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Exploring the Absence of Science Clubs in Rural Schools: Challenges and Opportunities

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Abstract

Science clubs enhance learner engagement, promote scientific literacy, and support inquiry-based learning beyond the classroom. However, their presence remains limited in rural schools. This study explored factors influencing the absence and potential establishment of science clubs in selected rural schools within the Vhembe East District, Limpopo Province. Using a qualitative approach framed by the Communities of Practice (CoP) theory, data was collected from 19 Science teachers across seven rural schools in Vhembe East District through focus group interviews and questionnaires. The findings reveal limited awareness of science clubs, lack of resources, insufficient teacher training, minimal administrative support, and geographic challenges as key barriers. Despite these constraints, teachers acknowledged the value of science clubs in developing learners' critical thinking and interest in science. The study recommends teacher training, increased resource allocation, improved institutional support, and partnerships with external stakeholders such as universities to ensure the existence of science clubs in rural schools. Adapting science club models to the rural context is essential for sustainability. These insights contribute to understanding the systemic and contextual factors affecting informal science learning and offer guidance for promoting science clubs in under-resourced schools.

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INTRODUCTION

Science education plays a vital role in developing learners' scientific literacy and equipping them with the skills needed to engage meaningfully with science in everyday life (Osborne, 2007). Science education is defined as the dissemination of scientific knowledge and processes beyond traditional scientific communities, science education aims not only to inform but also to cultivate critical thinking and inquiry-based learning (Jablon, 2020). Achieving scientific literacy requires both formal and informal learning experiences that foster learners' active participation in the broader scientific community (Osborne, 2007; UCMP, 2023).

One valuable avenue for informal science learning is the school-based science club. Science clubs serve as platforms for learners to explore science beyond the limitations of the classroom, often offering interactive and learner-centred experiences that stimulate curiosity, creativity, and deeper engagement with scientific concepts (Sewry et al., 2023). Learners have been shown to have an overall more positive attitude towards science as a result of their involvement in science clubs, and consequently, lead to enhanced conceptual understanding (Sewry et al., 2023). These clubs may vary widely in structure and focus from small, teacher-initiated groups to large, specialised networks addressing fields such as astronomy, biotechnology, or environmental science. Regardless of their scope, science clubs provide opportunities for informal, inquiry-driven learning that complements the formal curriculum and nurtures lifelong interest in science.

In the South African context, science clubs have been promoted as part of broader Science, Technology, Engineering, Mathematics and Innovation (STEMI) initiatives, particularly by the Department of Science and Innovation in collaboration with provincial education departments (Science Club News, 2023). While some schools have embraced science clubs as tools to enhance learner engagement and academic achievement in science, many others—particularly in rural areas—lack such initiatives. This disparity is evident in regions such as the Vhembe East District of Limpopo Province, where several schools still operate without science clubs despite national efforts to promote them.

The absence of science clubs in many rural schools raises critical questions about the underlying challenges and missed opportunities in advancing informal science learning. Against this backdrop, the present study explores the factors influencing the absence of science clubs in selected rural schools in the Vhembe East District. By identifying key challenges and potential enablers, this research aims to contribute to ongoing efforts to improve science engagement and educational outcomes in under-resourced contexts.

Problem Statement

South Africa continues to face significant challenges in the field of science education, including persistently low levels of scientific literacy, declining enrolment in mathematics and science at higher grade levels, and consequently, limited participation in science, engineering, and technology (SET) programmes at tertiary institutions (Sedebo et al., 2024). Compounding these issues is a critical shortage of qualified, motivated, and well-supported science teachers (Sibuyi et al., 2024). Teachers already in the profession often contend with overcrowded classrooms, curriculum changes, learner discipline issues, and limited time or resources for professional development or extracurricular engagement (Osaı et al., 2021).

Amid these systemic challenges, learners in under-resourced rural schools are particularly disadvantaged with fewer opportunities to engage meaningfully with science outside of formal classroom instruction (Mtsi & Maphosa, 2016). While science clubs have been promoted nationally as a means to foster informal science learning and spark learner interest in STEM careers (Science Club News, 2023), many schools, particularly in rural districts such as Vhembe East in Limpopo Province, lack these initiatives. The absence of science clubs in these contexts represents a missed opportunity to

nurture curiosity, scientific thinking, and long-term engagement with science (Martín-García et al., 2024). Despite policy-level encouragement, the factors contributing to this gap remain underexplored in empirical research. This study seeks to address this gap by examining the contextual, institutional, and systemic barriers that inhibit the establishment of science clubs in selected rural schools. In line with this aim, the study was guided by the following research questions, which were developed to explore the multifaceted nature of this issue:

- What are the science teachers' perceptions and understandings of science clubs in rural schools?
- What challenges and opportunities exist in establishing science clubs in rural schools?
- What contextual and institutional factors influence the establishment of science clubs?

Literature Review

Science education contributes significantly to learners' intellectual and practical development, preparing them for careers in STEM fields (Smith, 2018). Studies show that extracurricular science activities, such as science clubs, enhance student engagement, motivation, and academic performance (Bekomson et al., 2020; Denault & Poulin, 2009). However, in developing contexts, several barriers hinder the formation of these clubs.

