Exploring Middle-Level Science Teachers' Perceptions of Inquiry-Based Practical Activities in Addis Ababa: Addressing Challenges and Harnessing Opportunities

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Abstract: *This study explores the perceptions of general science teachers regarding the implementation of Inquiry-Based Practical Activities (IBPAs) in middle-level schools across Addis Ababa, Ethiopia. This study aims to assess how teachers perceive the value of IBPAs and identify the challenges hindering its implementation. A mixed-methods descriptive design was employed to gather data through questionnaire from 120 general science teachers and interviews with 20 department heads to explore the importance and challenges of implementing IBPAs. Findings disclose that teachers commonly concede the instructional value of IBPAs in supporting student engagement, critical thinking, and practical application of science principles. Majority of the teachers intensely agreed that IBPAs improves learning by integrating theoretical knowledge to everyday environments and motivates active participation. However, significant gaps persist between these positive perceptions and actual practice. Most teachers still prefer teacher-dominated approaches due to their simplicity, citing barriers such as lack of laboratory materials, lack of professional training, poor administrative support, and low student motivation. The results further reveal that demographic factors like teaching experience and qualification slightly influence perceptions, with less experienced and diploma-holding teachers showing more positive views. Despite widespread recognition of IBPAs importance, its implementation remains inconsistent and often misinterpreted as confined to laboratory settings. The study concludes that tackling these challenges through continuous professional development, improved resource allocation, and supportive educational policies is vital. It recommends targeted teacher training and curriculum reforms to bridge the gap between awareness and practice with the purpose of*

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promoting a more inquiry-based learning, student-centred science education system. These insights have implications for improving science pedagogy not only in Addis Ababa but in similar educational contexts striving to enhance learning outcomes through practical, inquiry-based learning.

Keywords: Science Education, Inquiry-based Practical Activity, Teacher Perception, Middle Schools

Introduction

Education occurs when students participate in exploratory, investigative activities and as an active transformative progression (Kolb's, 1984). In the universal educational discourse, it is widely believed that placing science instruction in real-world contexts enhances its appeal, relevance, and cognitive impact (Vogelzang et al., 2019). In accordance with this, extensive literature highlights the basic role of inquiry-based learning in endorsing scientific literacy and experience (National Research Council, 2011). In addition, science education experts emphasise the broad benefits of inquiry-based practical activities, which range from enhancing student motivation and curiosity to bridging theoretical knowledge with hands-on application. These strategies cultivate capabilities such as scheduling, researching, exploring, and evaluating, though enlightening exactness in observation, evidence processing, and reasoning development (SCORE, 2008).

The General Education Curriculum Framework of Ethiopia also states the middle school (Grades 7 and 8) plays a crucial transitional role within the national education system and it intends to equip students with the essential knowledge, skills, and attitudes required for everyday life as well as for progression to secondary education. Likewise, as this level represents the end of compulsory schooling, it also serves as a crucial foundation for future employment or self-employment, particularly for those learners who do not advance to higher levels of education.

Furthermore, the general science curriculum for Grades 7 and 8 is explicitly designed to promote inquiry-oriented instruction, emphasising hands-on engagement as a key pedagogical strategy and it emphasises on developing competencies that integrate knowledge, skills, and values, with a purpose of applying these competencies in real-life situations to promote self-reliance, ethical behaviour, and global competitiveness (MoE, 2020). However, the actual application of this curriculum needs vigorous professional development for teachers, including access to relevant facilities, instructional resources, and cooperative educational development. As Balta (2015) asserts, classroom-based practical activities offer students essential opportunities to engage with scientific tools and procedures thereby enhancing their mastery of scientific methods. Properly planned inquiry-based practical activities can attract student attention, sustain engagement, and promote deeper conceptual understanding of natural phenomena. The integration of such practices helps students to be active learners who explore, observe, experiment, and apply scientific concepts. This active engagement facilitates critical thinking, conceptual clarity, and a sense of ownership over the learning process. Modern instructional paradigms that prioritise participatory and dialogic learning, encourage students to engage in critical reflection, peer discussions, and cooperative learning to strengthen comprehension and resolve misconceptions (MOE, 2009).

Nonetheless, introducing inquiry-based practical activities into educational environment remains challenged due to conceptual uncertainty. Lunetta et al. (2007) distinguish between “teaching science as inquiry,” which emphases the epistemology of science, and “teaching science through inquiry,” which involves students in authentic investigations. This variance holds particular relevance within the

Ethiopian middle school science syllabus, where inquiry-based learning is actualised through a range of hands-on practical activities. Implementing practical activities is essential to developing students' knowledge, scientific outlooks, and problem-solving skills. Furthermore, the successful implementation of inquiry-based practical activities is strongly connected with teachers' perceptions and views which enlighten their instructional decisions and classroom practices.

Therefore, considering these perceptions is indispensable to support the effective instructional modification. Accordingly, the Federal Ministry of Education has practised tactics to improve science and mathematics education, particularly through practical experiences such as laboratory tasks, field visits, investigations, debates, problem-solving activities, reflection and contextual exercises etc.… (MOE, 2009, 2010). However, various researches conducted in Ethiopia revealed considerable gaps in execution, mainly within secondary schools. Some of these studies indicate that laboratory activities in secondary schools often lack real-world relevance due to factors such as insufficient infrastructure, insufficient teacher training, and limited motivation to adopt active learning strategies (Beyessa, 2014; Dessie et al., 2017). Considering the challenges at the secondary level, it is imperative to assess the implementation of inquiry-based practical activity in science curriculum in middle schools, where foundational scientific skills and attitudes are being cultivated.

Therefore, exploring science teachers' perceptions regarding the implementation of inquiry-based practical activities in Ethiopian middle schools particularly in Grades 7 and 8 is both significant and timely. Understanding these perspectives offers valuable information about the enablers and limitations affecting instructional practice and contributes to the wider effort to advance science education quality across the schools in Ethiopia.

Perception and Implementation of Inquiry-based Practical Activities in General Science Education in Middle Schools

Inquiry-based practical activities (IBPAs) have emerged as essential part of contemporary science education mainly in the context of encouraging critical thinking, enhancing scientific reasoning, and promoting active learners' participation. This pedagogical method, grounded in constructivist learning approach focused on learners-dominated investigation and cultivating deeper conceptual understanding and inquiry skills. The following section synthesises empirical evidence from both national and international contexts with particular attention to perceptions, challenges, and opportunities in implementing IBPAs in the middle school.

