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Research article

Primary school students' experiences of science learning content and support provided during guided inquiry-based science fieldwork

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Abstract: Inquiry-based science fieldwork (IBSF) is a widely recognised educational approach that fosters active student engagement and deeper conceptual understanding. However, implementing IBSF in primary science education can present challenges, particularly related to complex learning content and the need for teacher and peer support. These challenges also offer opportunities for pedagogical innovation. This study employed a qualitative case study design to explore which science learning contents primary students found most challenging during IBSF and to examine their experiences of teacher and peer support throughout the process. Twenty students, aged 12 to 14, from two primary schools in Namibia were purposefully selected to participate in a four-week intervention based on the Namibian INSHE curriculum. The intervention comprised 2,400 minutes of instruction across three science topics: plants, animal variation, and ecosystems. Semi-structured post-interviews were conducted, and the data were analysed using thematic and data-driven content analysis. Findings indicate that students encountered the most difficulty with the ecosystem topic due to its complexity. Some also struggled with plant-related content, especially identifying plant names and features, which was linked to gaps in prior knowledge and misconceptions. In contrast, the animal content was not seen as challenging, as students found it more familiar and relatable. Students highlighted the importance of teacher support in group management, maintaining a positive learning environment, and promoting cognitive engagement. Peer support—through emotional encouragement, informational assistance, and feedback—played a key role in fostering collaboration and facilitating meaningful exploration during IBSF. This study contributes to ongoing discussions about integrating IBSF in primary education and underscores the importance of structured support in enhancing science learning outcomes.

Keywords: guided inquiry-based science fieldwork, science learning contents, students' support

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1 Introduction

Outdoor science learning has gained significant attention in educational research due to its potential to enhance student engagement and deepen understanding of scientific concepts (Alabdulkareem, 2017; James & Williams, 2017; Reid & Gardner, 2020). Activities such as plant surveys, water testing, and weather observation allow students to connect classroom learning with real-world experiences (Alabdulkareem, 2017), helping science “come alive” beyond the classroom (Barker & Slingsby, 2002). In science education, developing practical skills such as observation, exploration, and data collection is essential for fostering meaningful learning (Moeed, 2013). These skills are central to both fieldwork and inquiry-based learning (IBL), which share the goal of engaging students actively in scientific processes. Field-based learning allows students to connect classroom knowledge with real-world environments, enhancing both conceptual understanding and scientific thinking (Hughes, 2009; Kervinen et al., 2020; Shivolo & Omari Mokiwa, 2024). Similarly, IBL emphasizes student-driven investigation, where learners ask questions, collect data, and draw evidence-based conclusions to construct scientific knowledge (Harlen, 2013; Qablan, 2024). This approach supports critical thinking and deeper engagement by placing students at the centre of the learning process (Amos & Reiss et al., 2012; Pedaste et al., 2015). In this study, the terms fieldwork, inquiry, and inquiry-based learning (IBL) are used interchangeably to refer to inquiry-based science fieldwork (IBSF)—a pedagogical approach that emphasizes outdoor, experiential learning supported by structured data collection and student-led investigation.

In Namibia, the primary school curriculum recognises the value of outdoor learning in promoting environmental awareness (Shivolo & Omari Mokiwa, 2024). However, an increasing emphasis on standardised testing has begun to limit opportunities for such experiences, reducing students’ access to meaningful, hands-on science learning (Shivolo, 2024; Kambeyo & Csapó, 2019). Despite these challenges, the elementary science curriculum has increasingly moved away from traditional, textbook-based instruction toward more engaging, student-centred approaches. This shift aligns with inquiry-based learning principles, encouraging students to actively explore scientific concepts, develop critical thinking skills, and apply their knowledge to real-world problems. Thus, this IBSF approach may encourage hands-on activities, peer-to-peer and teacher-student dialogue, and the development of critical thinking skills in Namibian primary schools (Kambeyo & Csapó, 2019; Shivolo & Mokiwa, 2024).

Building on this foundation, the present study aims to investigate which science learning content students find more challenging during guided IBSF activities and to examine how they experience support from teachers and peers throughout the IBSF process.

1. 1 The significance of IBSF in science Education

Authentic learning within Vygotsky's Zone of Proximal Development (ZPD) supports students' progression from their current level of competence to more advanced understanding through guided experiences (Kotsis, 2024; Rahman, 2024). The IBSF approach aligns with this perspective by building on students' natural curiosity and foundational data collection skills, enabling them to develop more advanced scientific abilities such as hypothesis formulation and observation-based prediction (Orosz et al., 2022). These activities promote analytical and logical thinking and foster a deeper engagement with scientific inquiry.

IBSF also encourages students to explore scientific concepts in depth, helping them view science not merely as a body of facts but as a meaningful and dynamic process for understanding and interacting with the world (Kotsis, 2024; Qablan, 2024). Through participation in investigative activities, students strengthen their research skills and information literacy by learning to collect, evaluate, and apply scientific information (cf. Pedaste et al., 2015). This process supports the development of independent research capabilities and higher-order thinking, while also increasing motivation and comprehension of scientific concepts (Sjølie et al., 2021).

