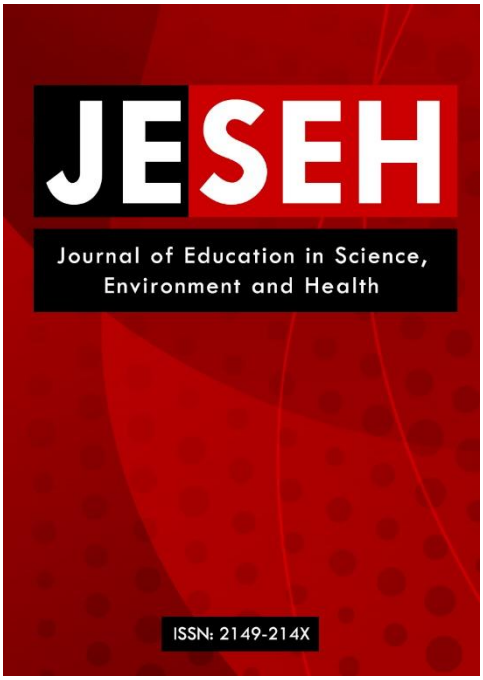

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Primary School Students' Learning Achievement and Attitudes Towards Inquiry-Based Science Fieldwork with Socio-Demographic Information

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Abstract

This study investigated the impact of school setting, gender, and age on Namibian primary students' learning achievement following an inquiry-based science fieldwork (IBSF) intervention and examined how attitude towards IBSF varied by these factors. A mixed-methods approach was used with 100 seventh-grade students from two socio-demographically different schools. From this group, 20 students were purposively selected for semi-structured interviews. Thus, multiple linear regression, exploratory factor analysis, multivariate analysis of variance, and Pearson correlation coefficients were conducted. Our quantitative results showed that school setting—but not gender or age—significantly influenced post-test learning achievement, underlining the critical role of the school environment in meeting learning outcomes. In contrast, school setting had no significant effect on students' attitudes toward IBSF. Gender differences emerged in attitudes: boys reported more positive views of IBSF's importance and greater eagerness to participate in future fieldwork, whereas girls expressed some reluctance despite strong performance. Content analysis of qualitative data confirmed that most students valued IBSF and were eager to engage again. These findings suggest that introducing IBSF at the primary level enhances students' understanding of science and its relevance to their futures. The study recommends that interventions also address gender stereotypes to promote equity and sustained interest in science education.

Introduction

In the current era of the educational revolution, where science knowledge is increasing rapidly, more students are adopting new learning methods to develop and improve their learning achievements (Ngana & Van Hong, 2021). However, there has been increasing public concern that many students perform poorly in science education (Mamili, 2017). Poor performance has been attributed to a lack of learning resources, overcrowded classes (Ndjangala et al., 2021), and unfavourable school classroom settings (Kibga et al., 2021). School settings refer to the school environment, number of students in the classes, and the diverse physical locations, contexts, and cultures in which students learn (Malik & Rizvi, 2018). Besides poor performance, teaching and learning methods contribute to students' poor attitudes to science education (Ndjangala et al., 2021; Çetin & Türkan, 2022). These students' poor attitudes generally do not apply to all countries but are very common in African countries such as Southern Africa (Marais, 2016). Thus, there is a need to investigate the African context in more detail and find different approaches to hinder the factors related to poor performance and attitudes. That is why it is necessary to improve students' learning achievement and attitudes to open the door to higher education, scholarships, and other competitive educational programs. In this study learning achievement refers to the measurable outcomes of a students' academic performance or mastery of specific science learning content (Aljermawi, 2024). It is typically assessed through standardized tests, exams, quizzes, assignments, or other evaluation tools that quantify a student's understanding, progress, and proficiency in the learning objectives (Kızkapan, 2024). In science education**,** learning achievement could also be defined as the score students receive on a science test, measuring their comprehension of key concepts covered during inquiry-based science learning (IBSL) (Ghimire, 2024). IBSL is a method aimed at engaging students in science through active participation and presentation (cf., Jaber & Hammer, 2016; Sim & Liow, 2021; Odhiambo, 2022).

In South African countries, it has been discovered that primary schools find it difficult to engage their students in science fieldwork, including practical work (Ngema, 2016), affecting students' learning achievement. Learning achievement is a product of the learning process attained by students after studying a particular subject (Sullivan

& Glanz, 2013). Thus, teaching and learning methods, such as IBSF, can directly or indirectly contribute to students' learning achievement and attitudes in science education.

In science education, 'attitude may be viewed as an emotional disposition of an individual which influences his or her behavioural intention as well as the commitment towards a given phenomenon' (Chata et al., 2019, p. 571). Some studies indicated that the role of attitude toward IBSF could be influenced by the students' age and gender (Roccatello et al., 2024). A study conducted by Cermik and Fenli-Aktan (2020) in Turkey revealed that the students' attitude towards science do not differ statistically according to their gender but are influenced by their upbringing, such as students' parental involvement in science activities. To the best of our knowledge, only a few studies in Namibia have investigated the quantitative part of the students' attitudes in fieldwork in science education (Uugwanga, 2020) and students are not used to working in groups outside lessons. Therefore, this paper investigates primary school students' learning achievements and attitudes towards IBSF, considering the impact of the school setting and students' gender and age on learning achievements and attitudes. Furthermore, investigates IBSF importance and future participation and examines the relationship between students' achievements and attitudes towards IBSF.

The Role of the School Setting, Gender, and Age in Informing Primary School Students' Learning Achievements in Inquiry-based Science Fieldwork

The school setting significantly shapes students' learning achievements and academic success (Korir, 2014; Hanaysh et al., 2023). Students encounter different school settings that can decrease or increase their performance (Wang & Eccles, 2013). Therefore, changes in students' academic success are accomplished by changing the school setting, including the school's structure and operations (MacNei et al., 2019). Harris (2018) outlined that the school shapes students' experiences as they engage in learning outside the classroom. Thus, the inquiry-based science fieldwork may offer possibilities to improve science learning as a positive and enjoyable learning environment (see Zaragoza & Fraser, 2017).