Benefits of Science Clubs

Innovation is widely acknowledged as the cornerstone of success across various fields (Edumatic, n.d.). By encouraging creativity, experimentation, and problem-solving, science clubs serve as a vital platform for fostering innovation among learners. These clubs provide opportunities for hands-on learning, participation in science competitions, and collaboration among peers (Manion & Coldwell, 2008). Additionally, they inspire students to explore STEM careers, cultivating their passion for science (Gonsalves, 2014). These science clubs aim to cultivate participants' attitudes, skills, and knowledge, with the goal of sparking interest and enthusiasm for science (Garcia- Guerrero et al., 2018). Beyond academic gains, science clubs encourage learners to debate scientific principles, adopt logical and critical approaches to problem-solving, and embrace the learning process beyond focusing solely on results. Importantly, they help students develop perseverance when faced with challenges, encouraging them to engage actively with the physical world rather than being reliant on digital devices (Edumatic, n.d.).

As highlighted by Braintastic! Science (n.d.), science clubs make science enjoyable by showcasing the excitement of exploration, experimentation, and discovery beyond rote memorization. They also foster friendships among participants, enhancing collaboration and teamwork. Moreover, learners acquire valuable life skills, such as leadership, effective communication, and problem-solving (Braintastic! Science, n.d.). Wegner et al. (2016) emphasize the alignment of science clubs with the constructivist approach to learning, wherein students construct knowledge actively through personal experiences and prior understanding. Through science clubs, learners articulate, discuss, and explore scientific ideas, developing individualized understandings of scientific contexts based on their own insights.

Challenges in Establishing Science Clubs

Resource Constraints

Rural schools often lack access to basic scientific resources, including laboratory apparatus and consumables essential for practical science learning (Jones, 2015). These shortages stem from chronic underfunding, with schools in marginalized communities often operating with limited infrastructure and outdated equipment (Hartley, 2014). As highlighted in the Science Club brochure by the South African Agency for Science and Technology Advancement (SAASTA), "learners' interest and participation in science activities depend on access to materials and a stimulating learning environment" (SAASTA, n.d.). However, in rural areas, even basic items like microscopes, test tubes, and reliable electricity may be absent, limiting opportunities

for hands-on experimentation (Samaneka, 2015). Furthermore, schools may be forced to prioritize immediate operational needs—such as textbooks and teacher salaries—over extracurricular science initiatives. This situation discourages the establishment of science clubs, which are often viewed as non-essential or "extra" activities despite their role in enriching science learning.

Teacher Training and Motivation

Teacher preparedness plays a significant role in the implementation of science clubs. Ngema (2016) notes that insufficient teacher training compromises the quality of science education, especially when teachers lacks both content knowledge and pedagogical skills specific to inquiry-based learning. This is supported by evidence from research on teacher professional development, which shows that many rural teachers are not equipped to guide learners through practical science investigations due to a lack of confidence, mentorship, and exposure (Spaull, 2013). Additionally, the workload of rural teachers, often exacerbated by multi-grade teaching and limited support staff, diminishes the time and energy they can dedicate to extracurricular initiatives like science clubs (Chikumbu & Makamure, 2000). The motivation to initiate and sustain science clubs is further weakened by the absence of recognition, incentives, and institutional support. In such environments, even enthusiastic teachers may face burnout or lose interest due to systemic constraints.

Administrative and Community Support

School management and community support are vital for the establishment and sustainability of science clubs. However, in many rural contexts, principals and school governing bodies may not recognize the value of such initiatives or cannot support them logistically and financially. Manion and Coldwell (2008) emphasize that administrative buy-in is critical for promoting extracurricular activities, yet rural schools often struggle with weak leadership structures and limited decision-making autonomy.

Community engagement also presents a challenge. Cultural perceptions, parental illiteracy, and lack of awareness about the importance of science education can limit local support for science clubs (see SAASTA, n.d.). As the "Science Clubs" brochure notes, successful clubs often rely on partnerships with local stakeholders—including NGOs and government agencies—but such collaborations are rare in isolated rural communities. Transportation issues, safety concerns, and the absence of role models in scientific careers further contribute to low participation and interest from learners and parents alike (Sinclair et al., 2025).

Opportunities for Establishing Science Clubs

Despite the challenges, several opportunities exist to promote and sustain science clubs in rural schools. These opportunities can serve as entry points for policymakers, teachers, and NGOs seeking to bridge the science education gap.

Leveraging Government and NGO Initiatives

One of the most promising opportunities lies in partnerships with government bodies and non-governmental organizations. For instance, the South African Agency for Science and Technology Advancement (SAASTA) runs initiatives such as the National Science Week, AstroQuiz, and the Natural Science Olympiads, which actively encourage science engagement among learners and teachers (SAASTA, n.d.). These initiatives can be leveraged to establish and support science clubs by providing resources, training, and visibility. Moreover, programmes like the Dinaledi and MST (Mathematics, Science and Technology) focus schools have demonstrated that targeted support in science education can enhance learner performance and participation (Department of Basic Education [DBE], 2022). Rural schools that align themselves with such programmes may gain access to science kits, teacher training, and mentorship.