Different studies showed both the pedagogical and the implementation challenges of IBPAs in middle-level science education in Ethiopia. Among these Brhane, et al., (2025) conducted a comprehensive study across 22 middle schools in Addis Ababa and showed a dominant dependence on traditional lecture method, with limited use of IBPAs. Teachers reflected systemic challenges, such as insufficient laboratory facilities, large class sizes, and lack of trained professionals as key barriers. A study conducted in Sidama region by Geletu (2023) on teachers' perceptions towards IBPAs revealed secondary school science teachers hold positive perceptions of inquiry-based method although their actual implementation is low due to factors such as lack of instructional materials, laboratory apparatus, limited pedagogical competency and large class size. Another study conducted by Abraha and Tarekegn (2018) in South West Shewa zone revealed that the execution of inquiry-based method was hampered by factors such as workload, large class size and lack of teaching instruments. Thus, the

study underlined the importance of creating conducive learning environment collaboratively with all stakeholders' to foster the implementation of inquiry-based science instruction. The finding reveals the wider structural limitations within the education system that hinder the adoption of inquiry-based science instruction in Ethiopian schools.

The challenges detected in Ethiopian schools regarding the implementation of IBPAs aligned with international findings. The global evidence reinforces the importance of teacher agency and instructional self-efficacy in the successful implementation of IBPAs. A study conducted by scholars such as Twahirwa et al., 2022; Laius and Presmann, 2023; Bonet, 2021; and Urdanivia Alarcon et al., 2023 found that science teachers acknowledged the benefits of inquiry-based activities specifically in enhancing students' practical and higher order thinking skills but lack of continuous professional development hampered the effective execution of this educational approach (Twahirwa et al., 2022); pre-service teachers who trained in interdisciplinary science were more likely to value and use IBPAs.

However, there are notable gaps in teacher preparation programs (Laius and Presmann, 2023); middle school science teachers with higher self-efficacy were more likely to employ inquiry-based strategies but those lacking confidence in their teaching abilities often reverted to didactic, teacher-centred practices. Furthermore, a systematic review underlined that without continuous professional support, even well-intentioned efforts to implement inquiry-based methods often fall short of achieving their intended educational outcomes (Urdanivia Alarcon et al., 2023). As the literature indicated above a solid agreement on the potential of IBPAs in science education in the Ethiopian and international studies confirmations the positive perceptions held by teachers and the proven benefits of IBPAs for student learning. Conversely, the application residues earmarked by different barriers such as resource limitations, and gaps in teacher preparation.

Statement of the Problem

IBPAs are broadly accepted as a basic and effective science education, as they engage students through direct, practical interaction with scientific conceptions and procedures (Crawford, 2014). The national curriculum framework of Ethiopia focuses on student-centred pedagogy that promotes exploration, creativity, and active participation in the learning process (MOE, 2020). Specifically, the science curriculum for Grades 7 and 8 promotes the use of inquiry-based learning approaches intended to enhance comprehensive reasoning, critical thinking, and the hands-on implementation of understanding. However, observed researches recommend an insistent gap among curricular targets and authentic classroom practices, particularly in the application of science activities.

Research conducted across many Ethiopian regions show different challenges in implementing laboratory-focused tasks in science teaching. For instance, a study conducted by Hussen et al. (2022) in North Wollo Zone (Amhara region) revealed that, despite chemistry teachers recognising the significance of practical application, its execution remains limited due to supply constraints and absence of complete support. Similarly, a study by Gogile and Alemayehu (2016); Muleta et al. (2016); Tesfaye et al. (2010); Shitaw (2017); and Brhane et al. (2025) underlined critical obstacles such as inadequate laboratory equipment, lack of trained laboratory experts, inadequate teaching resources, limited professional capability among teachers, and the absence of effective institutional monitoring and provision circumstances. These systemic issues hinder the practice of inquiry-based learning strategies, thereby limiting students' prospects for pragmatic learning and theoretical mastery.

Whereas most of the existing literature is dedicated on the secondary school level, there remains a significant research gap concerning primary schools particularly Grades 7 and 8 general science curriculum where the foundations of scientific inquiry are expected to be established. At this level it is enormously important for science teachers to have an understanding of how inquiry-based learning strategies are interpreted and implemented, as they have a direct impact on classroom execution. Misalignments between curricular goals and teacher practices, often shaped by contextual limitations and personal beliefs, may compromise the intended educational outcomes.

Accordingly, this study seeks to explore the perceptions of science teachers in Addis Ababa's middle-level schools regarding the implementation of inquiry-based practical activities. It aims to identify both the opportunities that support and the challenges that hinder effective integration of these activities into teaching practice. By enlightening the attitudinal, pedagogical, and systemic dimensions influencing classroom implementation, the study contributes to the broader discourse on science education reform in Ethiopia. Specifically, it addresses the following research questions: (a) How do science teachers perceive the importance of inquiry-based practical activities in middle schools? and (b) What challenges do teachers identify in implementing these activities within the context of Addis Ababa's middle schools?

Methodology

To achieve the study's objectives and address the research questions, a descriptive design and mixed-methods research approach were utilized. This approach is suitable for examining perceptions through descriptive queries such as "what happened," focusing on a specific unit of study a bounded system that may include individual teachers, a classroom, or a school (Gay, 2012). Likewise, this method is commonly

employed in educational research to capture conditions, practices, beliefs, and attitudes (Creswell, 2009).

Data Sources and Sampling Techniques

The data source of this study contains general science teachers in middle level schools of Addis Ababa City administration. First, the total numbers (249) of middle schools found in each of the eleven sub-city administration are clustered. Then, two governmental middle level schools were randomly selected from each sub-city based on the clustering. As a result, 22 government middle-level schools were selected randomly. Simple random sampling was chosen under the assumption that it ensures a representative sample by giving each potential participant an equal and independent chance of selection (Yount, 2006). These schools can be taken as representative samples since there is homogeneity among all the schools with regard to human and material resources, demographic and socio economic background, pedagogical approach and administrative procedures of the government structure.

This study involved 120 general science teachers from 22 randomly selected government middle-level schools in Addis Ababa. All general science teachers were selected using a census sampling technique on account of the manageable number of teachers and their direct relevance to the research focus. To balance and deepen the quantitative data, a randomly selected 20 science department heads participated in interviews. The target population specifically comprised general science teachers active during the 2023 academic year. The general science subjects (Biology, Chemistry, and Physics) were purposefully chosen to

assess the implementation of inquiry-based practical activities due to the researchers' educational background.