In terms of learning achievements in science, gender differences vary worldwide (Mullis et al., 2020). Boys have been found to receive better marks and outperform girls (Ma et al., 2022; Pongsophon, 2023). However, some studies have shown that girls become more fascinated by science activities than boys, leading to better results (Maison et al., 2020; Aznam, 2022). On the other it has been argued that students' learning achievements are not affected by gender, but by the amount of time they invest in learning and their working memory capacity, which shows learning gained improved attitudes towards fieldwork because of the experience and time invested in setting up educational fieldwork (Riggs, 2005; McKinley et al., 2023).

Age-related factors can play a role in learning achievement. For example, poor performance has been associated with relatively older (older in age) students who know their capabilities better than younger students (Gualtieri & Finn, 2022; Rawlings et al., 2023) in the same grade. In contrast, some studies outlined that older students demonstrate relatively better academic achievement than younger students, implying that younger students face more difficulty in this regard (Navarro et al., 2015). Moreover, some older students in the same grade have a better level of learning ability, which affects their learning achievement (Boateng-Nimoh & Nantwi, 2020). If a class has students in different age groups, it is necessary to understand how age affects their learning progress. Younger students can lose interest in fieldwork activities because they find the connection between science and the real world dry and boring (DeWitt & Archer, 2015; Said et al., 2016).

The Role of the School Setting, Gender, and Age in Primary School Students' Attitude towards Inquiry-based Science Fieldwork

A recent study indicated that a school setting affects students' attitude towards IBSF in science education (cf., Haynes et al., 2023). Thus, different school settings, such as the school environment, influence students' attitudes towards IBSF and allow them to develop new knowledge, arousing their curiosity and creative abilities (Carrier et al., 2013; Iskrenovic-Momcilovic, 2020; Kim, 2022). Furthermore, IBSF promotes active participation, which boosts student engagement when they explore and become more invested in their learning, helping them retain knowledge effectively (Peasland et al., 2024; Chalmeau & Julien, 2023). Moreover, a study conducted in Britain with primary students signifies that exposure to fieldwork settings may impact on students' environmental attitudes, environmental awareness, and science learning (Thompson et al., 2008). Additionally, different teaching and learning methods increase students' commitment to schoolwork (Küçük & Yıldırım, 2020), and fieldwork increases primary school students' inclination to aşk questions and explore science related to the school

environment (Matawali et al., 2019) and stimulates their engagement and active learning (Owens et al., 2020). For example, if students are interested in science, IBSF can influence their attitudes to that subject because they have more clarity on what the subject entails. Some researchers have found that having a good attitude profoundly improves students' learning (Jones & Washko, 2021), which can also increase their interest in IBSF (Bascope et al., 2023) and related career choices. Therefore, interactions with nature are crucial to fostering a sustainable future and environmental consciousness (Jeronen et al., 2009). Fieldwork also enables students to experience nature with all their senses (Palavan et al., 2016; Li et al., 2024) and their attitudes to and capabilities toward learning about fieldwork (Zhu, 2022). IBSF enhances students' attitudes by offering hands-on learning experiences that deepen their understanding of scientific concepts and processes (Chalmeau & Julien, 2023). Moreover, students actively engage with their natural surroundings, nurturing a sense of environmental appreciation (Nazir & Pedretti, 2016). Primary school boys have been found to have better attitudes when learning outside than inside the classroom (Carrier, 2009; Ashjae et al., 2024). Randler et al. (2005) found that involvement in a fieldwork activity heightened interest in well-being and lower levels of anger, anxiety, and boredom among elementary school boys. Furthermore, the relationship between the teacher and the student was positively realigned through a shared outdoor learning experience (Scott et al., 2013; Erickson et al., 2024).

Reasons for gender differences in childhood and adolescence differ in terms of their attitudes towards IBSF (cf., Nation & Muller, 2023). Research finds that boys receive more reinforcement than girls to get involved in fieldwork activities and are more likely to be active in high school and pursue degrees in college (Posselt & Nuñez, 2022). Therefore, masculinity is associated with fieldwork (Vanderbeck, 2005; Bartholomaeus, 2013). Although a field-based environmental summer camp revealed that girls found the fieldwork interesting and felt they were helping to complete valuable research (Nation & Muller, 2023). Moreover, a study conducted in Namibia revealed that students develop autonomy through hands-on practical activities as they conduct inquiry activities (Shivolo & Mokiwa, 2024).

A study conducted in the United Kingdom on fieldwork in earth sciences and environmental sciences argued that stimulating effective approaches to learning during fieldwork happens regardless of age (Boyle et al., 2007). Accordingly, Lowe (2004) stated that younger students' attitudes towards fieldwork are more positive than older ones. Where else, Goulder et al. (2013) argued that older students had a more positive perception of fieldwork because they enjoy themselves while participating in fieldwork, feel safe, believe that they are making good use of their time because it provides first-hand experience of recording and interpreting scientific data, the ability to work in a team.

The ideas of exploration and investigation can be viewed as part of IBSF and valuable in science education. Subsequently, the IBSF learning method creates and improves students' positive learning achievements and attitudes (Bogut et al., 2017). Fieldwork engages students' intellectual, emotional, interpersonal, intrapersonal and physical abilities (Pamulasari, 2017), allowing them to perform academically well in science subjects (Talib et al., 2009). Therefore, the role of fieldwork challenges students to take responsibility for their learning, permitting them to discover new ways to think and not rely only on the textbook (Hill & Woodland, 2002; Hirsch & Paczyńska, 2024). Therefore, a strong positive correlation exists between academic achievement and attitude towards fieldwork, especially the enjoyment of science lessons (Afari, 2011; Haynes et al., 2023). A recent study by Lee (2020) asserted that while conducting the field tasks, students became more active, adventurous, talkative, and responsible for what was happening compared to classroom learning.

