interdisciplinary teaching (Leung, 2023).

Thus, it is clear from the literature that teacher-related issues are not just about knowledge gaps; they involve confidence, identity, and adaptability to integrate STEM education into an educator's classroom. Importantly, these findings challenge deficit-based assumptions that rural teachers will not be able or unwilling to teach and show how systemic barriers make teachers' classroom practices and professional function more challenging. Despite the challenges, there are also several promising and transformative practices happening in rural STEM education. The literature is increasingly calling for context-based and culturally responsive STEM education that draws from local environments, indigenous knowledge, and community resources as a foundation for learning. For Sabah, the natural environment and indigenous cultures provide a great place to learn STEM. Ghazali et al. (2023) stressed that a good preschool STEM education should go beyond textbooks and should be hands-on, peer-based, collaborative, and problem-solving based on what the kids are doing during their daily lives.

Similarly, integrated STEM and design thinking methods show that meaningful STEM learning can be achieved on a localized basis, in collaboration, and in a flexible pedagogical style (Ho & Pang, 2024). This point of view is particularly important for the field of technology, and pedagogical creativity and context-specificity. In addition, the literature shows that working with colleagues and peers and school-community partnerships can improve confidence in rural teachers in STEM teaching as well as their ability to teach. This has implications for the way we work in marginalized communities to have meaningful STEM education and to take the leadership by providing teachers who are active innovators in their local environments to make a difference in STEM education, and it's hard to ignore what the literature shows for the rural Sabah community and how much it is the intersection of opportunity, marginalization, and resilience. The understanding and challenges of preschool teachers are also informed by policy expectations, resources, career opportunities, and sociocultural realities, as well as society as a whole. Despite teachers' positive outlook on STEM education, their work is also subject to structural, regional, and cultural inequalities and context-specific challenges that are prevalent in rural settings.

However, current research is showing that the abilities and capacities of rural educators are increasing to address these issues through the application of local and culturally sensitive teaching methods. In addition, the synthesis of literature suggests that future STEM research must not place urbanized models on preschool-based preschools but focus on culturally responsive, contextually relevant, and equity-driven approaches and not simply deficit models. Future research should also explore how rural preschool teachers construct STEM meanings in their social context and not through deficit frameworks. In conclusion, STEM education in the margins of rural Sabah should not be viewed only as an educational access issue but as a broader issue for educational equity, inclusion, and context in early childhood education.

3.0 Method

This section describes the research methods employed to address the objectives of the study and to systematically investigate STEM implementation among preschool teachers in rural Sabah.

3.1 Research Design and Participants

This study is based on qualitative case studies to investigate preschool teachers' understanding, challenges and strategies regarding STEM education in rural Sabah. The methodology is tailored for an in-depth assessment of teachers' experiences in their teaching environments. Three rural preschool teachers were selected by purposive sampling. The selection criterion was more than ten years of experience in preschool teaching so the study could draw on those who have experience in preschool teaching. From Table 1, the participants have a total of 17 to 22 years of teaching experience. The sample was intended to provide contextual depth rather than statistical representation of preschool teachers across Sabah.

Table 1. Participants' Information

Name	Age	Educational Level	Teaching Experience
Participant A	56 years old	Bachelor's degree in early childhood education (Keningau Teacher Education Institute)	22 years
Participant B	42 years old	Bachelor's degree in early childhood education (Universiti Sains Malaysia, USM)	17 years
Participant C	54 years old	Malaysian Certificate of Education (SPM)	22 years

4.0 Data Collection

Data was collected in interviews and classroom observations. The interview questions were prepared in advance and organized around the three study objectives of STEM, implementation challenges and integration strategies. The format of the interview was structured to ensure that participants' views were consistent across these subjects and that the information was not lost in the data and that participants' perspectives were well-developed. Interviews were conducted before classroom observations. There were observations of teaching aids, teaching methods and children's responses during STEM activities, and field notes were taken for context on implementation.

4.1 Data Analysis.

Interview responses and classroom observations were combined to assess how well teachers understood STEM and their implementation challenges and integration strategies. The analysis connected participants' descriptions of STEM with the

constraints and teaching methods described in the findings. In each theme, direct quotations are shown for the reader to be able to consider the relationship between participants' accounts and the interpretation.