Integration with the Curriculum

Science clubs can be structured to complement the formal curriculum, thereby increasing their relevance and reducing the perceived burden on teachers. When club activities are aligned with the Natural Sciences

and Life Sciences syllabi—especially in the development of inquiry-based skills—they can reinforce classroom learning while providing experiential opportunities for learners to explore scientific concepts in greater depth (DBE, 2011). This curricular integration also allows teachers to use science clubs as platforms for alternative assessment and differentiated learning, particularly for learners who may struggle with theoretical instruction but excel in practical tasks.

Utilising Indigenous Knowledge and Local Resources

Rural contexts are rich in indigenous knowledge systems and natural resources that can be harnessed to support science club activities. Learners can explore topics such as traditional medicine, water purification methods, soil fertility techniques, and sustainable farming practices through a scientific lens (Wegner et al., 2016). Using locally available materials not only mitigates resource constraints but also contextualizes science learning, making it more meaningful and relatable (Mkhwebane, 2024). This approach promotes environmental awareness and contributes to the goals of Education for Sustainable Development (ESD).

Digital Platforms and Peer Learning

The growing penetration of mobile technology, even in rural areas, opens doors for digital science engagement. Platforms like the Siyavula learning platform and virtual science clubs can supplement in-person meetings by providing learners and teachers with interactive simulations, online mentorship, and access to a broader community of practice (SAASTA, n.d.). Additionally, peer-led clubs—where older or more advanced learners mentor younger ones—can foster leadership and sustain interest among learners. These models reduce the burden on teachers and encourage a culture of collaborative learning (Science Club News, 2023).

Building a Culture of Science Through Role Models and Events

Exposure to scientists, science fairs, and school-based exhibitions can inspire learners to consider careers in STEM fields. The presence of role models from similar backgrounds has been shown to positively impact learner motivation and self-efficacy (Wegner et al., 2016). Schools can invite local professionals, alumni in science-related careers, or university students to participate in club activities or share career insights. Events such as science weeks or inter-school competitions create visibility for science clubs and foster a sense of pride and achievement among participants (Kwarteng & Obeng-Ofori, 2021). These occasions also offer opportunities to engage parents and the broader community in the learners' scientific journeys.

Theoretical Framework

This study employs Communities of Practice (CoPs) as a framework to investigate the absence of science clubs in rural schools. Wenger (1998) defines Communities of Practice as groups of individuals who share a common passion or concern, engaging in collaborative learning to enhance their skills and understanding. Within this context, science clubs serve as informal learning environments where learners, supported by teachers, actively explore scientific concepts. These clubs foster confidence, collaboration, and scientific literacy among participants.

The framework identifies three critical components of CoPs—domain, community, and practice—which inform the structure and function of science clubs. The domain encompasses science education and practical scientific engagement, forming the foundation for all club-related activities. The community consists of learners, teachers, and external stakeholders, such as local scientists and environmental organizations, who collectively contribute to the clubs' growth. The practice involves shared tools, such as science kits, established rituals like weekly meetings, and collaborative initiatives, including science fairs and waste recycling projects (Wenger-Trayner & Wenger-Trayner, 2015). These activities not only promote scientific inquiry but also address broader objectives, such as fostering critical thinking and sustainable development awareness.

METHODS

The Study Group

The research approach us in this study is qualitative in nature which is considered as a method of inquiry by making sense of central phenomena in studying participants in their context. Creswell (2017) points out that a qualitative research design allows for the investigation of the phenomenon within its real-life context. In phenomenological research, no assumptions are made by researchers, but rather an effort is made to understand the experiences of the participants. In this study a multiple case-study design was used because the researchers were more interested in obtaining in-depth details of what was being explored (Nkanyani & Mudau, 2019). This design allowed the researchers to treat each case differently as participants had different background and teaching experiences.

Purposive sampling was used to select seven schools in the Vhembe East district in the Limpopo Province for this study. In each selected schools, Natural Sciences, Physical Sciences, Life Sciences and Agricultural Sciences teachers were selected to take part in the study, as it was referred to by Maree (2017) as the best selection of information-rich cases for an in-depth study using participants who are knowledgeable about the phenomenon under investigation, Sampling was done based on the following criteria: Participants (teachers) where teaching either Natural Sciences, Physical Sciences, Life Sciences and Agricultural Sciences. Lastly, only participants who were willing to participate in the study were considered. A total of 19 science teachers participated in the study across seven rural schools. These included teachers teaching Natural Sciences, Physical Sciences, Life Sciences, and Agricultural Sciences.

Data Collection Tools

Qualitative data collection in this study included two strategies. The first strategy consisted of focus group interviews with a set of pre-determined questions (Creswell, 2017; Maree, 2017). The groups of teachers from selected schools were interviewed on, "Do you think that it is important to have science clubs in schools?" In these interviews, follow-up questions such as "If, yes/no explain?" were asked to seek further clarity and capture more data.

Even though interviews are considered to be time-wasting and costly Sahin-Topalcengiz and Yildirim (2020), this technique has been determined to be the most relevant one to collect data because of the small number of participants who participated in the study and because of the personalised nature of the interview data. It is through the interviews that sufficient and relevant information was gathered (Nkanyani & Mudau, 2019). Moreover, interviews provided a richer source of descriptive information than could not have been gathered in instruments such as questionnaires (Madueño Serrano et al., 2020). The interview responses were tape recorded to ensure that the researcher had correctly captured the participants' responses.