Research Aim and Questions

In Namibia, primary science education is referred to as integrated natural science and health education (INSHE) (Namibian Ministry of Education, Arts and Culture, NMoEAC, 2016). Consequently, primary school students' learning achievements have declined (Ndjangala et al., 2021), since they are not performing well, and current teaching and learning methods have encountered obstacles (Mashebe & Zulu, 2022). A decline in students' positive attitudes towards different teaching methods in science at the primary level was reported (Çokadar & Külçe, 2008). The factors responsible for this decline include the quality of instruction, classroom setting, and medium of instruction (Liem et al., 2008). Implementing IBSF remains less practiced by teachers in Namibian science education, particularly in poorly resourced schools (Shinana et al., 2021). However, it is believed that the use of inquiry-based learning to examine fieldwork has an impact on students' attitudes and improves academic performance and the acquisition of new skills (Iskrenovic-Momcilovic, 2023). Conversely, when students do not perceive the value of explorative teaching and learning methods such as IBSF, they use other kinds of surface learning methods (e.g., memorization) to learn (Liem et al., 2008). The results of this study may extend the current understanding of school settings, gender, and age in order to increase students' learning achievements and attitudes

toward IBSF. Although a few studies have looked at students' learning achievements in science education, to the best of our knowledge, none have explored how primary school students, learning achievements and attitudes towards IBSF differ according to the school setting, gender, and age. Hence, the following research questions guide this research:

RQ1. To what extent do school setting, gender, and age impact primary school students' learning achievement after an IBSF intervention?
RQ2. To what extent do primary school students' attitudes toward IBSF vary by school setting, gender, and age?
RQ3. To what extent are primary school students' learning achievements and their attitudes toward IBSF related?

Method

Research Design

This study used a quasi-experimental case study design in which socio-demographic variables such as school setting, gender and age were measured with regard to learning achievements after an IBSF learning experience. Quasi-experimental study is a type of research design that attempts to establish a cause-and-effect relationship (Rogers & Revesz, 2019). In this study, we wanted to determine how the IBSF intervention affects students' learning achievements and attitude towards IBSF after experiencing it. The design provided opportunities to understand the impact of experiencing IBSF learning among selected students to regulate external variables. In addition, the study supports further developments in using the IBSF teaching approach in the Northern Namibian context.

The study was implemented in a school setting, and the first author selected the participating schools based on her local knowledge to find appropriate, well-representative public schools from the savannah ecosystem. Savannah ecosystem is a mixed grassland ecosystem characterized by a combination of open grassy areas and scattered trees, which is typically found in tropical and subtropical regions, such as Africa, it is known for its unique climate and wide range of plants and animal species (Williams et al., 2022). At the same time, classes were randomly assigned as the "control" and "experimental" groups. Random sampling was used in this study to select a subset of individuals from a larger student community each individual has an equal chance of being chosen. This technique is crucial for ensuring that the sample accurately represents the population being studied, which enhances the validity and reliability of the research findings (Stratton, 2021). Data were collected from learning achievement tests before and after the IBSF learning experience, from questionnaires on students' attitude and semi-structured interviews. Moreover, the selection of the schools had been done through purposive sampling. In this case purposive sampling (Kelly, 2010, p, 317) was necessary to obtain data from the schools located in the savannah ecosystem. All seventh-grade classes were assigned to participate in study by the school principal, and students' participation depended on their guardians signing a consent form. Moreover, the interview participants were selected based on students' requirements, such as participation in the intervention and completion of the attitude questionnaire, as students were able to express themselves well in the English language based on the teacher's observation.

IBSF Intervention

As far as the intervention was concerned, the researchers designed the curricular activities based on the science learning objectives (cf. NMoEAC, 2016). The general aim of the intervention lessons was for students to share their environmental experiences of the different types of ecosystems they lived in and the kinds of plants and animals within the Savannah ecosystem. However, before the implementation of the intervention, the activities were thoroughly and critically reviewed by the researchers and science teachers in terms of their perceived feasibility and efficacy. The interventions were implemented over a period of approximately four weeks for each school. In terms of the social aspects of the learning environments, the students were not used to working in groups outside lessons and making inquiries, which, to some extent, caused challenges for the teacher.

Introduction (Six Lessons, 10 Minutes)

This part of the intervention involved making students aware of the learning competencies, the division of groups, and completing the worksheets via guided inquiry. Guided inquiry is considered beneficial and was recommended over other types of inquiry strategies (Bunterma et al., 2014).

Development of the Intervention Part (Six Lessons, 80 Minutes)

This part involved solving the science learning objectives within IBSF group work. The students worked collaboratively as a group guided by the teacher. They completed the learning materials (worksheet), which directed them to develop knowledge and competencies using stimuli within the environment. In this study the type of IBSF activities implemented involved observation, investigating and collecting data. As such students completed the worksheet with answers during IBSF intervention and report the findings based on the competencies (cf., Appendix 1). The students discussed questions raised by other students and compared them with the textbook content. In addition, the teacher clarified the misconceptions.

Evaluation of the Learning Process (Six Lessons, 20 Minutes)

The students reflected and presented their findings from the IBSF using poster presentations, textbooks and internet research. Post-test for learning achievement and attitudes was administered four weeks after the students' initial participation in the pre-test. The learning achievement test was a paper–pencil test, and the attitude questionnaire was completed online, and the participants' names, grade, age and name of the school were written on the test paper but were omitted during the reporting of results in this study for confidentiality purpose. The interviews of 20 students at the schools were audiotaped, and each one took approximately 15–20 minutes. The study was conducted following the guidelines of the ethics committee of the National Board on Research Integrity (2019) and of the executive director of the NMoEAC. All stakeholders were informed about the study, and their voluntary participation and the confidentiality of the data used were highlighted. All stakeholders, such as the school principals, teachers, guardians, and students, consented to the study. Fortunately, none of the guardians refused their children to participate in the study because they were provided with the content of the study and how it aligned with the revised school curriculum.