Moreover, IBSF promotes collaboration and knowledge exchange, as students share findings, perspectives, and interpretations with their peers (Pedaste et al., 2015; Streule & Craig, 2018). In studying ecosystems, for example, students engage with complex systems such as food chains through real-world applications (Mambrey et al., 2022), gaining experience in systematic observation, trend identification, and environmental analysis (van Dijk-Wesselius et al., 2020). By mimicking the practices of scientists, IBSF enables students to develop a hands-on understanding of the scientific process and its relevance to everyday life (Rodríguez-Loinaz & Palacios-Agundez, 2024; Shivolo, 2024).

IBSF supports students in constructing environmental understanding and fostering long-term learning through guided, hands-on experiences (cf. Kervinen et al., 2020). By actively interacting with their surroundings, students not only deepen their conceptual understanding of environmental issues but also build personal connections to the environment, promoting critical thinking and sustained environmental awareness.

However, the success of IBSF depends heavily on its instructional design. Without sufficient support, students may struggle with deeper content engagement and inquiry processes (Scott et al., 2012; Stagg & Dillon, 2023). Therefore, teacher and peer guidance play a critical role in bridging theory and practice, fostering knowledge development, and encouraging self-regulated learning (Ferns & Moore, 2012; Shivolo & Mokiwa, 2024). Also, some teachers remain hesitant to fully implement IBSF due to concerns about students' preparedness for inquiry-based approaches (Kervinen et al., 2020). Addressing these concerns through targeted teacher support and professional development may be essential for broader adoption and effective practice.

1. 2 Science learning contents in IBSF: focus on plants, animals, and ecosystem

Learning contents such as plants, animals, and ecosystems are particularly well-suited to IBSF, as they are dynamic, observable, and lend themselves to hands-on learning. These topics allow students to engage in real-world scientific practices—such as forming hypotheses, making observations, and conducting investigations—which can increase motivation and conceptual understanding (James & Williams, 2017; Bevan, 2017).

Plants: IBSF activities involving plants often include identification, classification, and exploration of plant structures and functions (Bacon, 2023; Iskrenovic-Momcilovic, 2023). This hands-on approach helps students distinguish between species and recognise key plant characteristics. However, primary students frequently struggle with basic plant concepts, such as parts of the plant and their functions (Fokides et al., 2020). These challenges underscore the importance of experiential learning to improve comprehension of core biological processes, such as photosynthesis—an essential process that sustains life by forming the basis of the food chain (Kamarudin & Mat Noor, 2024). Moreover, although IBSF can deepen students' understanding of plant reproduction (Schussler & Olzak, 2008), plants are often perceived as less engaging than animals due to their static and "unresponsive" nature (Sanders et al., 2018; Stagg, 2020). This perception can hinder students' interest in plant-related content. As Parsley (2020) suggests, including varied and interactive plant-related learning experiences is essential for overcoming this barrier.

Animals: In contrast, animals tend to capture students' attention more easily due to their movement, sound, and visible features such as shape, colour, and size (Randler et al., 2012; Marek & Parker, 2010). These characteristics support memory retention and engagement. IBSF provides opportunities for students to investigate animal behaviors, habitats, and ecological roles, fostering interest and understanding (Binta Islam et al., 2023). However, while animals are generally engaging, students may still lack awareness of the ecological roles of less familiar species, such as amphibians and reptiles (Chyleńska & Rybska, 2018). Addressing topics like biodiversity and conservation through IBSF can improve students' understanding and foster interest in sustainability-related issues.

Ecosystems: Compared to plants and animals, ecosystems present additional cognitive challenges. Students often struggle to understand the relationships between biotic and abiotic components and the complexity of systems thinking (Assaraf & Orion, 2009; Martín-Gámez et al., 2020). Although students may become more aware of ecosystem elements, they frequently have difficulty integrating this knowledge into a coherent understanding (Hokayem & Gotwals, 2016; Mambrey et al., 2022). Ecosystem learning through IBSF can support students in observing real-life interactions, such as nutrient cycles and energy transfer (Martín-Gámez et al., 2020). However, these systems often vary by environment, which adds another layer of difficulty in generalising concepts (Ayotte-Beaudet et al., 2023). For students to understand complex environmental issues like climate change and biodiversity loss, instruction must support them in connecting local experiences to broader ecological patterns.

The success of IBSF in teaching plant, animal, and ecosystem content relies heavily on the support of teachers and peers due to its challenges. Teachers can provide structured guidance, clarify difficult concepts, and foster deeper inquiry (Förtsch et al., 2016). Peer interaction enhances learning by allowing students to exchange ideas, share observations, and co-construct knowledge (Skarstein & Skarstein, 2020). Together, this support structure ensures that students are not only engaged but also able to make meaningful connections across scientific content areas.

1. 3 The role of teacher and peer support for students during IBSF

In IBSF, the teacher acts as a facilitator who guides inquiry while allowing space for peer interaction. Teacher support during IBSF can be understood through three key dimensions: *group management, supportive climate, and cognitive activation*. Group management involves organising students for instruction and managing their behaviours during fieldwork activities (cf. Dorfner et al., 2018). A supportive climate refers to the creation of a positive learning environment, which includes building strong teacher-student relationships, providing constructive feedback, and responding to student questions in meaningful ways (Praetorius et al., 2014). Cognitive activation involves connecting to students' prior knowledge, promoting higher-order thinking, encouraging content-related discussions, and supporting in-depth understanding of science concepts (Förtsch et al., 2016).