4.2 Participant Identification and Evidence Presentation

Participants are identified as Participant A, Participant B and Participant C in the reporting of findings. Quotations are attributed to these codes rather than participants' names. Classroom observations and field notes provide additional contextual information alongside the interview accounts.

5.0 Results

This section presents the findings of the study based on the thematic analysis of interview and classroom observation data. The findings are organised according to the main themes that emerged from the analysis.

5.1 Preschool Teachers' Understanding of STEM

The results of the study found that preschool teachers in rural areas understand STEM as an integrated learning approach encompassing Science, Technology, Engineering, and Mathematics. STEM is not just the teaching of theory or basic memorization, but rather providing opportunities for students to think critically, creatively, and develop logical skills from an early age. Teachers see STEM education as a medium to spark children's curiosity through questions, exploration, and experimental activities. According to Participant A, each STEM element can be naturally integrated into daily activities, thereby encouraging children to think critically even at the age of five or six;

> *"For me, STEM is like a modern magic tool, but in the form of science, technology, engineering, and mathematics. Sometimes we are not just teaching children to count numbers or do simple soap-water experiments, right? It is more about encouraging them to ask questions and think about why things happen the way they do. Even though these children are still young, their curiosity is very high. Sometimes, even we cannot imagine the kind of ideas they come up with because their thinking can be very far outside the box."* (Participant A)

They also have teachers who know that STEM is very important in building students' confidence to ask questions and find answers themselves. Students are encouraged to try, test and evaluate something on the spot, and learn through real life. This method not only teaches problem solving but also helps students learn actively and meaningfully. Participant B said that STEM is not just project oriented but also can be taught indirectly through the day-to-day teaching practice;

> *"For me, STEM covers many things. People often think STEM must involve projects, but actually that is not necessarily true. In our daily*

> *teaching, there are already indirect STEM elements. For example, when we teach children about flowers and their parts such as leaves, roots, and petals, that already falls under the field of science."* (Participant B)

Teachers also relate STEM to students' daily lives, for example, through the use of simple materials, building games, or recycling activities. This makes the STEM concept closer to the reality of preschool children, thereby making it easier for them to understand a concept in a fun way. Overall, teachers' understanding of STEM illustrates that this education is seen as a holistic teaching method that forms critical, creative, and logical thinking suitable for implementation from the early childhood stage. Participant C stated that STEM should be taught to children through play-based approaches so that it can be more easily understood;

> *"For me, STEM is a combination of science, technology, engineering, and mathematics. But in preschool, we do not teach it like in secondary school. We teach through play so that children can understand more easily. For example, we conduct simple experiments or ask them to build something using straws, Lego, or recycled materials."* (Participant C)

5.2 Challenges in Implementing STEM Education

The study found that teachers are struggling to implement STEM education in rural preschools. The main issue is that there are varying levels of student involvement. Some students are really good at the concepts and understand them quickly, while others are just shy or lose interest very quickly, so teachers need to use various strategies so students are involved.

> "S*ome children are rockets, they understand very quickly. Some are like turtles and need to be explained many times. But I consider every child unique. As teachers, we need to be smart in planning activities so that the children can be organized so they can all be able to participate based on their own abilities as a whole. For example, we need different approaches so they can all understand.*" (Participant A)

> "*As for the children, their involvement has been quite good, especially if we do some really fun things. I think any teaching really depends on the ways and materials we use to get the kids interested in what we want to teach them so that we can bring their attention, and so that they are interested in what we want them to learn.*" (Participant B)

> "Children who are shy or easily get bored are also one of the challenges." (Participant C)

The lack of resources and teaching aids is also an issue. Rural schools struggle with technological equipment, experimental materials, and modern learning facilities.

Teachers need to make use of recycled materials or local resources to continue to do STEM learning. Teacher creativity can make up for these deficiencies, but activities that are not implemented due to lack of suitable materials are very difficult.