Data Gathering Tools

The data collection instruments were developed based on the objectives and research questions of this research study, as well as insights from the reviewed literature. Before applying the instruments in the main study, experts peer review and pilot test were conducted to confirm the tools clarity, relevance and reliability in two randomly selected middle schools that were not included in the main study. Questionnaire and interview guide were used to collect comprehensive data from the general science teachers about their perceptions on IBPAs and enable methodological triangulation. The questionnaire contained twenty closed-ended Likert scale items and three open-ended questions intended to collect general science teachers' perceptions of the importance and comprehensive understanding on the implementation related challenges of IBPAs.

Interviews were also conducted to gather further detailed views on the IBPAs perspectives and practices of general science teachers (Bryman, 2012). Five unstructured interview questions were used to support the qualitative investigation and permit teachers to elaborate easily, hence stirring the quantitative data from the questionnaire. All interviews were audio-recorded to confirm the correctness of the replies and to enable detailed analysis.

Reliability and validity of the data collection instruments

In this study, both instruments used to collect data were reviewed by experts and pilot tested to ensure the reliability and consistency of the questionnaires. This is because confirming the consistency and validity

of data collection tools is crucial to ensure the accuracy, consistency, and trustworthiness of the findings. Peer reviewers with expertise in educational research also contributed to validating the instruments. Based on feedback from both expert and peer reviewers, further modifications were made to enhance the content and construct validity of the instruments.

Moreover, the pilot process familiarised the researchers with the administration of the instruments and facilitated preliminary analysis of the internal consistency of questionnaire items. The reliability of the instruments was assessed using Cronbach's Alpha coefficient, which measures the internal consistency or the degree to which a set of items is interrelated (Kombo & Tromp, 2006). Given that the questionnaire for teachers aligned with the research objectives, reliability analysis was conducted separately for each category to ensure that the scores accurately reflected the intended constructs. Accordingly, the coefficient of reliability value of teachers' based on the category of importance and practice related challenges the outset measure as (0.87 and 0.78) respectively each items related with the inquiry-based practical activities in general science subjects. Conferring, the results from teachers' questionnaires suggest a high level of internal consistency, demonstrating that the items within each category reliably measure the underlying constructs associated with inquiry-based practical activities in general science instruction. Therefore based on the feedback and pilot alpha scores, the researchers made enhancements on the instruments.

Data Collection and Analysis

Data were collected using questionnaire from general science teachers and complemented by unstructured interviews intended to get deeper qualitative insights into teachers' perceptions and practice related challenges regarding inquiry-based practical activities. A strict ethical standards were maintained to ensure participant privacy and the confidentiality of all collected data throughout the research process. Quantitative data collected through the questionnaires were analysed using descriptive statistical techniques, such as frequency distributions and mean scores, to identify patterns and trends. Data from interviews were subjected to thematic analysis, enabling the extraction of determined themes and categories. Interview participants were anonymized using coded identifiers such as "T1," "T2," up to "T20" to preserve their confidentiality. Following sections present and interpret the findings, drawing upon both the empirical data and pertinent scholarly literature to contextualise and support the argument.

Ethical Procedure

During this study, ethical procedures were followed to, ensuring the truthfulness of the research process and the protection of all participants. The study was conducted following the steps outlined below as a guideline: Prior to data collection, all participants were communicated about the purpose of the study, the nature of their engagement, and the use of the data collected. Written informed consent was also obtained from each participant, guaranteeing their voluntary participation and their right to withdraw from the study at any time without any adverse consequences. Ensuring participant confidentiality was a main concern throughout the study. All personally identifiable information was removed from all study documents and data, ensuring that individual responses could not be linked back to specific participants. In addition, efforts were made to minimize bias throughout the research process. The questionnaire and interview questions were reviewed by external experts in the field to ensure they were free of leading or biased language. Moreover, the research process was documented in detail,

providing transparency and allowing for accountability. All methodologies, from data collection to analysis, were clearly described to enable replication and to uphold the standards of research rigor.

5. Results and Discussion

5.1. Profile of teachers

The general science curriculum at the middle school encompasses three core disciplines: biology, chemistry, and physics. Currently, the educators responsible for teaching general science are graduates from specialized departments within these disciplines. Typically, their academic backgrounds include combinations such as biology and chemistry (from either the biology or chemistry departments), or physics and mathematics (from the physics department). Although the subject taught is labeled “General Science,” there is no dedicated General Science degree program; rather, it falls under the broader classification of natural sciences. Consequently, all general science instruction is delivered by teachers trained specifically in one or more of the three individual disciplines biology, chemistry, or physics rather than by graduates from a unified General Science program.

Table 1: Demographic characteristics of teachers

Variable	Category	Count	%
Department (Teachers graduated educational background)	Biology	41	34.2
	Chemistry	41	34.2
	Physics	38	31.7
Sex	Male	85	70.8
	Female	35	29.2
Qualification	Diploma	61	50.8
	B.Ed.	0	0.0
	B.Sc./MSc	22	18.3
	B. Sc.+PGDT	37	30.8
Pedagogical training during	On job/in-service	22	18.3
	Undergraduate/ pre-service	98	81.7
Teaching experience	<5	29	24.2
	6-10	34	28.3
	11-15	13	10.8
	16-20	21	17.5
	>=21	23	19.2

A total of 120 teachers were involved in this study, as shown in Table 1. The teachers are almost evenly distributed across three departments: Biology, Chemistry, and Physics, with each department constituting roughly a third of the total teacher population (41(34.2%) for Biology and Chemistry each, and 38 (31.7%) for Physics). This suggests a balanced

staffing across the three educational backgrounds of science departments. There is a significant gender imbalance among the teachers, with males comprising 85 (70.8%) and females 35 (29.2%) of the total. This indicates a male-dominated environment within the teaching staff.

The qualifications of the teachers vary: A majority 61 (50.8%) hold a Diploma, no teacher has a Bachelor of Education (B.Ed.), indicating a possible gap or oversight in teacher education specific to education degrees, 22 (18.3%) of the teachers hold either a Bachelor's or Master's (BSc/MSc) degree in science, and 37 (30.8%) have a Bachelor of Science with Postgraduate Diploma in Teaching (BSC+PGDT), suggesting a significant proportion have enhanced their education degree with a teaching qualification. The majority of teachers 98 (81.7%) received their pedagogical training as part of their undergraduate or pre-service education, indicating that the foundational teacher training occurs predominantly before entering the profession. Only 22 (18.3%) of the teachers have received pedagogical training on the job or through in-service programs, highlighting a potential area for improvement in continuous professional development.