Peer support also plays a crucial role in IBSF, particularly in encouraging communication, collaboration, and self-directed learning (Remmen & Frøyland, 2015; Skarstein & Skarstein, 2020). It draws on students' prior experiences and fosters meaningful dialogue. According to Mostafaei et al. (2020), peer support consists of five dimensions. Emotional support refers to expressions of care, encouragement, trust, and attentive listening that promote a sense of belonging (Blotenberg et al., 2024). Informational support refers to provision of knowledge related to problem-solving, access to instructional materials, and guidance on subject content, including support outside the classroom (Hanaysha et al., 2023). Instrumental support refers to practical assistance, such as helping peers with materials or spending time to support their learning (Malecki & Demaray, 2003). Feedback refers to sharing information related to performance, collaboration, and behavioural improvement during group work (Luo et al., 2022). Lastly, companionship support refers to engaging in social activities like field trips or school events, which strengthen group cohesion (Eva, 2024). Overall, IBSF is a powerful approach that enhances students' confidence in working collaboratively with their peers (Asilevi et al., 2023).

Together, teacher and peer support enhance the effectiveness of IBSF by creating a learning environment in which students feel guided, connected, and capable of engaging in meaningful scientific inquiry.

2 Research aims and questions

IBSF faces several challenges, particularly in urban schools, where students often have limited access to natural environments and insufficient guidance for learning outside the classroom (Amos et al., 2012; Remmen & Frøyland, 2015; Scott et al., 2012). In Namibia, IBSF remains underutilised and lacks adequate support from both teachers and students (Shivolo & Mokiwa, 2024). Many teachers use IBSF infrequently, prioritising syllabus coverage and exam preparation instead (Lawrence et al., 2023; Shivolo & Mokiwa, 2024). As a result, research on the challenges related to science learning content and the role of teacher and peer support in IBSF remains limited, despite the need for more effective strategies to enhance student engagement (Chata et al., 2019; Kambeyo & Csapó, 2019).

Students frequently struggle to transfer theoretical knowledge to practical situations during IBSF, which impedes their conceptual understanding (cf. Soysal, 2024). In addition, there is a lack of practical strategies for integrating IBSF effectively into the science curriculum to support knowledge acquisition (cf. Stagg, 2020). Many students still prefer structured, traditional learning approaches over inquiry-based fieldwork (cf. Shivolo, 2024). This preference highlights the importance of establishing clear, consistent support systems for both students and educators to bridge the gap between theory and practice.

In response to these challenges, this study aimed to investigate why primary school students find certain science topics more difficult than others when engaging in IBSF. It also explores students' experiences of the support provided by teachers and peers during IBSF activities. Based on these aims, the following research questions were developed:

RQ1. What factors make certain science learning contents more challenging than others for primary school students during IBSF?

RQ2. How do teachers and peers support students during IBSF, according to students' experiences?

3 Methods

3.1 Intervention description

The IBSF intervention took place in Omatando village, located near the participating schools (Appendix 3). Students engaged with three key science content areas—plant and animal variation, and ecosystems—through observation, investigation, and data collection. The aim was to enhance students' abilities to share ideas, engage in scientific discussion, and deepen their inquiry-based learning experiences. The intervention spanned approximately four weeks and was implemented in six lessons, organised into three phases: introduction, development, and conclusion, following the Namibian INSHE curriculum.

Phase 1: Introduction (10 minutes per lesson)

In the introductory phase, students were briefed on the learning objectives and activities to be conducted outside the classroom (see Appendix 2). The teacher divided the students into groups and posed guiding questions, such as How do plants and animals interact in an ecosystem? What kinds of living and non-living organisms are present in the environment? These questions served as a framework for inquiry, designed to stimulate curiosity and help students formulate their hypotheses. The teacher's role was to activate students' thinking and support them through challenging concepts. Students then planned how they would collect data—by recording observations, taking photographs, sketching, and collecting samples relevant to the day's learning objectives.

Phase 2: Development (80 minutes per lesson)

During the development phase, students collected data in the field using various tools, including cameras, voice recorders, textbooks, and internet-enabled devices for research and documentation. They later synthesised their findings into poster presentations, linking field data with textbook knowledge across the three science content areas. For example, students identified types of plants by examining the shapes of leaves and root systems, determined whether the plants were shrubs or trees, and observed a butterfly extracting fluid from a flower. They also described birds' eggs and nests seen in the area and named various animals they encountered.

Phase 3: Conclusion and Evaluation (20 minutes per lesson)

In the final phase, students reflected on their IBSF experiences. They participated in group discussions, shared feedback, and provided suggestions or conclusions based on their investigations. The teacher guided the discussion, clarified misunderstandings, and addressed misconceptions by offering feedback and elaborating on difficult concepts. Throughout the intervention, both teachers and peers played a vital role in supporting student learning. Teacher support was particularly prominent in guiding fieldwork and leading reflective discussions, while peer collaboration helped students articulate their ideas, ask questions, and deepen their understanding—especially during phases two and three.

3. 2 Participants and sample

A total of 20 seventh-grade primary school students were purposively sampled based on their participation in the IBSF intervention and their ability to express themselves clearly in English as a second language during the interview. The sample also included students who were repeating the seventh grade for a second time. Table 1 shows the participants' demographic data, including the age, gender and the number of times the students were in seventh grade.