McLeod (2023) defines questionnaires as research instruments consisting of a sequence of organized questions aimed at gathering information from respondents. They facilitate the effective gathering of data, especially in instances where the researcher's presence is unnecessary throughout the process. This approach is particularly beneficial for big populations, where individual interviews would be logistically impractical and time-intensive... However, the disadvantage of questionnaires could be the participant might leave other questions unanswered and makes it difficult for the researcher to seek further clarity but the best part about questionnaires is that they save time and it is easier to compare their results (Chiwome & Thondhlana, 1992). This research involved answering questions related to science clubs within schools through the use of questionnaires. Interviews and questionnaires assisted in data triangulation.

Data Analysis

Content analysis was used to analyse data collected from interviews and questionnaires for this study. Audio-taped interviews were analysed by listening to them several times and

transcribed into a word document. After transcribing the data from interviews, the researchers listen the audio several times. This was done to ensure that the transcribed data corresponded to the participants' responses. The transcribed data from interviews were read, and the researchers highlighted significant statements that provides understanding of the participants to create themes and categories using research questions (Creswell, 2017).

RESULTS AND DISCUSSION

Results

This section presents the results or findings from qualitative data collected through focus group interviews and individual questionnaires. While descriptive statistics such as percentages were used to summarize questionnaire responses, the study did not employ inferential statistical analysis or hypothesis testing. The data reveal significant insights into the understanding, perceptions, challenges and potential of science clubs in rural schools, structured around three main themes. These themes are understanding and perceptions of science clubs, practical challenges and opportunities and factors influencing the establishment of science clubs. The themes are presented below.

Theme 1: Understanding and Perceptions of Science Clubs

Understanding teachers' perceptions and awareness of science clubs is crucial for identifying potential barriers and opportunities for their implementation in schools. This theme explores the varying perspectives and levels of knowledge among teachers regarding science clubs.

Teachers' understanding of science clubs

Teachers' understanding of science clubs varied, reflecting a spectrum of expectations and comprehension. For instance, one teacher described science clubs as a platform for *"actively engaging in discussions about science"* (S2-T2*)*, while another participant from S4 said that his understanding of science clubs is *"a team of science learners that engage themselves in science aspects to share understanding and common knowledge"* (S4-T1), suggesting a focus on interactive learning.

Teachers in this study also explained that they view science clubs as "an Expo, which assists learners in understanding science-related topics and other things better" (S7-T2), and also as "clubs or institutions that focus on the learning of science because we are living in a science world. You will find that when we talk of science clubs, we are talking about things like Eskom Expos, SAATA, and any other science-related endeavor that also includes technology, because when we talk of science, we must always include technology" (S1-T2).

Contrarily, a questionnaire response from a participant who completed the questionnaire indicates a lack of familiarity, with one out of 19 respondents admitting, *"I have no idea what it is" (Questionnaire Response)*, highlighting the need for increased awareness. When questioned about their awareness of science clubs, only 21% of the teacher reported familiarity, while a significant majority of 74% were unaware, and a mere 5% had only heard of them, as shown in the bar graph below in Figure 1. This indicates a substantial gap in knowledge and engagement with science clubs among the teachers, highlighting a potential area for educational development.

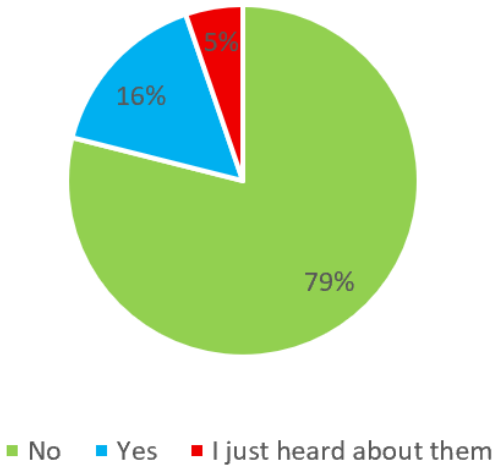

Figure 1. Pie chartof knowledge of science clubs among teachers

Perceived Value and Importance of science clubs

The perceived value of science clubs was universally recognized among participants. Teachers noted that science clubs enhance *"scientific knowledge" and "critical thinking skills" (Questionnaire Response).*

The findings from the questionnaire also show that all teachers unanimously acknowledged the importance of science clubs, with 100% affirming their significance in the educational landscape. Figure 2 below displays the responses of all teachers who answered the question about the importance of science clubs. This strong consensus suggests that while current engagement and support for science clubs are lacking, there is a recognized need and potential enthusiasm for their development within the district's schools.

