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Original Article

Perception and performance of secondary school science teachers' inquiry-based methods of teaching in Hawassa University Technology Transfer Villages

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Abstract

The study investigated perception and performance of secondary school science teachers' inquiry-based methods of teaching in Hawassa University technology villages. The researchers employed mixed method with quantitative driven embedded mixed (QUAN+quan) design. The primary sources of data were principals, department heads, and teachers. The researchers selected participants using availability, purposive, and stratified sampling techniques. The researchers' collected data using questionnaires, interview, and observation from data sources. The researchers analyzed quantitative data by using frequency, percentages, mean, independent sample t-test and one-way-ANOVA using SPSS-26. The data obtained through interviews and observations was qualitatively narrated under their main themes using NVivo-14 software. The findings of the study revealed that science teachers positively perceived inquiry-based teaching methods regardless of their implementation. Despite of respondents' positive perception, the practices of inquiry-based teaching methods in science were limited, and that there were no statistically significant differences of means of respondents. The major challenges those impeded teachers from implementing inquiry-based teaching methods were lack of instructional materials, absence of laboratory equipment, chemicals, manuals and lab-technicians, large class size, lack of creativity and innovation among teachers and lack of teachers' competences. Therefore, the study recommended that school of teacher education, district educational offices and schools should enhance teachers' performance via devising necessary professional and pedagogical training.

1 Introduction

Inquiry in science education has a long and complex history; the term "inquiry" is grounded in the ideas of key educators such as Dewey (1996) and Bruner (1960). John Dewey has rooted inquiry in experience and described the pattern of inquiry, which is located in human culture, language, and everyday experience. According to Dewey, learning experiences should be collaborative and placed in the context of the reconstruction of knowledge. Moreover, Girma (2022) suggested that teacher's professional and pedagogical competencies play paramount importance in implementation of various active

learning strategies (cooperative learning, differentiated instruction and micro-teaching) in classrooms.

Recently, there has been a pedagogical shift in contemporary curriculum theory aimed at encouraging teachers to incorporate scientific inquiry into their practice as a means to enhance learners' interest in science (Dillon, 2009; Gudyanga and Jita, 2019). The inquiry-oriented approach emanated from the appreciation of the fact that learners' interest in science subjects develops through a process that allows them to obtain scientific knowledge by investigating phenomena rather than listening to the teacher and summarizing main ideas. Keller et al. (2016) stated that inquiry-based teaching is a major determinant and predictor of learner motivation and teachers' self-efficacy. Besides, Chen et al. (2018) stated that inquiry-based teaching is a relatively new and innovative practice that requires learners to carry out scientific investigations instead of cramming facts from a textbook.

In supporting the above ideas, the National Research Council (2000) described that when students are involved in inquiry, they go through the five steps that constitute the essential features of inquiry. Firstly, learners are engaged by scientifically-oriented questions. In the best of cases, these questions should come from the students, even though often they are provided by the teacher. Secondly, learners give priority to evidence, allowing them to develop and evaluate explanations that address these scientifically oriented questions. Here, the teacher does not simply provide recipe-like instructions for each experiment; rather, learners plan and decide how experiments are to be conducted. Thirdly, learners formulate an explanation based on evidence to address scientifically oriented questions. This explanation should refer to the initial question they were trying to answer. Fourthly, once students have made the explanation based on the data they collected, they evaluate it and consider whether it fits into the evidence they already have. Lastly, learners communicate and justify their proposed explanation. Each of these features of inquiry hen applied in a classroom, it varies both in terms of the amount of learner self-direction on the one hand and the amount of the teachers or material's direct involvement on the other hand. Through this process, science teachers create an enabling learning environment. Moreover, Zoller (2011) discussed that science learning should require the development of students' ability to be engaged in higher-order cognitive skills based on forms of inquiry such as question-asking, critical thinking, evaluative system thinking, decision-making, and problem-solving capabilities in dealing with characteristically interdisciplinary everyday life. An important element in this higher-order cognitive skills model presented by Zoller (2011) is the transfer capability, which is the capability of transferring different learning situations into real-life problem-solving contexts. Therefore, inquiry-based education proves vital, especially with respect to achieving complex and comprehensive "higher-order" objectives such as understanding science principles, comprehending scientific inquiry, and applying scientific knowledge to personal and societal issues (Anderson, 2002). Hence, inquiry pedagogies emphasize, among others, the teacher's role: a shift from "dispenser of knowledge" to facilitator or coach for supporting students' learning. Because of this, the role of the teacher switches from being the authority to becoming a guide who challenges students to think beyond their current processes by offering guided questions and preparing wisely planned scaffolds (Anderson, 2002; Windschitl, 2002).