Table 1. Participants' demographic information

Demographic category	**n**
Age	
12 years	8
13 years	9
14 years	3
Sex	
Boys	11
Girls	9
Number of times in Grade 7	
First time	17
Repeaters	3

3. 3 Interviews

Semi-structured interviews were conducted by the first author with the participating students, each lasting approximately 10–15 minutes. The interviews took place during the post-intervention phase to explore students' experiences following the IBSF activities. This format allowed students to describe their experiences in their own words, with minimal influence from the interviewer's perspective (Hanson et al., 2005). Follow-up questions—such as "why"—were used to prompt participants to elaborate on their reasoning and responses. The interviews aimed to gather detailed accounts of students' experiences with IBSF, including the aspects of the learning content they found challenging and the forms of support they perceived from teachers and peers. To strengthen the credibility of the process, co-authors reviewed the interview questions, language, sequencing, and interview protocol prior to data collection.

3. 4 Data collection and ethical consideration

Data were collected in the spring of 2022 from two schools. To ensure confidentiality, participants were assigned pseudonyms, and all interview recordings were stored in a password-protected environment. Students were informed that their participation was voluntary and that they could withdraw from the study at any point without consequence. Consent letters outlining the purpose and objectives of the study were distributed to the students' guardians. Each guardian provided written consent for their child's participation.

The research was conducted in alignment with the Namibian Revised Integrated Natural Science and Health Education (INSHE) curriculum. Ethical approval was obtained in accordance with the guidelines of the Finnish National Board on Research

Integrity (2019), as well as from the Executive Director of the Namibian Ministry of Education and Culture (Phase et al., 2016). No instances of physical or emotional distress were reported during the data collection process.

3. 5 Data analysis

This study employed a qualitative case study design to explore the implementation and impact of outdoor science learning in a primary school setting. A case study approach is particularly appropriate for examining a phenomenon within its real-life context, allowing for an in-depth understanding of how outdoor science learning supports student engagement and conceptual development (Aydin & Tonbuloğlu, 2014).

Data analysis was conducted using thematic and data-driven content analysis methods. Thematic analysis does not quantify words, but rather identifies patterns, ideas, and conceptualisations within the data (Braun et al., 2008). Through careful reading and interpretation of the interview transcripts, indicators of students' perceived challenges with specific learning content were identified through inductive categorisation and grouping.

The thematic analysis followed the six steps outlined by Kiger and Varpio (2020). In the first step, the first author familiarised themselves with the data, focusing on identifying learning content that students perceived as more challenging during the IBSF activities. In the second step, the data were read multiple times before being coded and analysed until themes began to emerge. Preliminary codes were developed directly from the data to capture key concepts expressed by students regarding their difficulties with certain science content. In step three, the focus was on identifying how the coded data aligned with the emerging themes. For example, the student statement, "Ecosystems challenged me the most, and I did not understand the basics of ecosystem compared to other topics" (Grace), was coded as "ecosystem" and assigned to the broader theme "lack of conceptual understanding" (see Table 2). Step four involved a review of the themes by the first author. This step focused on clarifying emerging patterns in students' responses, identifying the reasons why certain content was perceived as more challenging during IBSF, and using these patterns to begin drawing analytical conclusions. In step five, the analysis was further refined by re-evaluating the data to include the broader context of students' conversations. This involved synthesising claims across participants and merging them into overarching themes, each of which was then clearly defined and named. Finally, in step six, the documentation process began. The first author, with input and feedback from the co-authors, refined and finalised the themes, ensuring consistency and clarity in the presentation of findings.

The second part of the data analysis focused on deductive content analysis (Kim et al., 1985), which examined the types of support students received from teachers and peers during IBSF. Through the review and interpretation of the interview transcripts, instances of teacher and peer support were identified and categorised using a deductive approach. Given that teacher and peer support have been extensively examined in prior literature, the first author employed a deductive framework to conceptualise the relevant categories. Teacher support was categorised into three main areas: classroom management, supportive climate, and cognitive activation (see Table 3). These categories were marked with an (x) to indicate the types of support students reported experiencing during the IBSF activities. Similarly, peer support was classified into four types: emotional support, informational support, feedback, and companionship support (see Table 4). These, too, were marked based on students' reported experiences. To ensure consistency with the research questions, the research team collaboratively reviewed and refined the categories through ongoing discussions.

A systematic coding approach was employed to identify and label meaningful data units from the interview transcripts. These codes were then organised and refined through peer review, which enhanced the credibility and consistency of the findings. While interviews inherently carry the limitation of being retrospective in nature, notes taken during the interview process helped to strengthen the validity of the data.

The study was conducted in only two schools, the consistency of the findings suggests that they may be cautiously generalised to other similar schools within the Namibian context. This is due to the representativeness of the selected sites. In Namibia, many schools—particularly those in rural and urban settings—share common structural and contextual characteristics, such as limited access to teaching and learning resources, overcrowded classrooms, insufficient learning aids, and students from socioeconomically disadvantaged backgrounds. The two participating schools reflect these widespread challenges, making them appropriate case examples for drawing tentative conclusions about comparable schools across the country.