Measurements

Pre- and Post-Learning Achievement Tests

Before and after an IBSF learning experience, students' learning achievements were measured using a prepared paper-pencil test (cf., Appendix 4). The authors created the pre-and post-tests following the INSHE syllabus for seventh grade students in Namibia (cf. Appendix 2). According to the syllabus, the tests should be out of 20 marks and feature different types of questions, from easier multiple-choice questions to more explanatory types of questions with pictures that students can identify. The measure consisted of nine closed and open-ended questions in total. The marking scheme was formulated using the INSHE platinum textbook in Namibia. The school's science teacher reviewed and approved the pre-and post-tests and the marking scheme.

Questionnaire and Interview

Students' attitudes to IBSF in science education were determined based on the revised attitude questionnaire by Barmby et al. (2008). The instrument consists of 14 statements (see Appendix 2), and a Likert scale with five options was used (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). The semi-structured interviews were to determine students' attitude towards IBSF after participating in an IBSF intervention. Semi-structured interviews were chosen to allow the respondents to explain their viewpoints (Creswell & Creswell, 2017) and to obtain more information from them. The interviews consisted of two questions (see Appendix 3), the first focusing on the students' views on the importance of IBSF and the second tapping into students' future participation in the IBSF. All authors validated the interview questions and agreed on the related themes.

Participants

A total of 100 primary school students from Northern Namibia participated in the study. They were all seventh graders (grade 0-7th grade is part of elementary school in Namibia) who were considered to have had satisfactory year-end exam performances in their subjects of choice after completing sixth grade. All the students from the two schools used the same national curriculum in science education; however, every school environment is set up based on the teachers' preferences and students' needs. For example, the arrangement of chairs in the class and the

type of teaching and learning strategy performed. Table 1 shows the participants' socio-demographic information whereby students were 12–14 years old, including those who were repeating seventh grade for the second time > 14 years old.

Table 1. Demographic information of the participants

Item	IBSF (f) *N* = 100
First time seven graders' age (years)	
12	43
13	36
Repeaters of seven graders' age	
≥ 14	21
Gender	
Boys	44
Girls	56
Participants per school	
School 1	53
School 2	47
Interviewed students	
Boys	11
Girls	9

Data Collection and Research Ethics

The study design was piloted in spring 2021 with 50 seventh-grade Namibian students who did not form part of the main study group. Based on the results of the pilot study, we removed three low-validity attitude factors ($\alpha <$ 70) from the current study and the remain items had acceptable Cronbach's alpha. Furthermore, all students were given the same amount of time to complete the questionnaire which is 10-15 minutes. All students completed within the given time.

The main study data from the pre-and post-learning achievement tests and attitude questionnaires were collected in spring 2022. The pre-and post-test data were collected during INSHE lessons, which took 45 minutes. Pre-test were carried out individually in each class as a paper–pencil task. After that, the students participated in the IBSF attitude questionnaire and interview.

The IBSF was based on three topics from the Namibian INSHE syllabus: ecosystem, plants and animals (cf. NMoEAC, 2016; see Appendix 1). Paper–pencil science tests on the three topics were administered to the students before and after the IBSF intervention. Prior to the intervention, students mostly associated IBSF with school field trips, such as to museums, aquariums and animal parks. For this intervention, all students were new to this method of learning, and they learned in environments near to the schools in a village.

Data Analysis

The study used a mixed-methods approach, combining both quantitative and qualitative data analysis. Quantitative methods were applied to assess students' learning achievements, while qualitative methods provided deeper insights into students' attitude towards IBSF. This combined approach enhanced the overall understanding of the research findings (Tashakkori & Creswell, 2007). Quantitative data were analyzed using SPSS version 25. Since data were collected from two different schools, variations in students' school setting, gender (with unequal group sizes), and age were taken into account (see Table 1). Prior to analysis, the data were cleaned to remove duplicates from the pre- and post-test learning achievement and attitude questionnaires, ensuring result accuracy. Data analysis began with the calculation of descriptive statistics, providing a foundational understanding of the data and its relationships. Next, the validity and reliability of the questionnaire and interviews were assessed using inferential analyses. Before proceeding with more advanced analyses, assumptions were tested for appropriateness. Finally, multiple linear regression, exploratory factor analysis (EFA), multivariate analysis of variance (MANOVA), and Pearson correlation coefficients were conducted.

Qualitative data from the interviews were analyzed using content analysis. Content analysis in the study was to develop a valuable coding framework that could be enhanced by categories emerging from the data (cf. Schreier,

2012). The lead analyst (first author) thoroughly reviewed the transcripts to comprehensively understand the data. Consequently, the research team familiarized themselves with the information gathered from students' interviews and observations, which provided them with initial insights. Initial codes were derived directly from the data, reflecting concepts related to students' responses about positive learning experiences in IBSF (PLE-IBSF) and future engagement and valuing in IBSF (FEV-IBSF). Categories were formulated based on research questions and defined according to the outcomes of the coding process. Codes were created based on the frequency of phrases identified in the students' responses while also considering variables such as school setting, gender, and age. Similar codes were subsequently grouped under corresponding categories and interpreted using a tabular format (see Tables 13, 14, 15) In this stage, each student's IBSF transcript, which typically contained multiple sentences, was treated as a unit of content analysis. A systematic approach was utilised for coding, beginning with identifying and labelling meaningful data units within the transcripts. The codes were then compiled into a list and continuously refined through peer review. This collaborative effort enhanced the trustworthiness and credibility of the findings, ensuring consistency across the dataset.

Results

RQ1. Impact of school setting, gender, and age on primary school students' learning achievement following an IBSF intervention

To answer the first research question, we conducted regression analysis to quantify the relationship between the independent variables (school setting, gender, and age) and the dependent variable (post-test scores). Assumption checks revealed no violations of linearity, and the scatterplot confirmed a linear relationship between the covariate (pre-test scores) and post-test scores. Assumptions of independence (Durbin–Watson = 1.37), homoscedasticity, and absence of multicollinearity (VIF values < 10) were met. Skewness (–0.622, SE = 0.241) and kurtosis (–0.463, SE = 0.478) fell within acceptable limits, suggesting no major departures from normality. Although the Kolmogorov–Smirnov test was significant ($p < .001$), indicating non-normality, we proceeded with the regression analysis, nonetheless, noting that no outliers were present. Tables 2, 3, and 4 present the mean, median, standard deviation, and range of post-test scores across the categories of school setting, gender, and age.