The distribution of teaching experience among the teachers is varied: 29 (24.2%) have less than 5 years of experience, indicating a notable portion of relatively newer teachers. 34 (28.3%) have between 6 to 10 years of experience, representing the largest experience category. Fewer teachers 13 (10.8%) fall into the 11 to 15 years' experience category. Those with 16 to 20 years, and more than 21 years of experience make up a significant portion 21 (17.5%) and 23 (19.2%),

respectively), suggesting a seasoned cohort that provides a backbone of experience to the teaching staff.

The data highlights three key inferences such as the need to address gender imbalance by encouraging more female participation in teaching; the importance of improving teacher qualifications through education-specific programs and enhanced in-service training; and the potential to implement mentorship programs, given the large proportion of early-career teachers and the presence of experienced staff.

Teachers' Perceptions on the importance of Inquiry-Based Practical Activities

Table 2 provides data on teachers' perceptions of inquiry-based practical activities (IBPA) across various statements. The table shows varying degrees of agreement among teachers on the efficacy and impact of IBPA in the educational context. The response options ranged from 1 (Strongly Disagree, SD) to 5 (Strongly Agree, SA), with the distribution of responses and calculated means indicating the overall sentiment towards each statement. The mean scores for each statement range from 3.25 to 4.23, suggesting that overall, teachers view IBPA positively. The highest agreement is for the statement "The role of the teacher is facilitating the learning process rather than controlling," with a mean of 4.23, highlighting a strong endorsement of facilitative teaching roles in inquiry-based settings. The lowest mean score of 3.25 is associated with the statement regarding the preference for practical over theoretical learning. This reflects some reservations about fully prioritizing practical learning over traditional methods.

A significant majority (72.5%) agree that IBPA are easy to implement and help learners solve their problems, indicating a positive view of the practicality and effectiveness of IBPA. Most teachers (89.2%) acknowledge that IBPA helps learners understand science concepts within their environment or context better. Statements regarding the

development of self-confidence and independent learning for both teachers and learners score above 3.5 on average, signifying a strong belief in the personal development benefits of IBPA. Teachers also largely agree that IBPA prepares learners to address real-world problems, reinforcing the practical value of this teaching approach. There is a nearly unanimous agreement that the role of a teacher should be more about facilitating rather than controlling, which underscores a paradigm shift in teaching perspectives among the respondents. Responses show that teachers believe IBPA contributes to the development of self-learning abilities and interpersonal skills among students.

Table 2: Perceptions about the importance of inquiry-based practical learning

Statements on inquiry-based practical activities with positive insights	**SD (1)**		**D (2)**		**U (3)**		**A (4)**		**SA (5)**		**Mean**	**SD**
	n	**%**	n	**%**	n	**%**	n	**%**	n	**%**		
IBPA are easy to implement and enable learners to solve their problems.	0	0.0	10	8.3	23	19.2	87	72.5	0	0.0	3.64	0.63
IBPA provide learners with better understanding science concepts in their environment/context.	0	0.0	4	3.3	9	7.5	92	76.7	15	12.5	3.98	0.58
IBPA help the learners to share experiences &learn from each other.	0	0.0	17	14.2	20	16.7	76	63.3	7	5.8	3.61	0.80
IBPA develop self-confidence & independent learning for the teacher.	0	0.0	9	7.5	27	22.5	76	63.3	8	6.7	3.69	0.71
IBPA develop self-confidence & independent learning for the learner.	0	0.0	0	0.0	18	15.0	76	63.3	26	21.7	4.07	0.60

Statements on inquiry-based practical activities with positive insights	SD (1)		D (2)		U (3)		A (4)		SA (5)		Mean	SD
	n	%	n	%	n	%	n	%	n	%		
IBPA prepare the learner to solve real problems in the society.	0	0.0	6	5.0	26	21.7	83	69.2	5	4.2	3.73	0.62
The role of teacher is facilitating the learning process rather than controlling.	0	0.0	0	0.0	0	0.0	93	77.5	27	22.5	4.23	0.42
Using IBPA helps to develop students self-learning abilities and skill.	0	0.0	14	11.7	44	36.7	61	50.8	1	0.8	3.41	0.70
IBPA strategies promote the development of students' interpersonal skill.	0	0.0	0	0.0	31	25.8	78	65.0	11	9.2	3.83	0.57
IBPA strategies promote the students to learn from practical world than the theoretical one.	0	0.0	41	34.2	24	20.0	39	32.5	16	13.3	3.25	1.07
										Grand Mean	3.74	

The grand mean across all items is approximately 3.74. This value indicates a generally positive perception among teachers regarding the importance and effectiveness of inquiry-based practical learning, with respondents leaning towards agreement on most statements. The standard deviations are relatively low (ranging from 0.42 to 1.07), with most under 0.80, indicating a general consensus among the responses. However, the highest SD associated with learning from practical vs. theoretical worlds suggests some variability in opinions on this aspect.

The data supports further integration of IBPA into curricula as teachers recognize its benefits in enhancing practical understanding, developing skills, and fostering independent learning. Educational policymakers should consider these insights to promote more hands-on learning environments. Given the strong endorsement of facilitative teaching roles, professional development programs might focus on training teachers to be facilitators who empower students rather than controllers of the learning process. The positive reception to IBPA underscores the

need for adequate resources, such as laboratory equipment and materials, to implement these activities effectively.

Despite the enthusiasm for practical learning, the variability in opinions regarding the balance between practical and theoretical education suggests that a blended approach might be necessary to cater to diverse learning needs and preferences. Generally, the data from Table 2 discloses a strong confirmation of inquiry-based practical activities, with implications for teaching practices, curriculum development, and educational policy.

The analysis of the data presented in Table 2 and the consequent argument discloses the following important insights:

1. Favorable Reception: The data strongly show that teachers recognize inquiry-based practical activities (IBPA) as a valuable learning methodology. The high mean scores through different items prove either agreement or strong agreement that IBPA improves learning results, containing problem-solving, self-learning and interpersonal skills.
2. Considered Benefits: With a mean score of 4.23, the data exhibited that respondents were remarkably in agreement with the role of teachers as facilitators. As demonstrated by the mean score of 4.07, respondents strongly agreed on the significance of a facilitative teaching role and the growth of learners' self-confidence and independence. These results show that these important IBPA features have strong support.
3. Area of concern: this lesser mean score (3.25) and higher standard deviation (1.07) for learning from the real world

recommend some reservations about IBPAs effectiveness in contrast to more conventional, theoretical approaches.