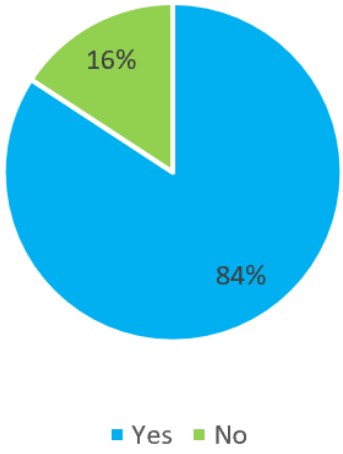

Figure 2. Pie Chart of Teachers' Views on the importance of science clubs

Similarly, the response from the focus group interviews also emphasized the importance of science clubs in schools. When asked if they think science clubs are important, teachers responded positively. One participant from S4 stated, *"It is important to have science clubs in schools so that learners will have more knowledge about what happens at the extremes of physical science"* (S4-T2). Teachers also perceive science clubs as a motivational agent for learners to solve scientific problems. One Teacher emphasized that science clubs are important because "*Some learners also get motivated, because you will find that learners don't think that they can*

use science to solve problems, but when they attend the science clubs and see, then they get motivated" (S5-T1).

Furthermore, a teacher from S1 also mentioned that "With the introduction of science clubs, most of the learners will become interested in doing science, so science clubs are important" (S1-T1).

Teachers also perceive science clubs as important because they can assist learners in conducting practical experiments. In responding to the importance of science clubs, a teacher from S7 said, "It is important to have science clubs in our schools because learners will be able to do experiments and explore more in the field of science" (S7-T1).

The findings from this theme highlight the diverse perspectives and levels of awareness among teachers regarding science clubs. While there is a universal recognition of their importance, there is also a need for increased awareness and understanding. Addressing these perceptions and knowledge gaps is essential for promoting the successful implementation of science clubs in schools.

Theme 2: Challenges and Opportunities in Establishing Science clubs in schools

Resource challenges

Insufficient resources pose a significant challenge to the establishment and sustainability of science clubs in schools. This theme explores the resource limitations faced by teachers and schools, hindering the development of science clubs.

Findings from the questionnaire in this study revealed that 94.7% of the teachers reported the absence of science clubs at their schools, with only one teacher (5.3%) confirming their existence. These findings are shown in Figure 3 and 4 below. This lack of science clubs underscores a potential lack of resources or institutional support for such extracurricular science activities. Resource limitations were frequently cited as the primary barrier to establishing science clubs, with *"We don't have equipment" being a common refrain (Questionnaire Response).*

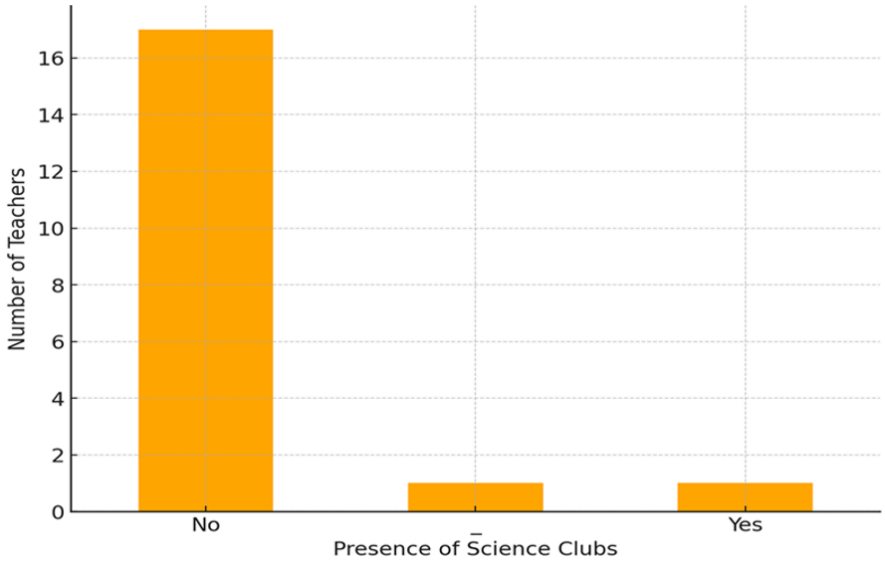

Figure 3. Bar Chart of teacher response about presence of science clubs in schools

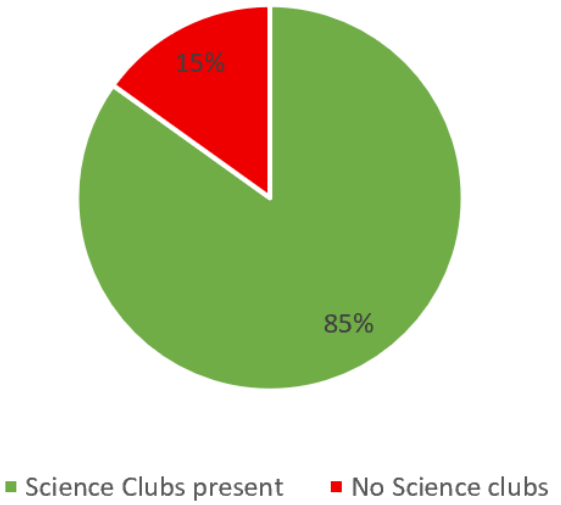

Figure 4. Pie Chart of teacher response about presence of science clubs in schools

Echoing the results from the questionnaire, interviewed teachers also indicated that they need resources to start science clubs in their schools. When asked about essential resources for establishing and maintaining science clubs in rural schools, one teacher, S5-T2, said, *"the practical equipment that we can use to do practical things".* He further explained, *"We don't have a class that we can use as a laboratory; the only available class that we can use is also used as a storeroom for old chairs and desks. We don't have a lab that we can say is a lab for science"* (S5-T1). T1 from S7 added, *"We need a lot; for example, we need science kits for subjects like Natural Science, we need a science laboratory to perform experiments".*