> "*There is definitely a shortage when materials are unavailable or insufficient, and it really affects our learning activities. When teachers want to do activities, we're usually having to find the materials ourselves or use recycled materials*." (Participant A)

> "*In rural schools, we know that the materials provided are still very limited*." (Participant B)

> "*That is indeed a problem. Here, not all materials are available. Occasionally we teachers are forced to use discarded materials such as plastic bottles, egg cartons, leaves, and sand—whatever is available around us, we use it. People say we need to be creative because of the lack of resources and materials to make the activities work.*" (Participant C)

Time constraints also affect the application of STEM. Project-based activities and experiments take a long time, while preschool teaching schedules are often packed with other tasks.

> "*When the workload is too heavy, we simply don't have the time to do better STEM activities or projects that are more involved and more impactful*." (Participant A)

Teachers are also burdened with various administrative tasks, such as meetings, documentation, and school programs that reduce time to plan and implement STEM activities in depth. This makes STEM implementation happen very fast, and so the effectiveness of learning is compromised.

> "*Sometimes there are too many programs, meetings, and documentation tasks, so the time available to plan and conduct STEM activities becomes limited*." (Participant B)

> "T*eachers are not only teaching but also need to manage files, attend meetings, and organize classroom activities. So sometimes the STEM activities have to be kept simple and not too time-consuming*." (Participant C)

5.3 STEM Integration Strategies in Preschool Teaching and Learning

Despite various constraints, rural Sabah preschool teachers still try to employ creative and practical methods to ensure STEM education can be carried out. Hands-on approaches are the most prevalent; students are encouraged to try, build, and do learning activities themselves. This method facilitates students to learn through real

experience and develop knowledge through direct touch.

> "*I use a hands-on approach where the children touch and do things themselves. For example, in building activities, I only give them a little idea first, then let them try on their own, even though sometimes the outcome turns out differently*." (Participant A)

Also, we do play-based learning. Kids are given fun things to do, such as building games, group games, and simple experiments that will help them to learn at a relaxed level. This way, the interest and participation of students will increase, and STEM concepts will be made more understandable.

> "*I will do things that are fun teaching and learning or learning through play. So, building blocks or Lego toys for them to build something. They are actually integrating STEM teaching and learning into the field of engineering, indirectly*." (Participant B)

Teachers also use recycled materials (plastic bottles, egg cartons, sand, or leaves) for STEM activities. Not only are they saving a lot of money, but the students are taught about sustainability and creativity by the teachers.

> "*This school does not have many facilities, but if there is a laptop, I will show short videos. If not, I print pictures or bring real objects. Sometimes I bring stones or leaves and show them directly to the kids. The important thing is that they can see and touch the objects themselves*." (Participant C)

In combination, the stories of participants show adaptations in the design of the materials, the skills of the activities, and the use of technology. These strategies indicate how the teachers were seeking to continue STEM-related activities within the resources they had available, but they do not establish the effectiveness of the activities for children's learning by themselves.

6.0 Discussion

The findings of this study provide a detailed picture of the reality of STEM in rural preschool settings, particularly in Sabah. Teachers were able to establish a good understanding of STEM as an integrated, inquiry-based and experiential way of learning as a whole. This is consistent with the new early childhood STEM literature that places teachers as facilitators who drive exploration and problem-solving and not simply provide knowledge (Leung, 2023; Wan et al., 2020). This understanding is indicative of a gradual pedagogical move by rural preschool teachers towards constructivist and child-centred approaches and suggests that STEM discourse has become a part of classroom practice. Lal Chan and Mohamad Hapni Joblie (2025) state that STEM pedagogy is not only about access to digital tools, but also how technological use is in line with the pedagogical agenda, disciplinary knowledge and reality. But for better or worse, this conceptual understanding doesn't translate into

consistent pedagogical integration at school, highlighting the lack of commonality between educational theory and classroom practice.