Other IBPAs principles are also perceived differently, which suggests differences in implementation and points to possible areas that need extra support, many resources, and practical adjustments.

4. Consistent Understanding: Based on the low standard deviations found for the common of questions, it appears that teachers constantly recognize and worth the advantages of IBPAs, which is in line with their outlooks and learning visions.

Generally, this analysis highlights a strong endorsement of inquiry-based practical activities within the educational process, underscoring its significance in fostering a practical, interactive, and learner-centered learning setting. Furthermore, teacher respondents during the interviews, reflect as recognized the importance of IBPAs but they reported not incorporating them into their lessons. A notable comment from Teacher 3 illustrates this disconnect:

> *Practical activities are invaluable because students can replicate theoretical concepts in a laboratory setting. However, this remains a theoretical or ideal rather than a tangible reality in our school due to the lack of appropriate resources in the laboratory.*

Supporting to this, acknowledging the merits of inquiry-based learning, T2 expressed concern over the feasibility of catering to students' diverse learning needs in a resource-constrained environment.

He further said,

> *In my classes, many students possess creative skills that could be fostered through practical tasks. Conversely, how can this be*

attained in a school that struggles to procure even a single dynamo or material to engage students?

This gap between appreciation and application underlines the necessity to tie the awareness gap concerning inquiry-based practical science instruction. It is critical to improve the positive insights of IBPAs by increasing awareness and providing needed training for teachers and other stakeholders. This method enables the transition from IBPAs are fully appreciated in the classroom.

Teachers' Perceptions on the Challenges in Implementing Inquiry-Based Practical Activities in Science Lessons

Table 3 recapitulates the perceptions of science teachers concerning the challenges related to implementing Inquiry-Based Practical Activities (IBPA) in science lessons delivery. This presents a comprehensive summary of general science teachers' responses to negatively framed statements concerning the execution of IBPAs, offering valuable insight into their perceptions and doubts. The data, rated on a scale from 5-point Likert scale ranging from Strongly Disagree (5) to Strongly Agree (1), the responses reflect varying levels of agreement with statements that express potential difficulties in using IBPA. The analysis includes mean scores and standard deviations for each item, offering insights into the extent and consistency of these perceptions. The overall data recommends that while IBPAs in educational settings are generally favored for their participatory approach, however there are prominent

concerns regarding their practical application, in terms of different limitations and the perceived difficulty in applying these tactics.

Regarding the statement, “It is too difficult to practice IBPA in schools”, respondents reflect a mean score of (3.39) indicates that a substantial portion perceive implementing inquiry-based practical activities in schools as a difficult task. However, there is a significant amount of variety in the replies, as perceived by the huge standard deviation of (1.23), regarding to some people may find IBPA challenging to implement, but others might not feel the same way. This implies that perceived difficulty may vary depending on the setting, with certain schools, subjects, or teacher experience levels affecting the perception on implementation.

In response to the statement “Learning is occurring when learners are silent & passive receivers of information from the teacher”, the participants expressed a mean score of 3.99, signifying a strong disagreement with the notion that passive learning is effective. This aligns with modern educational philosophies that prioritize active learning and student engagement. Moreover, the low standard deviation of 0.97 indicates strong consensus among respondents regarding the scantiness of passive learning methods.

Teachers were asked about their perceptions of the IBPA teaching style, by asking them if they believed that the traditional method is preferable because IBPA takes time. The majority of them disagreed with this notion. The average score of 3.83 shows a definite disagreement with the notion that traditional procedures should be chosen just because of IBPA’s time constraints. Despite the time pledge, respondents strongly think that IBPA is valuable, as indicated by the relatively low standard deviation (0.66). This demonstrates the prevalent belief that the advantages of active, inquiry-based learning exceed the difficulties brought on by the extra time commitment. It also suggests a desire for

more innovative teaching strategies as opposed to conventional lecture-based methods.

Teachers were also asked to respond to the question: “Learning is effective when teachers narrate subject matter knowledge rather than how to teach.” According to the mean score of (3.44), which indicates a slight disagreement with the statement, the majority of respondents prefer a more active approach to learning, one that underscores teaching methods alongside content delivery. The standard deviation of 1.02 suggests some variability in responses, in which the majority of respondents disagree with the statement, and a few still worth the importance of teacher narration. Supporting the claim that “lecture is helpful because it fills learners’ minds quickly”, teachers gave a mean score of 3.49, which leans towards “Disagree.” This indicates that, despite the fact that lectures can impart knowledge fast, most respondents do not think of them as the most effective teaching approach. The moderate variety of opinions indicated by the standard deviation of 1.07, suggests a significant portion of teachers that account 20.9% view the lecture method as beneficial for transmitting knowledge efficiently, while others do not. Teachers also expressed a positive outlook on their role in the inquiry-based approach, disagreeing with a Mean score of 3.42 and SD of 0.93, with the idea that teachers should primarily be sources of knowledge rather than facilitators.

However, there is notable doubt concerning the effectiveness of IBPA in promoting practical over theoretical learning. This is reflected in the mean score of 3.18, which supports slightly toward disagreement, suggesting some uncertainty about IBPA’s practical focus. Similarly, the high proportion of unsure answers (44.2%) illustrates the diversity of

viewpoints, indicating that while some participants associate IBPA with practical learning, many remain uncertain. This doubt extends to the applicability of IBPA; the idea that IBPA is only used in lab classes is rejected by a mean score of 3.32, which supports the wider use of IBPA in a variety of educational settings. The low standard deviation of 0.69 further indicates strong agreement among respondents that IBPA can be effectively implemented beyond just laboratory environments.

A strong majority of respondents that account 85%, with a Mean of 3.17 and SD of 1.02, indicates that while the majority disagrees with the statement, there is some variation in responses, with a portion of participants unsure about the effectiveness of IBPA in this regard. Furthermore, the statement is agreed with by a significant majority of respondents, as shown by the mean of (2.63), which suggests that IBPA makes teaching science more difficult. A moderate response spread is revealed by the standard deviation of (0.99), suggesting that many teachers find IBPA complicates the delivery of general science lessons, emphasizing the challenges of implementing these methods in educational settings.