Table 2. Post-test scores by school setting

	Mean	Median	Standard Deviation	Range of post-test scores
School 1	10.89	11.00	4.24	1.50-20.50
School 2	17.47	18.00	2.400	10.00-20.50

Table 3. Post-test scores by students' gender

	Mean	Median	Standard Deviation	Range of post-test scores
Boys	13.70	14.50	5.43	1.50-20.00
Girls	14.21	14.75	4.37	2.50-20.50

Table 4. Post-test scores by students' age

	Mean	Median	Standard Deviation	Range of post-test scores
12	14.52	16.50	4.98	2.50-20.00
13	13.83	13.50	4.69	2.50-20.00
14	12.22	12.00	4.35	5.50-19.00
above 14	18.83	18.50	1.53	17.50-20.50

Table 5 presents multiple regression results predicting post-test scores from school setting, gender, and age. The overall model was significant ($F(4, 95) = 27.69$, $p < .001$), with an adjusted R^2 of .538. The effect size ($f^2 = 1.17$) was moderately large, indicating that these predictors had a substantial impact on student performance. After controlling pre-test scores, school setting was found to be a significant predictor of learning achievement (post-test) ($\beta = .693$, $t = 9.856$, $p < .000$).

Specifically, students in setting 2 (M = 17.47, SD = 2.40) outperformed those in setting 1 (M = 10.89, SD = 4.24). In contrast, gender ($\beta = .005$, $t = 0.076$, $p = .940$) and age ($\beta = –.140$, $t = –1.959$, $p = .053$) were not significant predictors. Pre-test scores also significantly predicted post-test performance ($\beta = .219$, $t = 3.121$, $p = .002$), indicating that higher pre-test scores were associated with higher post-test scores.

Table 5. Multiple linear regression analysis examining the impact of school setting, gender, and age on students' learning achievement

Intercept	B	SE	β	t	p
Pre-test scores	.414	.133	.219	3.121	.002
School setting	6.63	.673	.693	9.856	.000
Gender	.052	.688	.005	0.076	.940
Age	-.800	.408	-.140	-1.959	.053

RQ2. Primary School Students' Attitudes Toward IBSF Differed by School Setting, Gender, and Age

Before addressing the second research question, we assessed the validity and reliability of the students' attitude scale via exploratory factor analysis (EFA) using principal axis factoring with oblimin rotation (Kaiser normalization), followed by Cronbach's alpha tests. According to the EFA results, there were two distinct factors. The items in the first factor mainly gauged students' positive learning experiences, which increased their interest and confidence in IBSF.

The second factor measured students' willingness to engage in IBSF and the extent to which they valued their IBSF experiences. Thus, we named the factors Positive Learning Experience in IBSF (PLE-IBSF) and Future Engagement and Valuing IBSF (FEV-IBSF). All items loaded above .40 on their respective factors. Cronbach's alpha values were .911 for PLE-IBSF and .886 for FEV-IBSF (see Appendices 4 and 5), indicating high internal consistency. Given these two dependent variables, we selected MANOVA to examine group differences in both simultaneously.

Prior to analysis, we confirmed that all dependent measures were continuous with no outliers. The independent variables were all categorical, consisting of two dichotomous factors (school setting and gender) and one three-level factor (age group), with an adequate sample size ($n > 50$). Box's test of equality of covariance matrices was non-significant at the .001 level (Box's $M = 57.466$, $p = .005$; Pallant, 2010), meeting the homogeneity-of-covariance assumption. Levene's tests showed homogeneity of variances for PLE-IBSF ($F(13, 86) = .958$, $p = .499$) but not for FEV-IBSF ($F(13, 86) = 2.193$, $p = .016$). Consequently, we used Pillai's Trace for the MANOVA, as it is robust to variance-homogeneity violations (Finch, 2005). Tables 6–8 present descriptive statistics for PLE-IBSF, stratified by participants' background characteristics. Similarly, Tables 9–11 show descriptive statistics for FEV-IBSF across the same background variables.

Table 6. Descriptive statistics of PLE-IBSF by school setting

	Mean	Median	Mode	Standard Deviation	Range of attitude scores	Frequency Distribution
School 1	29.00	30.00	28.00	3.90	14.00-34.00	53
School 2	29.70	30.00	30.00	3.12	21.00-35.00	47

Table 7. Descriptive statistics of PLE-IBSF by gender

	Mean	Median	Mode	Standard Deviation	Range of attitude scores	Frequency Distribution
Boys	29.95	30.00	33.00	3.22	22.00-35.00	44
Girls	28.84	30.00	31.00	3.75	14.00-35.00	56

Table 8. Descriptive statistics of PLE-IBSF by gender

	Mean	Median	Mode	Standard Deviation	Range of attitude scores
12	29.00	30.00	28.00	3.16	21.00-35.00
13	28.67	28.50	28.00	4.21	14.00-35.00
14	30.11	30.50	31.00	2.85	24.00-35.00
above 14	28.33	28.00	24.00	4.51	24.00-33.00

Table 9. Descriptive statistics of FEV-IBSF by school setting

	Mean	Median	Mode	Standard deviation	Range of attitude scores	Frequency distribution
School 1	28.58	29.00	28.00	3.09	20.00-33.00	53
School 2	29.38	29.00	31.00	3.67	21.00-35.00	47

Table 10. Descriptive statistics of FEV-IBSF by gender

	Mean	Median	Mode	Standard Deviation	Range of attitude scores	Frequency Distribution
Boys	29.45	29.00	28.00	3.01	23.00-34.00	44
Girls	28.57	29.00	31.00	3.63	20.00-35.00	56

Table 11. Descriptive statistics of FEV-IBSF by age

	Mean	Median	Mode	Standard Deviation	Range of attitude scores
12	29.19	30.00	31.00	3.00	22.00-35.00
13	28.17	28.00	28.00	3.40	20.00-34.00
14	30.28	31.00	31.00	3.58	21.00-35.00
above 14	27.33	24.00	24.00	5.77	24.00-34.00