Teachers also mentioned that they lack the necessary materials and resources to have science clubs in their schools because they do not have sufficient finances to start a science club. Responding to the question about resources, a T2 from S6 said, *"Good finance and support from the government might help".* According to the teachers, finance is needed to buy materials for science clubs, such as *"science kits for subjects like natural science, we need a science laboratory to perform experiments"* (S7-T2*), "further training to utilize resources effectively"* (S2-T2), and *"having simple equipment that we can use to start science clubs, such as glass beakers, test tubes"* (S6-T2). Supporting the need for materials to start science clubs, a T1 from S1 expressed that they have to travel many kilometres to take their students to science centres, so they need resources starting from the building. She said, *"We have to travel around 100 km to visit the nearest science centre so that learners can be taught practically, so we really need a building to have our small science centre. We don't have resources, and we need learners to be more interested in science, and the resources are the key"* (S1-T1). Addressing these resource constraints is crucial for fostering a conducive environment for science education and extracurricular activities in schools.

Administrative challenges

Challenges to establishing science clubs extended beyond resource challenges, encompassing a lack of support and awareness from school management. Teachers emphasized the pivotal role of approachable and supportive school management in fostering science clubs: *"I think our school management and SGB need to be approachable because this science club is something that involves the school, so if the management is not interested, then we cannot participate in science clubs"* (S1-T1). However, some administrators were perceived as unaware of what science clubs entail: *"I don't know. They are not doing anything. They don't even know what science clubs are. So, we need some expertise. So, there is nothing"* (S5-T1), highlighting a need for greater expertise and awareness.

Community support and engagement

Community and administrative support were also critical factors, with logistical issues such as delayed circulars impeding participation in science-related activities. T2 from S5 mentioned that *"Administrators do encourage participation in science projects. It is just that as a school, we do not participate. Things like science Olympiad, we do receive circulars, but it is just that we receive them in our rural schools very late, sometimes when other schools have already participated".* Some participants noted the lack of external motivators for learners and the importance of role models and community support in fostering interest in science: *"Yes, it does because learners do not have external motivators, like something they can look into to say, if I do science, I can do this just like someone else, and maybe I can become like this person"* (S6-T2).

Strategies to overcome the challenges

Despite these challenges, participants proposed several strategies to overcome them, including enhanced teacher training, improved coordination and resource allocation, and increased community involvement. *"I believe science teachers should train students in using equipment, while the principal and circuit manager could oversee the organization of science clubs".* Furthermore, teacher collaboration was seen as vital for sharing knowledge and resources effectively, *"It can lead to other teachers; you might find that a teacher from one school knows something that I don't know about science clubs. So, if we collaborate, I think we can get better"* (S5-T1).

While establishing science clubs in rural schools is fraught with challenges, it offers a unique opportunity to enhance science education and engagement. By addressing resource limitations, improving school management support, and fostering community engagement, the establishment of science clubs can be effectively promoted. Leveraging these opportunities can not only enrich the educational experience for learners but also inspire a deeper appreciation and understanding of science in the community.

Theme 3: Factors Influencing the Establishment of Science Clubs

The establishment of science clubs in rural schools is influenced by a variety of factors, as discussed by teachers during the interviews.

Geographic and Logistical Challenges

Distance and accessibility were highlighted as significant barriers. One teacher mentioned that the remoteness of their location makes it difficult to access existing science clubs, emphasizing the need for local solutions:

"Yes, factors like distance play a significant role. If science clubs are too far away, it becomes challenging for us to access them. Establishing clubs within our community would be more advantageous" (S2-T2).

Roles and Responsibilities in Establishing Science Clubs

The role of different stakeholders in establishing science clubs was a key point of discussion. Teachers suggested that while science teachers should focus on training students in using equipment, principals and circuit managers should oversee organizational aspects:

"I believe science teachers should train students in using equipment, while the principal and circuit manager could oversee the organization of science clubs. Their role would involve coordinating activities and gathering resources for the clubs' operation" (S2-T2).

Additionally, teachers themselves need training and awareness about the importance of science clubs:

"Additionally, teachers themselves need training and awareness about the importance of science clubs" (S2-T3).

Support from School Administrators and Education Authorities

Support from school administrators and education authorities is deemed crucial for the success of science clubs. Past support in obtaining equipment was noted, and it was suggested that if the benefits of science clubs are well understood, support would likely be forthcoming:

"Yes, they would. In the past, they have supported us in obtaining equipment. If they understand the benefits of science clubs, they will likely provide support for their establishment and maintenance" (S2-T2).

T3 from S2 also indicated that support from school administrators is very important, she said:

"Indeed, their support is crucial for the success of science clubs in our school" (S2-T3).

Community Influence and Support

The community's influence on the establishment of science clubs was discussed, with mixed views. Some teachers felt that there are no significant barriers from the community and that community support could actually enhance the success of science clubs:

"I think the community would also support learners participating in the science clubs because it will also bring growth to the community" (S1-T2).