Table 3: Frequency distribution on the challenge of inquiry-based practical activities among teachers

Statement	SD (5)		D (4)		U (3)		A (2)		SA (1)		Mean	SD
	count	%	count	%	count	%	count	%	count	%		
It is difficult to practice IBPA in schools.	18	15.0	59	49.2	4	3.3	30	25.0	9	7.5	3.39	1.23
Learning is occurring when learners are silent & passive receivers of information from the teacher.	36	30.0	63	52.5	8	6.7	10	8.3	3	2.5	3.99	0.97
IBPA take time so, traditional methods are preferable to implement.	14	11.7	88	73.3	11	9.2	7	5.8	0	0	3.83	0.66

Learning is effective when teachers narrate subject matter knowledge rather than how to teach.	4	3.3	79	65.8	12	10.0	16	13.3	9	7.5	3.44	1.02
Lecture is helpful because it fills learners' minds quickly.	13	10.8	81	67.5	1	0.8	17	14.2	8	6.7	3.49	1.07
In IBPA, teachers are the source of knowledge.	1	0.8	81	67.5	8	6.7	27	22.5	3	2.5	3.42	0.93
IBPA doesn't promote learning from the practical world.	0	0.0	26	21.7	53	44.2	35	29.2	6	5.0	3.18	0.83
IBPA strategies are for lab classes only.	7	5.8	76	63.3	29	24.2	8	6.7	0	0	3.32	0.69
IBPA doesn't prepare learners to solve societal problems.	1	0.8	65	54.2	12	10.0	37	30.8	5	4.2	3.17	1.02
IBPA makes science lessons difficult.	0	0.0	38	31.7	6	5.0	70	58.3	6	5.0	2.63	0.99
										Grand Mean		3.39

While respondents generally show a substantial level of agreement with the potential benefits of IBPA, they also recognize its limitations and inconsistencies in their ability to apply this understanding in actual practice, as indicated by the grand mean of 3.39. This score demonstrates an understanding of the importance of IBPA in promoting critical thinking, student involvement, and active learning. In addition, items with means above 3.50 (for example, items 2 and 3) show strong disagreement with the negative views, supporting the value of IBPA. Nevertheless, it also highlights the difficulties that respondents have, especially those that are related to time limits, implementation difficulties, and the unique situations in which IBPA might not work or implement in general science instruction classes.

Generally, the research points to inquiry-based practical activities as a useful teaching approach even though its success largely depends on how well it is incorporated into instructional practice, the availability of resources, and the quality of training provided to teachers. Since of this, future educational improvements should concentrate on giving teachers with adequate resources, professional development opportunities, and time management techniques to help them successfully apply IBPA. In addition the results underline to make sure that IBPAs In addition the result of this study underline how critical it is to warrant that IBPAs are used in a diversity of learning situations specializations to simplify learners' education.

Furthermore, to infer more on the perceptions of inquiry-based practical activities among middle-level science teachers were also analysed using disaggregated data based on demographic variables such as department, gender, qualification, and teaching experience. Respondents disaggregated by demographic variables will presents as follows:

Table 4 presents analysis of respondents' perceptions related with the benefits and implementation related challenges linked with executing inquiry-based practical activities (IBPA) in general science education in the middle schools of Addis Ababa. The data is classified by key demographic and professional variables, including department, sex, educational qualification, and teaching experience. Mean scores and standard deviations (SD) are provided for each group with respect to their views on both the benefits (overall grand mean = 3.74) and challenges (overall grand mean = 3.39) of IBPA.

Table 4 Respondents Disaggregated by Demographic Variables

Variable	Category	Respondents	Benefits of IBPA (Grand mean=3.74)	Challenges to IBPA (Grand mean=3.39)

			Mean	SD	Mean	SD
Department	Biology	41	3.74	0.22	3.39	1.23
	Chemistry	41	3.73	0.21	3.99	0.97
	Physics	38	3.75	0.22	3.83	0.66
Sex	Male	85	3.75	0.22	3.44	1.02
	Female	35	3.73	0.21	3.49	1.07
Qualification	Diploma	61	3.77	0.20	3.42	0.93
	BSc/MSc	22	3.70	0.26	3.18	0.83
	BSC+PGDT	37	3.73	0.22	3.32	0.69
Teaching experience	<5 years	29	3.76	0.24	3.17	1.02
	6-10 years	34	3.74	0.20	2.63	0.99
	11-15 years	13	3.74	0.21	2.52	0.26
	16-20 years	21	3.68	0.23	2.63	0.33
	>=21 years	23	3.78	0.20	2.65	0.29

The results in Table 4 present the perceived benefits and barriers of inquiry-based practical activities (IBPA) across various demographic categories of teachers, with means and standard deviations (SD) for both benefits and challenges.

Subject Specialisation and Perceptions

Looking at the teachers educational background or department, across academic departments all three departments reported nearly identical levels of perceived benefits (around 3.74-3.75), indicating a shared belief in the value of IBPA across disciplines. Furthermore, Physics

background teachers reported the highest perceived benefits (M = 3.75, SD = 0.22) with high challenge score (M = 3.83), indicating practical difficulties despite seeing the highest benefits; teachers with Biology background showed balanced perceptions, with benefits equal to the grand mean (3.74) and challenges also exactly matching it (3.39), indicating a moderate and stable view. Whereas Chemistry background teachers identified the highest level of challenges (M = 3.99, SD = 0.97) suggesting strong perceived barriers. This consistent recognition on the benefits of IBPA across disciplines indicates that the concept of inquiry-based learning booms well with science ability, regardless of specialization. However, the inconsistencies in perceived challenges point to discipline-specific barriers that may impact the effective implementation of IBPA. The significantly high challenge rating among Chemistry and Physics teachers despite reporting the highest perceived benefits suggests that different obstacles in the implementation and addressing these barriers may simplify inquiry implementation in general science education in the middle schools.

Gender and Perceptions of Inquiry-Based Practical Activities

As illustrated in the above Table on the perceptions of male and female teachers regarding inquiry-based practical activities (IBPA), the mean scores for the benefits of IBPA show minimal difference between males with mean of 3.75 and females with mean of 3.73, suggesting that both genders perceive similar advantages from IBPA. This marginal difference suggests that gender does not play a significant role in shaping teachers' perceptions of IBPA as both groups demonstrate a similar spread of opinions. However, females report slightly more challenges with a mean of (3.49) as compared to males with a mean of (3.44). This indicates that while the perceived benefits are nearly

identical, females may face marginally more obstacles, potentially linked to external factors, like workload or access to resources. The low standard deviations for both benefits and challenges reflect a high level of consistency in the responses within each gender group, and the lower means for both genders highlight shared challenges or constraints, indicating a need for targeted interventions to enhance overall perceptions.

Qualification as a Determinant of Perceptions

Table 4 sheds light on the influence of educational qualifications on teachers' perceptions. Regarding qualifications, 61 teachers with Diploma holders, 37 BSc+PGDT and 22 BSc/MSc general science teachers comprised.