Finally, a MANOVA was conducted to examine whether primary students' attitudes toward IBSF varied by school setting, gender, and age. According to the result, the overall model was significant, (Pillai's Trace = .132, F(27, 3926.50) = 1.850, p = .005). To be specific, the effect of school setting on students' attitude towards IBSF was not significant (Pillai's Trace = .013, F (2, 85) = 0.555, p = .576, η^2 = .013), indicating a small effect size. In contrast, a significant effect of gender was observed with boys (M= 4.27, SD= 0.48) scored higher than girls (M= 4.13, SD= 0.52) on PLE-IBSF (Pillai's Trace = .073, F (2, 85) = 3.357, p = .041, η^2 = .073), indicating a moderate effect size, suggesting that boys displayed a more positive learning experiences in IBSF compared to girls. A similar pattern emerged for FEV-IBSF, with boys (M = 4.21, SD = 0.45) slightly above girls (M = 4.09, SD = 0.52).

Table 12 between-subjects effects confirmed a significant gender difference on PLE-IBSF (F(1, 86) = 4.218, p = .043, η^2 = .047) and a stronger effect on FEV-IBSF (F(1, 86) = 6.490, p = .013, η^2 = .070), suggesting gender plays a larger role in students' willingness to participate and valuing IBSF. Age did not significantly influence overall attitudes (Pillai's Trace = .095, F(6, 172) = 1.427, p = .207, η^2 = .047). However, LSD post hoc tests on FEV-IBSF revealed that 13-year-olds (M = 4.33, SD = 0.50) scored significantly higher than 14-year-olds (M = 3.95, SD = 0.79), p = .025, indicating specific age-group differences despite the non-significant omnibus test.

Table 12. Results of the MANOVA test for the effects of school setting, gender, and age on PLE-IBSF and FEV-IBSF

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
School setting	PLE-IBSF	.105	1	.105	.407	.525	.005
	FEV-IBSF	.234	1	.234	1.121	.293	.013
Gender	PLE-IBSF	1.088	1	1.088	4.218	.043	.047
	FEV-IBSF	1.357	1	1.357	6.490	.013	.070
Age	PLE-IBSF	1.152	3	.384	1.489	.223	.049
	FEV-IBSF	1.660	3	.553	2.646	.054	.085
Error	PLE-IBSF	22.184	86	.258			
	FEV-IBSF	17.977	86	.209			
Total	PLE-IBSF	1781.163	100				
	FEV-IBSF	1734.735	100				
Corrected Total	PLE-IBSF	25.553	99				
	FEV-IBSF	23.140	99				

To further address RQ2, the qualitative findings were used to explain the results of the attitudes questionnaire. Similar to the quantitative findings, two categories emerged: Positive Learning Experiences in IBSF (PLE-IBSF), and willingness to participate and valuing IBSF (FEV-IBSF). Accordingly, the two interview categories were identified based on research questions to complement the quantitative results. According to the students' responses to the question 'How does IBSF affect your learning?', the PLE-IBSF category was generated (see Table 13). Six students in School 1 indicated that IBSF had a positive role in their learning because it allowed them to experience science and understand that learning was not exclusive to the classroom, which increased their knowledge and learning. On the other hand, nine students enrolled in School 2 considered IBSF to be good and responded positively to it because they could recall the things they had learned, learn more outside class, and get fresh air while participating in IBSF. For example, one student responded that "*It affected my learning in a positive way because going out in the field give us an opportunity to experience compared to when taught in the classroom, we*

saw birds flying". Regarding FEV-IBSF, it is notable that students from Schools 1 and 2 acknowledged that they wanted to participate in IBSF in the future because they considered life to be all about learning and could explain what they were taught after engaging in IBSF. Moreover, science was fun, as they could explore and learn more. For examples, one student responded that *"IBSF is a lot of fun to be outside and experience nature".*

Table 13. Students' attitudes towards IBSF by school setting

Category	School 1	*f*	School 2	*f*
PLE-IBSF	Understanding	1	Good	5
	Knowledge	2	Learning more	3
	Positivity	3	Positivity	1
FEV-IBSF	Learning more	4	Exploring	1
	Fun	5	Remembering	3
	Remembering	1	Performing much better	2
			Interesting	4

Table 14 summarises the qualitative interview responses by gender. Concerning PLE-IBSF, seven girls expressed that they understood science better due to IBSF because it affected their learning in a very positive way. In addition, going out in the field allowed them to experience new things, compared to when they were taught in the classroom, and they could learn that the environment provided them with oxygen and shelter; as a result, they learned more about things they did not know. However, two girls expressed that IBSF did not affect their learning. Where else, eight boys stated that IBSF positively affected their learning because it allowed them to learn more, understand the outside world better and connect what they had been taught. Lastly, one boy stated that going out allowed students to get fresh air. Regarding FEV-IBSF, two girls stated that IBSF would not impact their futures, as they believed they would gain more knowledge once they moved on to higher grades. Moreover, two boys said that they could not focus when they were outside and that IBSF does not upgrade their learning.

Table 14. Students' attitudes towards IBSF by gender

Category	Girls	*f*	Boys	*f*
PLE-IBSF	Understanding and learning more	7	Learn and understand more. Fresh air	8
	Has no effect	2	IBSF does not upgrade learning	1
	Delayed Learning			
FEV-IBSF	Perception	2		2

The qualitative findings, as illustrated in Table 15, suggest that students' perceptions of IBSF varied by age. To be specific, among the 12-year-olds, four students expressed that they learned more during IBSF than in the classroom. IBSF allow them to experience nature beyond what was taught in textbooks, get a better and more robust understanding and knowledge of science and get fresh air. Among the 13-year-olds, three students found IBSF to be beneficial and could recall the things they had learned because they connected what was being taught with what was outside the classroom.