Table 2. Themes identifying the challenges primary school students face with learning content during IBSF

Themes	**Examples of students' responses**
Lack of conceptual understanding	"Ecosystem challenge me the most, I did not understand the basics of ecosystem compared to other topics" "Plants was most difficult because I am not that close to plants sometimes it is just really hard to get the names of the plants"
Lack of interest	"Ecosystem because it was not interesting" "Ecosystem was difficult which makes it less interesting, I mostly like animals"
New learning contents	"I did not do it in previous grades" "It sounds like it is my first time learning it"
Difficulties to recall the learning contents	"I forgot everything that was taught in previous classes" "I did not understand the basis of ecosystem"

3. 6 Validity and reliability

A pilot study was conducted to ensure that the study design and methods were appropriate for effectively addressing the research questions and that the research process was feasible in terms of time and participant availability. Unlike the pilot study, which primarily aimed to identify challenging science topics, the interview questions in the main study were slightly modified to focus more specifically on why some science content was perceived as more challenging than others during IBSF. Feedback from the pilot phase was essential in refining the interview protocol and ensuring its readiness for the main data collection.

To enhance the trustworthiness of the study, several strategies recommended by Hanson et al. (2005) were applied. These included involving co-authors in reviewing the research design, data collection procedures, and emerging findings, which helped to identify potential biases or assumptions that might otherwise have been overlooked. This process contributed to the overall credibility and quality of the study.

The first author, who has professional experience within the Namibian education system, was responsible for conducting the data collection and analysis, ensuring alignment with the research context and questions. Meanwhile, the co-authors, who were not involved in the Namibian education system, served as peer reviewers to provide external perspectives.

Finally, to support reliability, semi-structured interview questions were carefully designed to be as clear and simple as possible to minimize misunderstandings. Participants were also given sufficient time to respond, allowing them to express their thoughts fully and comfortably.

4 Results

4.1 Challenges experienced in the learning process

Students faced several challenges in their learning process. First, a lack of conceptual understanding made it difficult for them to grasp fundamental ideas. This was exacerbated by a lack of interest in the subject matter, which reduced their engagement and motivation. Additionally, the introduction of new learning content created further obstacles as students struggled to adapt to unfamiliar learning material. Finally, difficulties recalling previously learned content added to the overall challenges they experienced. Together, these issues significantly impacted their learning experience.

4.1.1 Lack of conceptual understanding

Some students shared that the science content on ecosystem and plants presented challenges during IBSF rather than animal variation. Students found the ecosystem more challenging because it has many features and diverse characteristics. Additionally, ecosystems are challenging for students because they involve complex interactions, diverse components, and abstract concepts like energy flow and species relationships, which often makes it difficult to link theory to the real world. Moreover, students find it challenging to identify plant names and lack knowledge about plant descriptions, making understanding the concepts, such as the names and how organisms are interconnected within the ecosystem, more challenging. Some students explained that the IBSF process was overwhelming, which led to gaps in understanding, problem-solving, critical thinking, and self-directed exploration. Some of the students' reflections are encapsulated below:

> Ecosystems challenged me the most, and I did not understand the basics of ecosystems compared to other topics (Grace).

> Learning content on plants was the most difficult because I am not that close to plants, and sometimes, it is just really hard to get the names of the plants (Dafney).

4.1.2 Lack of interest

Under this thematic area, students' experiences, along with their individual interests and preferences, also affect their level of engagement during IBSF. Some students may naturally gravitate toward activities which they find more relatable or exciting. Some students explained that the time was limited for them to explore topics in depth; students feel like they did not fully engage with the subject matter, resulting in a lack of interest because their interest may be diminished. Students lack the foundational prior- knowledge needed to understand the new material, leading to confusion and disinterest, while some students simply prefer other learning contents over others leading to disinterest. Students recount their own experiences:

> Ecosystem was difficult to learn because it was not as exciting as to learn because I did not know much about it which makes it harder to stay interested and exciting (Paulina).

> Ecosystem was a challenging topic of all, there was no enough time for me to learn it which makes me more interested in other topics (John).

4.1.3 New learning content

Students shared that they had forgotten much of the content taught in previous classes, especially material related to ecosystems. They explained that learning about ecosystems was particularly challenging due to their complexity and their lack of prior exposure to the topic in earlier grades. Some students noted that new scientific content often introduces specialised vocabulary and terminology that they may not be familiar with. Understanding new concepts is crucial to grasp, but students often struggle with this language barrier when encountering new content for the first time. Additionally, students mentioned that their preconceived ideas or misconceptions about the subject can hinder their understanding of new material. As alluded to by the students below:

> I did not do ecosystem in previous grades (Eduward).
>
> Ecosystem, because I did not learn about it before, and it has difficult term (Hope).

4.1.4 Difficulties in recalling the learning content

Some students report their experiences that they are more likely to forget content that they did not fully understand. They explained that when foundational concepts are unclear, such as how plants obtain their nutrition for survival, retaining or building upon the material becomes challenging. Additionally, without regular review or opportunities for practice, newly learned information tends to fade over time. The lack of reinforcement or application of the content can lead to difficulties in recalling it when needed. As alluded by the students below:

> It was difficult to learn and recall on ecosystem (Elizabeth).
>
> Ecosystem, because when you are taught something in the classroom you do not always understand easily, but when you are taught outside, you get a different picture, for example, you know that an eagle has feathers and a peak, but sometimes you do not believe everything compared to when you are taught outside, so IBSF is important (Moses).