The participants' accounts suggest conceptual knowledge is not enough to overcome barriers to STEM implementation. The shortages of teaching materials and the lack of technology made us think about the options for these teachers. Those accounts can be viewed in the context of broader rural resource access and the digital divide (Dai, 2025; Selwyn, 2004). In this case, the relationship between understanding and implementation is seen from the classroom context and teacher knowledge. The findings do not indicate the prevalence or causes of these constraints in Sabah. The participants' descriptions of STEM planning also relied on time and administrative activities. Teachers said meetings, documentation, and other activities reduced the time to do activities and projects. This is consistent with the professional development research on lesson planning (Yabaş & Abanoz, 2024) that focuses on lesson planning support. Professional learning should be accompanied by teachers' ability to prepare for and sustain activities, and one practical implication here is that teachers should be informed of the time and space for that.

However, the present study did not systematically assess the duration or depth of STEM instruction. Children's readiness and engagement were also reported as struggles in implementation. These accounts suggest that flexible activity design and support for participation are needed. Professional development in lesson planning may help teachers to consider different levels of engagement (Yabaş & Abanoz, 2024), but the present findings do not suggest that teachers did not have differentiated-instruction training or formal assessment of children's developmental differences. Participants also spoke of agency in adapting activities to their environment. Hands-on building, play-based tasks, and working from everyday materials enabled STEM-related inquiry and exploration. These practices can be put alongside the literature on experiential STEM learning and play-based learning (Salahova, 2023; Mohammed et al., 2026).

Participant C's portrayal of using pictures and real objects in the absence of digital tools is a good example of how to adapt the materials to different situations. This kind of resourcefulness should be relevant for teachers and not a substitution for that which is in fact there. This case has brought together conceptual knowledge, practical limitations, and material adaptation in the accounts of the same three teachers. The practices of one of these authors indicate that digital equipment is one of many resources and not the only tools to explore STEM. At the same time, the accounts illustrate why resourceful activity design still requires planning time and institutional support. These relationships help us consider support tailored to rural preschools that are similar to these, but do not imply that the case is the only rural preschool case.

The research therefore suggests that support for STEM in such rural preschool contexts should have a mix of professional learning opportunities, materials, and attention to planning needs. The implications for these findings come from the participant accounts of implementation conditions. Further research on the effectiveness of particular adaptations may need to be done by adding detailed classroom evidence and children's learning outcomes.

7.0 Conclusion

This study contributes to early childhood STEM scholarship through the lens of integration as a situated pedagogical judgement: how educators translate disciplinary ideas into learning opportunities that are appropriate for young children in their classroom. The experiences of three experienced preschool teachers in rural Sabah illustrate that in order to understand implementation, we should look at what teacher knowledge, how they prepare and what resources children can explore. We can see that this perspective provides a window into STEM provision that goes beyond equipment availability.

From an early childhood education perspective, the work brings children into the discussion of STEM implementation. The teachers' descriptions of questioning, exploration and construction play suggest that everyday preschool experiences can be the entry points to STEM. These stories also raise a future question for future research: in what circumstances do these experiences develop into meaningful connections between STEM disciplines? Notifying STEM components in an activity and showing integrated learning are separate claims, and the latter will require more analysis of classroom interactions and children's learning. So, the practical contribution is to provide support which builds on teachers' contextual background and gives them the ability to develop appropriate inquiry.

Resource provision, time to prepare for work and professional learning need to be considered. Although this case does not establish effectiveness and does not represent all rural preschools, it shows relationships that others have that are worth investigating in similar contexts. Its contribution is a grounded understanding of how early STEM opportunities are shaped by teachers' decisions in preschool education.

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9.0 Conflict of Interest Statement:

The authors declare that there is no conflict of interest regarding the publication of this article.

10. Research and Publication Ethics Statement:

The authors confirm that this study was conducted in accordance with relevant research ethics guidelines. Informed consent was obtained from all participants, and their confidentiality and anonymity were protected throughout the research process. The authors further declare that the manuscript is original and complies with accepted standards of publication ethics.

11. Author Contributions:

All authors contributed to the conception and design of the study, data collection, data analysis and interpretation, and preparation of the manuscript. All authors

reviewed and approved the final version of the manuscript and take responsibility for its content.

12.0 Data Availability Statement:

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

13.0 AI Disclosure Statement:

The authors used ChatGPT to improve the article's readability, and Grammarly to ensure grammatical accuracy. All AI-assisted content was reviewed and verified by the authors, who take full responsibility for the final content of the manuscript.

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