Table 15. Students' attitude towards IBSF based on age

Category	12 years	*f*	13 years	*f*	14 years	*f*
PLE-IBSF	Opportunity to learn more	4	Recall the subject content	2	Get more knowledge	2
	Understand better	2	Connecting what has been taught	1		
	Get fresh air	1				
FEV-IBSF	Focus outside	4	Learn more.	4	Gain more information.	2
	Job related	1	Work well with people.	1	Learn what is taught.	1
	Learn more	2	Fresh air	2		
	Take care of the environment	1	Perform well	1		

For the 14-year-old students, two students expressed that they obtained more knowledge from learning outside and were positive. Concerning FEV-IBSF, all 12-year-old students wished to take part in IBSF in the future because it allowed them to see animals and plants and how they interact, and one wanted to learn more about science. Moreover, 13-year-old students stipulated that they learned more outside than in class, knew how to work

with other people and got fresh air. The 14-year-old students gained more information during IBSF and considered learning outside to better than in the classroom because they tended to know what they were being taught.

RQ3. The Relationship Between Primary School Students' Learning Achievements and Attitude Towards IBSF

We conducted Pearson correlation analyses between two attitudinal factors (PLE-IBSF and FEV-IBSF) and students' post-test scores to explore the relationship between attitudes and achievement. Before analysis, several assumptions were checked. First, post-test scores, PLE-IBSF, and FEV-IBSF were measured on continuous scales, fulfilling the requirement for correlation. Scatterplots for each variable pair revealed a consistent directional trend, confirming linearity. Univariate normality was assessed via skewness and kurtosis: post-test scores (skewness = –.622, SE = .241; kurtosis = –.463, SE = .478), PLE-IBSF (skewness = –1.080, SE = .241; kurtosis = 2.550, SE = .478), and FEV-IBSF (skewness = –.469, SE = .241; kurtosis = –.258, SE = .478). Levene's test for equality of variances showed no significant differences for post-test scores and PLE-IBSF ($p = .413$) but did for FEV-IBSF ($p < .001$), indicating a homoscedasticity violation; however, Pearson correlation is robust to this, so analyses proceeded. Finally, the independence of observations assumption was met, as each student contributed only one set of data.

A Pearson correlation analysis was conducted to examine the relationship between primary school students' post-test learning achievement and their attitudes toward IBSF. The results indicated a non-significant negative correlation between post-test scores and PLE-IBSF ($r(100) = –.022$, $p = .830$), as well as a non-significant positive correlation between post-test scores and FEV-IBSF ($r(100) = .044$, $p = .667$). These findings suggest that students' attitudes toward IBSF—whether related to their learning experiences or their motivation and values—may not be directly associated with their immediate academic performance.

Discussion

Socio-Demographic Differences in Learning Achievement

Our results showed that school setting significantly influenced post-test learning outcomes, underscoring the critical role of students' learning environment, which aligns with Hanushek and Woessmann (2011), who demonstrated that school context can directly influence student performance. Consequently, curriculum developers should strive for uniform implementation of educational content across all schools to ensure equitable learning opportunities (Cheung & Wong, 2012). In Namibia, urban schools generally benefit from superior infrastructure, more qualified teachers, and richer educational resources, whereas rural schools contend with overcrowded classrooms, limited materials, and teacher shortages (NMoEAC, 2018), which may explain the differences we observed across school settings.

In our study, gender did not influence post-test learning achievements, indicating that the IBSF intervention benefited boys and girls equally, the finding contradict the study by Wieselmann et al. (2020) which observed fifth-grade students engaged in integrated STEM activities, the findings revealed that boys predominantly assumed leadership roles, directing experiments and handling materials, while girls often took on supportive roles such as observing and recording. Likewise, Meece et al. (2006) observed that urban schools often employ teaching methods and resources that advantage one gender over another. Despite the absence of gender differences in our results, the Namibian Environmental Education Policy should continue to monitor and ensure equitable access to fieldwork opportunities for both boys and girls (Simasiku, 2020). Interestingly, our results showed that age did not significantly predict post-test learning achievement, despite a trend in which younger students outperform older ones who have a bigger age in a small grade. This contrasts with Boateng- Nimoh and Nantwi (2020) and Robinson et al. (2014), who reported that older students tend to have stronger learning abilities and higher academic performance. However, those studies did not account for grade repetition—a factor that may explain our findings, since older students in our sample were more often repeaters. These results emphasize that, in the Namibian context, grade repetition should be considered when designing educational content to ensure lessons remain appropriately challenging and aligned with students' learning needs (Ndjangala et al., 2021).

Impact of Socio-Demographic Factors on IBSF Attitudes

The quantitative and qualitative results revealed that students in both schools held positive attitudes toward IBSF, with no significant differences between settings. This suggests that students develop positive attitudes toward IBSF regardless of their school environment. Chalmeau and Julien (2023) reported that most primary and lower secondary students enjoy fieldwork because of the physical activities involved, the opportunity to engage with nature, and the novelty of learning experiences. Considering the limited experience of Namibian teachers with inquiry-based science fieldwork (IBSF), it is essential that both pre-service and in-service training programs equip all educators with uniform fieldwork skills to maintain consistently positive attitudes (Shivolo, 2024).

In terms of gender, boys reported more positive attitudes toward both interest and confidence in IBSF and willingness to participate and valuing IBSF, indicating that they value IBSF and are more eager to participate in future fieldwork than girls, in line with Ribeirinha et al. (2024) which found that boys generally report higher interest and confidence in inquiry-based science activities compared to girls, boys also expressed greater willingness to participate in future field investigations, suggesting they value hands-on, exploratory science learning more highly. However, it contrasts with Chetcuti and Kioko (2012), who found that Kenyan schoolgirls held more favorable attitudes toward science than boys. To address these gender differences, Mashebe and Zulu (2022) recommend mixed-gender rather than single-gender groupings during fieldwork; however, because our study already employed mixed-gender groups, we cannot evaluate the effectiveness of this strategy. Our qualitative data further revealed some girls' reluctance to engage in future IBSF despite strong performance, Nation and Müller (2023) study conducted with high school students suggest inviting females' fieldwork experts into the classroom to help girls feel more connected to these activities.