The result shows diverse patterns in the ways that general science teachers with various backgrounds view the advantages and difficulties of putting IBPA into practice. The major perceived benefits (M = 3.77) and perceived challenges (M = 3.42) were indicated by diploma holders. This infers that even while these teachers are passionate about the benefits of IBPA, they do not have the professional pedagogical knowledge or self-control to use it successfully. Their increased sense of difficulty may result from their previous training's greater reliance on organized, teacher dominated approaches, their limited exposure to instructional styles, or their lack of professional development chances etc...

Teachers with BSc/ MSc degrees, on the other hand, conveyed the lowest challenge scores (M = 3.18) and slightly lower perceived benefits

(M = 3.70). This group may feel more professionally prepared and capable of incorporating IBPA into their teaching, possibly because they have access to higher-level teacher education and stronger theoretical bases. Their slightly lower benefit score may reflect a more realistic or critical view of IBPA, shaped by more experience or familiarity with its practical limitations. Teachers with a BSc and PGDT qualification fall in between the two other categories in terms of perceived obstacles (M = 3.32) and rewards (M = 3.73). This implies a more impartial perspective, probably as a result of their formal pedagogical background and subject-matter experience. While they could be more prepared than those with diplomas, they lack the academic sophistication of those with more advanced degrees.

This suggests that teachers with foundational qualifications might perceive the advantages of IBPA more favorably compared to those with higher academic qualifications. Likewise, this indicates that advanced qualifications and additional professional training, such as the PGDT, are associated with more favourable perceptions of IBPA. Despite these differences, some groups fall significantly below the grand mean, underlining systemic challenges that transcend qualifications. On average, BSc/MSc-qualified educators agree that IBPA is beneficial. The relatively low standard deviation (SD = 0.26) suggests that their responses were closely clustered, meaning there was strong consensus among them about these benefits. However, the higher standard deviation (SD = 0.83) (0.83) means their opinions were more varied, suggesting that while some found implementation manageable, others faced more difficulty.

Influence of Teaching Experience

Finally, table 4 explores how teaching experience correlates with perceptions of IBPA. As experience increases, challenge ratings consistently decrease, reaching the lowest point among teachers with 11-15 years of experience (M = 2.52). This suggests that educators in

this range may have reached an optimal stage of professional confidence, pedagogical skill, and adaptability to implement IBPA effectively with fewer perceived barriers. However, perceptions of challenges show a more distinct down trend as teaching experience increases. Teachers with less than 5 years of experience reported the highest challenge level (M = 3.17), indicating that novice educators may feel less prepared or more overwhelmed by the demands of implementing inquiry-based strategies.The moderate variability in responses across experience levels further highlights diverse perceptions influenced by both personal and professional factors.

Thus, the results highlight that while demographic factors, such as department, sex, qualification, and teaching experience do influence teachers' perceptions of IBPA, and the overall trends indicate a general agreement regarding its benefits. However, challenges associated with IBPA tend to vary slightly across different groups, with certain demographics, such as those with more teaching experience etc… These insights can help inform strategies for the broader adoption of IBPA, particularly in addressing the specific challenges faced by different groups of educators. Furthermore, the analysis reveals that qualifications, teaching experience, and to a lesser extent, ssubject specialisation influence perceptions of IBPA.

Teachers with foundational and higher qualifications (Diploma and BSc +PGDT) and younger-career experience demonstrate relatively positive attitudes, underscoring the importance of advanced education and balanced professional growth. Nevertheless, the consistently low aggregate means across all demographic groups, relative to the grand

mean, emphasize systemic issues, such as resource constraints, lack of targeted training, and institutional support.

To address these challenges, comprehensive training programs should be prioritised. Professional development initiatives can deepen teachers' understanding of inquiry-based practical activities in general science teaching-learning, enhance practical implementation skills, and foster positive attitudes toward change. Tailored interventions, such as mentorship for less experienced teachers and targeted workshops for veteran educators, can address specific needs and barriers. Additionally, providing subject-specific resources and fostering collaborative learning communities can further support the effective adoption of inquiry-based methodologies. By investing in such strategies, educational organizations can improve teachers' perceptions and implementation of IBPA, ultimately enhancing students' engagement and learning outcomes in science education.

During the interview, twenty science department head teachers were interviewed to respond for five unstructured questions to secure information about the concepts, extent, and awareness of students, hindrance factors, preference and views of teachers on the significance of inquiry-based practical activities. Teachers were asked about the implementation of inquiry-based practical activities in the science curriculum in their schools, and they forwarded various means of implementing it.

They said as they use microscopes and local materials (chart, diagram, and pictures), lecturing methods, writing notes, present how the laboratory activities done, and question and answering as a means of practicing inquiry-based techniques in science. Evidently, these are methods of delivering science lessons, but all of they are one way or teacher directed and teachers did not mention most of the approaches used to implement practical activities in science classes. This can indicate that teachers are more concerned about theoretical knowledge

and skills than their practical faces. Similarly, in the interview, science department head teachers indicated that they give notes and students coping the same from the blackboard; teachers give notes, and students receive the information-theoretically.

Teachers were also asked to mention the method they prefer and significance of the methods to deliver the science curriculum, and they mentioned a few commonly used theoretical methods to teach science. They stated that giving explanations of the subject related to the environment, lecturing, and question and answering are the methods they prefer to teach science classes in their schools. In addition, teachers admitted that, despite recognizing the importance of inquiry-based practical activities, they had not implemented them into their lessons.

One interviewee, T3, stated,

> *Practical activities are significant because students can get the opportunity to imitate theoretical concepts in a laboratory setting with practical opportunity. Conversely, this remains a hypothetical or ideal rather than a tangible reality in our school due to the lack of suitable resources in the laboratory including teacher's skill to create and facilitate the strategies.*

Teachers were also asked to describe what they consider the simplest method for teaching science subjects. The majority indicated that using internet-based resources such as videos and downloadable materials offers an easy approach, as these tools are straightforward and require

minimal additional effort. Similarly, science teachers were asked to list down some of their strategies to implement practical activities.