"The community is positive, and I believe there are no factors that can stop learners from participating in science clubs" (S1-T1).

However, financial constraints and a lack of interest or awareness were also mentioned as hindrances:

"I think there are community factors that influence the absence of science clubs because most teachers in the village do not know how to assess science clubs or find finance to establish science clubs. Some, like we are in a deep rural area, so you find out that finance is one of the community factors that hinders the development of science clubs" (S7-T2).

Motivational Factors for Learners

The absence of external motivators and role models was identified as a factor that diminishes learners' interest in science:

"Yes, it does because learners do not have external motivators, like something they can look into to say, if I do science, I can do this just like someone else, and maybe I can become like this person" (S3-T1).

However, involvement from institutions like the University of Venda was seen as a positive influence that could help motivate learners:

"I think I have to add that the University of Venda has started adopting the school this year. So, since it is not far, I think it can be classified as a good community factor. This is because they do come to school and talk to students about science, and they also invite us as science learners to go and visit their institution. They also show us how to use the labs and the science centre" (S3-T2).

Teacher-Led Initiatives

Teachers emphasized the importance of their own role in initiating and sustaining science clubs. One teacher suggested that starting at the school level with available resources can be effective:

"I think implementing science clubs would be easy; we just need to go outside of the school and look for materials such as glass tubes because they also measure substances in science class. So, we need to start at a school level to develop our own science club" (S5-T3).

Another teacher highlighted the role of science teachers in leading these initiatives and inspiring their colleagues:

"The science teacher should take a lead role to start the science clubs; this can also inspire other teachers. Then he/she can show other teachers how to start and when to start having science clubs" (S5-T1).

By addressing these factors and leveraging both community and institutional support, the establishment of science clubs in rural schools can be effectively promoted, thereby enhancing the educational experience for learners and teachers alike.

Discussion

This study aimed to explore the absence and potential establishment of science clubs in rural schools within the Vhembe East District of Limpopo Province. The discussion is structured according to the three main themes that emerged from the findings and is framed within the Communities of Practice (CoP) theoretical perspective (Wenger, 1998), which highlights the role of shared learning, social participation, and the construction of collective meaning in educational communities.

Theme 1: Understanding and Perceptions of Science Clubs

The findings revealed varying levels of awareness and understanding among teachers regarding science clubs. While some teachers conceptualized science clubs as platforms for experimentation, discussion, and science-related competitions, others expressed unfamiliarity, with 74% of survey respondents reporting they had never heard of science clubs. This lack of awareness reflects an underdeveloped domain within the CoP framework—there is no shared understanding of the value and purpose of science clubs, which hinders the formation of a coherent community around science engagement. Without a common language or goal, it becomes difficult for stakeholders to collaborate or take ownership of club initiatives (Wenger-Trayner & Wenger-Trayner, 2015).

Despite limited familiarity, participants universally acknowledged the importance of science clubs for enhancing learners' scientific literacy, critical thinking, and motivation. These perceptions align with Braintastic! Science (n.d.), Gonsalves (2014), and Wegner et al. (2016) argue that science clubs foster curiosity, teamwork, and real-world problem-solving skills. The challenge, therefore, lies not in convincing teachers of their value but in providing a shared vision and practical strategies for implementation.

Theme 2: Challenges and Opportunities in Establishing Science Clubs

The study identified significant resource-related and institutional challenges that prevent the formation of science clubs. These include the absence of laboratories, science kits, and financial support—conditions corroborated by Hartley (2014) and Jones (2015), who highlight chronic under-resourcing in rural science education. In CoP terms, these resource deficits represent a lack of *shared repertoire*—the tools, routines, and artifacts needed for sustained practice. Teachers are unable to engage learners in meaningful scientific inquiry without the necessary materials. Moreover, the lack of school infrastructure, such as dedicated science spaces, further limits practical engagement.

Institutional challenges also emerged, particularly the lack of support from school management and delayed communication from education authorities. These findings echo Manion and Coldwell (2008), who emphasized the role of administrative buy-in in nurturing extracurricular science programs. In the CoP framework, these administrators are part of the broader community necessary for supporting sustained practice. Where school leadership is unaware or indifferent to science clubs, teachers lack the necessary backing to initiate or maintain them. Yet, opportunities also exist. Teachers suggested practical solutions such as peer collaboration, starting small with available materials, and engaging external stakeholders like universities. The involvement of the University of Venda, for example, has already proven effective in motivating learners and providing access to laboratories. This form of *boundary spanning*—where communities connect with external experts—can enrich the local practice and expand the community of science engagement (Wenger, 1998).

Theme 3: Factors Influencing the Establishment of Science Clubs

Several contextual and relational factors were identified as influencing the feasibility of science clubs. Teachers noted that geographic isolation made participation in existing science initiatives difficult due to transportation and time constraints—a common challenge in rural areas, as described by Sinclair et al. (2025). However, participants suggested that localized science clubs—formed within individual schools or villages—could mitigate these constraints. This reflects an effort to localize the CoP, ensuring that members can engage regularly and meaningfully without being dependent on external networks.