Concerning the age differences, our quantitative results revealed that 13-year-olds were more willing to participate in IBSF than 14-year-olds, implying that younger students hold more positive attitudes toward IBSF than older ones. This finding aligns with Chalmeau and Julien (2023), who reported that younger students are more interested in fieldwork, whereas older students primarily enjoy general outdoor activities. Buchanan et al. (2022) argue that this age-related decline in attitude may stem from younger learners' sensory-based engagement, which enhances their appreciation for science fieldwork compared to older students. Chalmeau and Julien (2023) further noted that students at different age levels value fieldwork for different reasons: upper-secondary students cite well-being factors—such as fresh air and tranquillity—and view it as a valuable learning experience, while primary students appreciate the physical activities and their affinity for nature. Accordingly, Burns (2023) recommends incorporating more physical, hands-on activities at all grade levels to bolster both learning and positive attitudes toward fieldwork.

Correlation Between Learning Achievement and IBSF Attitudes

While many studies (Boyle, 2007; Brackney, 2008) report a positive relationship between students' learning achievement and attitudes toward fieldwork, this was not the case in our study, this result implies that students' favorable attitudes toward IBSF may not automatically translate into higher achievement, suggesting a need for targeted instructional support that helps learners convert their engagement into concrete learning gains and to figure out their interest towards IBSF. Although the IBSF topics used in this study were well received, incorporating additional content, such as different soil types, could further expand students' knowledge and deepen their appreciation of IBSF in science education.

Conclusion

This study investigated primary school students' learning achievements in science education, considering the impact of school setting, gender, and age which indicated that IBSF contributes to students' learning achievement. It also examined how students' attitude towards IBSF vary based on school setting, gender, and age, as such the quantitative and qualitative results revealed that through IBSF, students have fun observing and indulging in different science learning activities. Additionally, students recognized IBSF as essential, and their positive attitude towards IBSF will encourage them to consider participating in IBSF in the future. Finally, the results did not indicate any relationship between students' learning achievements and attitudes.

Recommendations

The current study focused on two schools located in the same region which limit the generalization of results to the entire population, which has positively responded to the letter of consent to carry out the study. However, this study aimed to reach students in science education mainly in the Savannah ecosystem as it provides opportunities to achieve relevant learning experiences. Thus, future researchers are recommended to use different schools from

different regions to make the results stronger and generalize them to the whole country and different school settings. We believe that this work supports the results of similar studies by providing compelling evidence that can be used to influence decision-making by principals, teachers, and policymakers to promote IBSF in primary schools in the broader learning context. The implication of adopting IBSF orientation for primary school students is to employ real-world problems and include controversial topics in the curriculum to allow students to apply disciplinary knowledge to current affairs of science, critical thinking and reasoning skills to formulate educated judgments as IBSF fosters student discussion, interactions and direct engagement with the experiences of others. The positive attitude towards IBSF will encourage students to participate in IBSF in the future. Moreover, a contextual essay (Morales-Doyle, 2023) might be a great instrument for examining students of different ages in different schools' attitude towards IBSF.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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Appendix 1. Example of pre-test and post-test

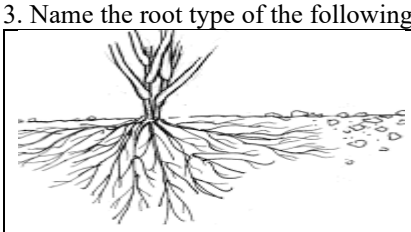
Name: _____ Grade: ____
Name of the school: _____ Gender (boy/girl): _____
Subject: Integrated Natural Science and Health Education Years in grade 7: _____
Age: _____
Instructions

- Circle one correct answer in the multiple-choice.
- Answer the structured questions on the question paper.

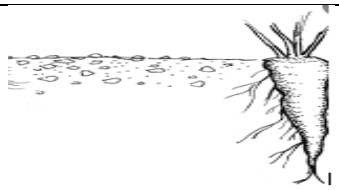
Topic: Plants

1. Monocots have flower petals in groups of _____
A. 2 B. 3
C. 4 D. 5 (1)
2. State three differences between the characteristics of flowering and non-flowering plants
_
_____(3)

3. Name the root type of the following plants (2)



A_____



B_____

Topic: Animal

4. Explain one physical difference between amphibians and reptiles
_____(2)

5. In your own words describe the living environment of the butterfly
_____(3)

6. Describe how birds are adapted to the environment for survival
_____(2)

Topic: Ecosystem

7. Define the term ecosystem
_____(1)
8. Describe the energy flow of living organisms within Savannah
_____(2)
9. Construct a food chain using organisms in your environment
_____(4)

Total marks: 20

Appendix 2. The content of teaching and learning 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 difference 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 adapt 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

Adapted from Namibia. Ministry of Education, Arts and Culture. (2016). Integrated Natural Science and Health Education, (INSHE), Grade 7.

Appendix 3. Interview Questions

1. How does IBSF affect your learning?
2. Would you like to take part again in IBSF in future?

Appendix 4. Exploratory factor analysis of students' attitude scale and students' attitude towards IBSF in science education measure

	Factor		Items
Item	1	2	
1. FEV-IBSF		.802	I look forward to my IBSF lesson
2. FEV-IBSF		.910	I would like to do more IBSF at school
3. FEV-IBSF		.752	I would like more practical work in my IBSF
4. FEV-IBSF		.574	IBSF is important for society
5. FEV-IBSF		.562	IBSF helps the poor learning learners
6. FEV-IBSF		.565	The benefits of IBSF are greater than the harmful effect
7. FEV-IBSF		.497	Practical work in IBSF is good because I can decide what to do myself
1. PLE-IBSF	.872		I learn interesting things in IBSF lessons
2. PLE-IBSF	.796		I get good marks in IBSF
3. PLE-IBSF	.843		In my IBSF class, I understand everything
4. PLE-IBSF	.709		Practical work in inquiry-based science fieldwork is exciting
5. PLE-IBSF	.728		I like IBSF practical work because you do not know what will happen
6. PLE-IBSF	.691		We learn science better when we do practical work
7. PLE-IBSF	.620		There are many exciting things happening in IBSF