Among T12 said that,

> *I provide the students with homework, classwork, group assignment, note provision, and prepare observation on technological materials from the internet in laboratory. This helps to the students by visualizing the materials they imagine how to implement practical activities for their future.*

This reflected that the practical activities are conducted in laboratory rooms through demonstrating only from the teacher side. Because most of the strategies the teachers mentioned are taken from the traditional teaching approach, so they are not the strategies of practical activities such as field visits, reflection, model preparation, demonstration, project works, discussion, sharing of experiences, laboratory practices, and peer teaching, etc. Likewise, science department head teachers were asked about their support to their teachers under their supervision relating to practicing practical activities in their department. In the words of T17,

> *As a department head and coordinator of the teachers in my department I tried to support teachers during the preparation of annual, monthly and weekly plans by observing the plans and correcting the procedures that need improvement. In addition to this, I retain my signature by observing the plan every week; I help my teachers by monitoring whether the content given in the year is going according to the plan and monitoring the exam process.*

Additionally, teachers were asked about their preferred methods for delivering the science curriculum. Common responses included theoretical teaching through notes, homework, group projects, PowerPoint presentations, and demonstrations of materials. One

teacher, referred to as T5, expressed a preference for traditional lecture methods, stating,

> *I always opt for the lecture method since it allows me to hold my students' attention and complete the course content efficiently. It's a challenge for me to teach through practical activities as most students seem disinterested in this technique, with only limited interest to engage in practical tasks.*

This preference suggests a concerning trend: teachers may be opting for less labory-based methods by providing students with pre-made lessons, potentially compromising the quality of education. Similarly, T2, T9, and T15 also mentioned commonly lack of teachers' commitment, lack of appropriate coordination from the school principals, facilities, professional training for teachers, and lack of interest from the students' side are the problems hindering the effective implementation of practical activities. Inline to this, science department head teachers were asked about the inspiration of students to use a practice-focused or participatory teaching method, they answered as the method is self is the source of disturbance. For example, T20 stated,

> *Most of the students found it to be an obstacle to using a participatory teaching method. This means that the students start disturbance and shouting even did not hear what they say to each other. Student's aspiration to learn through practice-focused or discussion is low. When I start to use such kind of method most of the students tried to get into shouting. During this school principals counted as the poor performance or low classroom management of the teacher. So I use the lecture method with full eye contact of the students.*

The participants reflect that teacher's common perception that students are less motivated to learn via practical tasks. However, the capacity for teachers to practice these techniques and motivate students to participate actively in their learning is crucial to ensure quality science education both inside and outside the classroom. Contrasting these practices, a study by Dagnew & Sitotaw (2019) at Diaspora Secondary School in Bahirdar, Ethiopia, found a positive correlation between the use of inquiry-based practical activities and student attitudes and achievements in Biology. This disparity highlights disconnect between teacher perceptions and the proven benefits of inquiry-based learning in fostering student engagement and achievement. This suggests a gap between recommended educational strategies and the methods preferred by some teachers.

The analysis of teacher feedback on the challenges of employing inquiry-based practical activities (IBPA) highlights comprehension differences in implementing practice-focused instruction. While teachers recognize the value and benefits of these activities, many continue to prefer teacher-oriented methods due to their simpler implementation. This trend aligns with research conducted by Shitaw, (2017) in Primary Schools of North Shewa Zone in Amhara Region and Brhane et al., (2025), in middle-level schools in Addis Ababa, Ethiopia. These studies suggest that while teachers hypothetically appreciate practical learning, they struggle to fruitfully incorporate it into real teaching-learning settings. Despite thoughtful the importance of inquiry-based instruction, teachers often neglect practical strategies from their lesson plans and practical approaches.

This preference shows a general neglect of active learning strategies, with general science teachers preferring traditional methods. This kind of trend points to a prominent lack in the exposure to and implementation of IBPA strategies among teachers in the target schools. Supporting these findings, a study by Tesfaye et al. (2010) revealed a lack of practical activities in science classes in Addis Ababa's elementary

schools. The study suggested for extensive interventions targeting student and teacher skills, school management, resources, curriculum, teaching strategies, and evaluation to promote a scientifically educated citizens. Furthermore, Barron and Hammond (2008) identified a significant gap in the use of inquiry-based learning, often perceived by teachers as unstructured and lacking essential support mechanisms like scaffolding and assessment. Addressing these gaps through constant professional development trainings and workshops is vital to enable teachers to better incorporate IBPA into their teaching, thereby improving student outlooks and performance in science teaching.

Conclusions and Implications

Conclusions

This study explored the perceptions of general science teachers in middle schools in Addis Ababa, Ethiopia, concerning inquiry-based practical activities (IBPA). The results showed that whereas teachers recognize the worth of inquiry-based practical activities in improving student learning, engagement, and problem-solving abilities, their actual integration of such activities into lessons is limited. Additionally, a key execution gap in the integration of inquiry-based practical activities in science instruction is underlined by general science teachers in the interview data. Science teachers' reliance on lecture-based or teacher dominated approaches reveals systemic and attitudinal impediments to inquiry-based active learning, even though they conceptually respect IBPAs and recognize its pedagogical potential.

The theoretical recognition and practical negligence points to deeper challenges rooted in teacher preparedness, institutional support, student engagement, and resource availability. The results highlight the urgent need for comprehensive, practice-oriented professional development, focused not only on promoting the value of IBPA but also on building teachers' capacity to implement it meaningfully. Furthermore, school leadership must move beyond administrative oversight toward pedagogical support, while fostering a school culture that inspires innovation, reflection, and experimentation in science teaching. If these hindrances are not resolved, science instruction opportunities will continue theoretical and learners will be denied the practical, inquiry-based practical experiences necessary for 21st century scientific literacy and problem-solving. Furthermore, there is an opportunity to improve the provision of science by offering policy and curricular support through the creation of supplementary policies and guidelines, adequate infrastructure, resources, and encouragement of teacher cooperation and preparation.

Implications

The study highlights several policy and practical recommendations for enhancing the effectiveness of science education.

First, it underscores the urgent need for ongoing professional development so teachers gain both pedagogical competence and confidence in practicing IBPAs, especially making effective use of local resources and indigenous environmental experiences in general science education. Second, it requires schools to provide adequate resources such as, physical materials, educational supplies, and updated curriculum guides to support the practical science education. Third, curriculum and policy reform is crucial, integrating inquiry-based learning in to the national standards and giving teachers strong, sustained support to teach general science. Fourth, there must be a move to more participatory classroom cultures, encouraging active, experiential

learning through leadership, community involvement, and sharing effective approaches. Finally, the results argument to the significance of continual research and appraisal to pathway the continuing effects of inquiry-based practice on students' learning, and to refine teacher professional training and curriculum development accordingly.

Therefore, stakeholders in Addis Ababa and similar educational settings are expected to improve the effectiveness of general science education and prepare students to meet the challenges of the modern world with improved critical thinking and problem-solving skills.

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