4.2 Support received during IBSF

4.2.1 Students' experiences of teacher support during IBSF

The experiences of the students regarding the teacher's support of students during IBSF in this study is categorised based on specific dimensions such as class management, which deals with how the teacher organises the lesson; supportive climate, which deals with the relationship between students and the teacher, and cognitive activation deals with what the students have learned. Table 3 shows that four students considered the teacher's management of the class as good because the teacher was patient with the students and expressed the content well, making them understand what was expected of them. Students also conveyed that the teacher supported them nicely because she answered students' work and oversaw how they were doing it. Additionally, ten students indicated that the teacher was supportive because she gave meaning to some words and ideas that the students did not know about. Furthermore, the teacher's explanations were loud and clear, allowing students to understand the teacher's explanation and guidance while many discussions were ongoing in small groups during IBSF. Lastly, ten students outlined that the teacher supported the cognitive activation of students through engaging students in various strategies that stimulate thinking, questioning, and deeper understanding.

Table 3. Students' experiences on how the teacher supported them during inquiry-based science fieldwork

Students	Group management	Supportive climate	Cognitive activation
Grace		x	
Dafney		x	
Moses		x	
Paulina		x	
Agripine	x		
Tuhafeni		x	
Sara	x		
Wesley			x
Hope	x		
Arnito			x
Pegia		x	
John			x
Carlos			x
Petrus			x
Eduward			x
Elizabeth			x
Maria	x		
Fernando			x
Enkono			x
Erastus			x

4.2.2 Students' experiences of peer support during IBSF

In terms of peer support during IBSF, six students noted that their classmates were effective collaborators in the IBSF activities, contributing a wealth of ideas that enhanced emotional support within the group. Additionally, eight students indicated that their peers provided valuable informational support as they engaged in discussions about answers to questions and shared insightful ideas when others were struggling, clarifying the topic's meaning. Furthermore, four students highlighted that their peers facilitated discussion, debate, and collaboration by offering constructive feedback on their work. Finally, two students felt that they helped each other significantly during IBSF, as most were dedicated to their tasks and worked as a cohesive team, creating an enjoyable and memorable working environment. A detailed description of how students supported one another during IBSF is provided in Table 4.

Table 4. Students' experiences of peers' support during inquiry-based science fieldwork

Students	Emotional support	Informational support	Feedback	Companionship support
Grace		x		
Dafney		x		
Moses		x		
Paulina		x		
Agripine	x			
Tuhafeni		x		
Sara				x
Wesley				x
Hope	x			
Armito		x		
Pegia	x			
John			x	
Carlos		x		
Petrus		x		
Eduward			x	
Elizabet	x			
Maria	x			
Fernando			x	
Enkono	x			
Erastus			x	

5 Discussion

The study aimed to explore why certain learning contents were more challenging for primary school students when engaging in IBSF activities. It also examined students' experiences of teacher and peer support during these activities. The results revealed that students found the topic of ecosystems particularly challenging. They struggled with basic concepts and had difficulty understanding interactions among organisms in the environment. This difficulty appeared to stem from a lack of foundational knowledge about ecosystems, particularly in the context of formulating questions and investigating how organisms interact in outdoor environments. This aligns with Ayotte-Beaudet et al. (2023), who noted that understanding ecosystems is difficult for students because these systems vary across different environments. Therefore, it is important to introduce the topic of ecosystems from the lower grades, so that students become familiar with the basic concepts and develop an understanding of the relationships between living and non-living components of the environment (Assaraf & Orion, 2009). These findings highlight the importance of conceptual support from teachers in the student learning process.

Some students showed a lack of interest in the ecosystem content, indicating limited engagement with the topic. This finding contrasts with the results of Hokayem et al. (2015), who reported that students' interest in learning about ecosystems increased when they were able to apply the concepts in different contexts. Therefore, it is important to foster students' interest in the interdependence of organisms within ecosystems (Rodríguez-Loinaz et al., 2024). One way to achieve this could be through the use of educational videos or other engaging materials prior to fieldwork activities (de Jong et al., 2023).

Our study found that the ecosystem content was unfamiliar to many students, which made it particularly challenging. Students struggled to connect their prior knowledge to the new concepts, hindering their understanding of how living organisms interact within ecosystems (see also Ayotte-Beaudet et al., 2023). To address this challenge in the future, teachers could adopt a learning progression approach to monitor and support students' conceptual development over time. This would help ensure that students build on their prior knowledge and skills in a structured manner. Additionally, using the learning progression approach can provide insights into how early elementary students begin to understand interactions within ecosystems (Hokayem & Gotwals, 2016).

Students' experiences of teacher support played a crucial role in guiding IBSF activities. This support was particularly evident in the early stages of the intervention, where teachers helped students formulate hypotheses, directed their exploration, and encouraged scientific thinking when approaching questions. However, Remmen and Frøyland (2015) reported that teacher support was often insufficient during fieldwork. Thus, teacher training focused on effectively facilitating student learning during field-based activities is required (Hughes, 2009). On the other hand, our findings show that students noticed the teacher actively responding to their questions and guiding their work, especially during the introduction to IBSF. This aligns with Speldewinde and Campbell's (2024) study, which highlights that IBSF fosters teacher-student interaction and contributes to building both social networks and science learning capacity. Furthermore, Kang (2022) emphasized that the quality of teacher-student relationships significantly affects science literacy and learning outcomes—students who perceive their teachers as fair and supportive are more likely to demonstrate higher engagement and improved performance in science. The IBSF approach helps bridge the gap between theoretical knowledge and practical application, making science learning more meaningful and relevant for students. Therefore, fostering close collaboration between teachers and students should be actively encouraged (Arnold et al., 2023).