Teacher leadership emerged as another key factor. Many teachers felt that science teachers should take the initiative, suggesting that when teachers model commitment and innovation, others—including learners and colleagues—are likely to follow. This supports

Gonsalves' (2014) claim that motivated and well-supported teachers are central to successful science clubs. Importantly, the community's role was seen as both a barrier and a support mechanism. While financial limitations and low awareness may hinder engagement, teachers also believed that community members—especially parents and alumni—could be mobilized to support science clubs. These insights reflect the CoP emphasis on the community as a dynamic, multifaceted group capable of sustaining and enriching shared practices.

CONCLUSION

This study explored the absence and potential establishment of science clubs in rural schools in the Vhembe East District, framed through the lens of the Communities of Practice (CoP) theoretical model. The findings, structured under three key themes, provide a nuanced understanding of both the challenges and opportunities surrounding science clubs in under-resourced contexts.

First, under the theme of Understanding and Perceptions of Science Clubs, the study found that although awareness of science clubs is limited among teachers, there is a widespread recognition of their educational value. Teachers identified science clubs as important spaces for enhancing critical thinking, experimentation, and learner motivation—hallmarks of informal science learning. However, the lack of a shared conceptualization of what science clubs entail remains a barrier to their widespread implementation. This points to the need for advocacy, training, and informational outreach to establish a collective understanding—the "domain" in CoP terms—that supports the development of such initiatives.

Second, the theme of Challenges and Opportunities revealed that the absence of resources, inadequate teacher training, and weak administrative and logistical support significantly hinder the formation of science clubs. Despite these limitations, teachers proposed practical solutions, such as starting small with available materials, peer collaboration, and forming partnerships with universities and science organisations. These suggestions highlight the existence of a willing "community" that, with the appropriate tools and support (the "practice" element in CoP), could enable the sustained operation of science clubs even in resource-constrained environments.

Third, the theme on Factors Influencing the Establishment of Science Clubs emphasized contextual dynamics, including geographic isolation, the role of teacher leadership, and varying levels of community and institutional support. While challenges such as distance, limited funding, and lack of role models were noted, the study also found promising signs of external support—such as the involvement of the University of Venda—which could be leveraged to catalyse local efforts. These findings stress that science club sustainability depends on aligning school-level efforts with broader systemic and community support, ultimately strengthening all three dimensions of a functional Community of Practice: domain, community, and practice.

Limitations

This study offers important insights into the barriers and enabling factors influencing the absence of science clubs in rural South African schools; however, several limitations should be acknowledged:

Contextual and Geographic Constraints:

The study was confined to a limited number of schools within the Vhembe East District, Limpopo Province. While the findings provide rich contextual detail, they may not be directly generalisable to rural schools in other provinces or national contexts with differing educational policies, infrastructure, or community dynamics.

Sample Composition:

Data were collected exclusively from science teachers, which, although appropriate for the study's focus, limits the breadth of stakeholder perspectives. The exclusion of learners, school leadership, and community members may have constrained a more comprehensive understanding of the systemic

and social dimensions affecting science club implementation.

Self-Reported Data:

The reliance on interviews and questionnaires introduces the potential for response bias, including social desirability and selective memory. Participants may have unintentionally over- or underrepresented their experiences or knowledge regarding science clubs.

Temporal Scope:

The study captures perceptions and conditions at a specific point in time. It does not account for temporal changes in resource availability, administrative policy, or stakeholder involvement that could influence the feasibility of establishing science clubs.

Recommendations

To support the establishment and sustainability of science clubs in rural schools, this study recommends the implementation of structured and ongoing professional development programmes for teachers. These programmes should focus on building pedagogical and practical skills necessary for facilitating informal, inquiry-based science learning, particularly in under-resourced environments. Training initiatives should also address gaps in awareness and equip teachers with strategies to initiate and manage science clubs using locally available resources.

Raising awareness among educators, school leadership, and the broader community about the educational value and curricular relevance of science clubs is essential. Advocacy efforts should aim to establish a shared understanding of science clubs as vital tools for promoting scientific literacy, learner motivation, and practical engagement. At the institutional level, support structures must be enhanced through clear policy alignment, timely dissemination of information, and the integration of science clubs into school development and improvement plans.

Given the widespread resource constraints identified in this study, it is critical to prioritise the provision of essential science materials—such as basic equipment and consumables—and to explore cost-effective solutions, including resource-sharing between schools and the creative use of indigenous or local materials. Partnerships with universities, science centres, and non-governmental organisations should be expanded to provide mentorship, access to laboratory facilities, and technical support. Such collaborations also offer valuable exposure to scientific role models and career pathways for learners.

Furthermore, science club models should be adapted to suit the local context, taking into account geographic isolation, logistical challenges, and the cultural dynamics of rural communities. Flexible and context-sensitive models that incorporate indigenous knowledge, peer-led leadership, and school-level autonomy are more likely to succeed in these settings.

Lastly, future research should broaden its scope to include learners, school leaders, and community stakeholders, and should employ longitudinal or mixed-methods designs to track the impact of science clubs over time. Incorporating policy analysis and learner outcome measures would also provide a stronger foundation for informing national and provincial strategies aimed at promoting informal science learning.

DECLARATION

We hereby declare that this is our original work, and it has not been plagiarised. The text has been edited and paraphrased using Quilbot.

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