Our results showed that some students received support from their peers during IBSF activities through discussions and debates. This peer interaction provided opportunities to exchange ideas and fostered mutual understanding. The findings suggest that when students work together, they may engage in peer teaching, explain what to look for, how to complete a task, or share their personal interpretations of what they are experiencing. Such collaboration enhances the effectiveness of IBSF by deepening students' understanding—aligning with Boyle et al. (2007), who found that fieldwork can be a powerful tool in building students' confidence to work with peers and explore their inquiry skills.

Moreover, the IBSF intervention helped students form personal connections, which is particularly important in environmental education. These connections not only enhance cognitive understanding but also promote emotional engagement with the content. They encourage teamwork and shared responsibility for addressing environmental challenges, as students exchange ideas and co-construct solutions. Therefore, incorporating more group work into field-based science education is recommended, as it allows students to learn from one another and evaluate each other's contributions (Rezaei, 2018).

This study has several limitations. First, it was conducted in a single region, which limits the generalisability of the findings. To address this, future research should include a more diverse sample across multiple regions or educational contexts to enhance the applicability of the results. Secondly, this study focused exclusively on students' challenges with science content, without addressing teacher-related challenges, which are also critical to the effective implementation of IBSF. Future studies should incorporate classroom observations and include both student and teacher perspectives to provide a more comprehensive understanding. In addition, as a qualitative study, this research does not include in-depth statistical analysis, limiting its ability to generalise findings to broader populations. Furthermore, the study involved only one expert teacher, potentially overlooking variations in teaching approaches that may influence student experiences and outcomes. To address this, future studies should incorporate multiple teachers with diverse teaching styles and include mixed-method approaches that combine qualitative insights with quantitative data to strengthen the validity and generalisability of the findings. Lastly, although outdoor learning and hands-on experiments can enhance student engagement, they may not be sufficient to address persistent misconceptions. Students often interpret observed phenomena through the lens of their existing, and sometimes inaccurate, prior knowledge. Without appropriate scaffolding and conceptual clarification, such activities may unintentionally reinforce these misconceptions rather than correct them.

6 Conclusion

Ultimately, this study highlights that some learning contents are more challenging for students in IBSF contexts, and that support from teachers and peers plays a crucial role in helping students navigate these difficulties. The findings indicated that students experienced greater challenges when learning about ecosystems and plant variation compared to topics related to animals. A major challenge was the lack of conceptual understanding, which hindered students' ability to grasp the underlying principles of scientific concepts. Additionally, students' interest in a topic significantly influenced their motivation to engage with the content. When students were uninterested, their participation in inquiry-based activities declined. New or unfamiliar content was often overwhelming, particularly when it introduced concepts that students had not encountered before. Furthermore, difficulties in recalling previously learned material limited students' ability to connect new information with prior knowledge, making it harder to construct coherent scientific understanding during the inquiry process.

Additional support was provided in areas such as group management, the creation of a supportive classroom climate, and cognitive activation. Furthermore, peers offered emotional support, shared information, provided feedback, and contributed companionship, all of which helped foster a collaborative learning environment. Promoting a culture of continuous learning and offering opportunities for students to explore their interests—with the necessary support—can strengthen their self-efficacy in conducting IBSF, particularly within the Namibian context.

The findings of this study suggest several key implications for elementary science education. Strengthening students' conceptual understanding through guided inquiry and clear explanations is essential. Stimulating student interest and connecting new content to prior knowledge can improve engagement and content retention. The results also underscore the importance of strong teacher-student interactions, indicating a need for teacher training in effective inquiry-based instructional strategies. Overall, the successful implementation of IBSF has the potential to support deeper and more meaningful science learning at the primary level.

Author contributions

M.N.A.: data collection, conceptualization, investigation, methodology, validation, visualization, writing—original draft preparation, writing—review and editing.

S.K.: conceptualization, investigation, methodology, validation, visualization, writing—original draft preparation, supervision and editing.

K.S.: conceptualization, investigation, methodology, validation, visualization, writing—original draft preparation, supervision and editing.

J.K.: conceptualization, investigation, methodology, validation, visualization, writing—original draft preparation, supervision and editing.

S.H.: conceptualization, investigation, methodology, validation, visualization, writing—original draft preparation, supervision and editing.

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Institutional review board statement

Research ethical guidelines recommended by UEF and Ministry of Education in Namibia.

Informed consent statement

Students' guardians provided consent to participation in the research.

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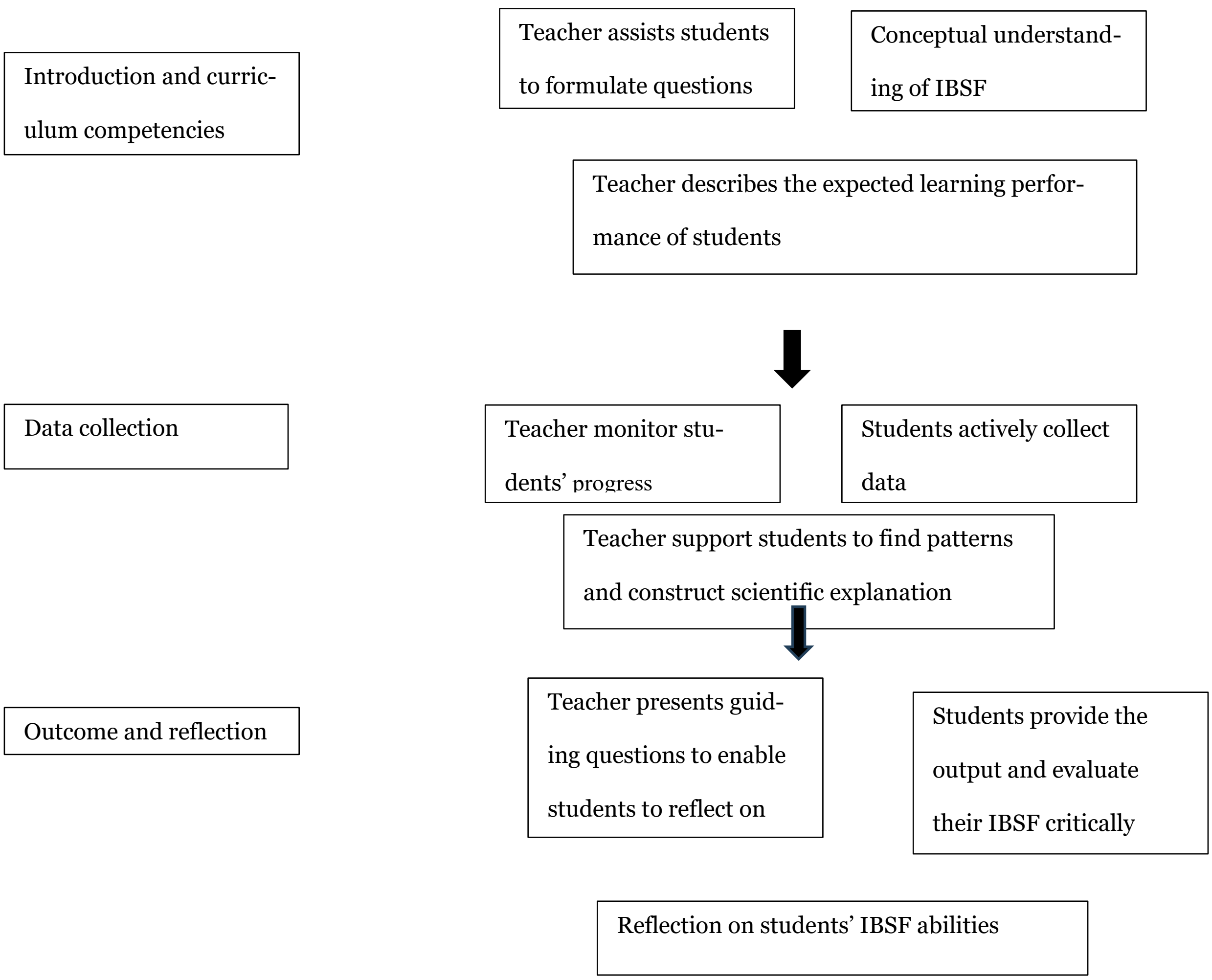
Conflicts of interest

The authors declare no conflicts of interest.

Appendices

Appendix 1. A design model for guided IBSF (cf., Pedaste et al., 2015)



Appendix 2. The content of teaching sequences and aims of the 7th grade lessons

Lesson	Content of the lessons	Aims of the lessons
Plants	• Identify the structure of a flowering and non-flowering plant (take pictures). • Describe the differences and similarities between flowering and non-flowering plants. • Describe the species of different plants. (Make use of small plants to identify the flowers, leaves, fibrous and tap roots).	• To understand the structure of flowering and non-flowering plants. • To understand the differences and similarities of flowering plants. • Describe the species of plants.
Animals	• Explain the physical difference between amphibians and reptiles. • Describe in your own words the living environment of the butterfly and what it is doing. • Describe how animals are adapted the environment for survival.	• Understand the physical difference between amphibians and reptiles. • Describe the living environment of the butterfly. • To understand how animals are adapted to the environment.
Ecosystem	• Define the term ecosystem • Describe the energy flow of living organisms within the Savannah Ecosystem. • Describe how birds are adapted to the environment for survival. • Construct a food chain using organisms in your environment.	• To gain knowledge of the ecosystem. • Understand the flow of energy in the ecosystem. • To understand how birds are adapted to the environment. • Construct a food chain

Note. Namibian Ministry of Education, Arts and Culture. (2015). Integrated Natural Science and Health Education, (INSHE), Grade.

Appendix 3. Pictures which primary school students took while in sub-groups during IBSF in Omatando village.

Figure 1. The picture reflects on students identifying different plants.

Figure 2. The picture depicts how students look at small organisms' dependence on plants for food and living as part of ecosystem.

Figure 3. The picture presents the millipede as an organism found in the savannah ecosystem.

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