Inquiry-based teaching improves the quality of teaching and learning in the natural sciences. At the same time, it encourages the teachers to undertake inquiry-based learning in a systematic manner to improve natural sciences teaching in classrooms. From this point of view, inquiry-based teaching could be considered one of the most important methods for teaching the natural sciences because it focuses on real teaching and learning processes and encourages students to construct their own knowledge. Pedagogical mentoring and coaching practices to novice and veteran teachers was limited to ensure instructional practices and students' learning engagement in classrooms via plan-do-study-act-evaluation paths to ensure their competencies (Girma, 2023). This encourages

the teacher to play significant roles in linking the learner and process of learning. The teacher not only plans the inquiry but also plans how this inquiry can end in a meaningful experience that can be used in the future. Implementing is not always the best way to learn. The important thing to consider is what makes the students gain conceptual development.

Teachers' capabilities in organizing and facilitating inquiry-oriented teaching and learning processes are essential. The paradigm shift from lecture method to active learning methods is essential to make students take the position of constructivists through developing positive interdependence, self-confidence, communication and information processing skills and critical thinking because of higher order thinking and learning practices (Girma, 2022). This professional and pedagogical capability cover issues such as self-efficacy, motivation, and enthusiasm for teaching (Tschannen-Moran and Woolfolk Hoy, 2001). In relation to this, Shalem and Peddlebury (2010) depict that teachers are at the core of curriculum implementation, and their perceptions about inquiry-based teaching methods can provide pedagogical insights that can enhance learner motivation in sciences.

Teachers' perception about inquiry is a problem that relates to curriculum delivery, and its investigation can improve the quality of learning and hopefully stimulate learner interest in science. The rationale behind conducting the present study was to investigate the perception and performance of secondary education natural science teachers and their performance of inquiry-based teaching methods in secondary schools at Hawassa University Technology Village.

2 Research Problem

The 21st century classroom requires the 21st century teachers and students, and in that both teachers and students are equally important to implement the curriculum in Ethiopian classrooms (Girma, 2022). Now days, it is evident that inquiry-based teaching methods improve the quality of teaching and learning in the natural sciences. It is on this ground that teachers, particularly secondary school natural science teachers, need to have positive perceptions and be encouraged to apply inquiry-based teaching in secondary schools.

Regarding this, secondary school teachers' lack experiences using inquiry-based teaching methods (Ramnarain and Hlatshwayo, 2018). Likewise, a study conducted in Rwanda by Mugabo (2015) revealed that science teachers did not understand what inquiry-based science teaching methods meant and tended to associate inquiry-based teaching methods with teacher-dominated demonstrations, even though inquiry-based teaching methods are the official curriculum policy in that country. Teaching sciences, such as well-equipped laboratories, was perceived as a challenge that discouraged sciences subjects, particularly biology, chemistry, and physics. For instance, a study in South Africa by Ramnarain (2015) indicates that teachers' lack of pedagogical content knowledge and general pedagogical knowledge greatly contributed to their inability to teach through inquiry. This implies that some teachers had difficulties teaching science subjects in a practical way and, in so doing, de-motivated learners. Other studies revealed that the problem of the lack of resources

In the Ethiopian context, there are some studies conducted in different areas of the country concerning the advantages of the inquiry-based teaching method. For instance, the findings of a study conducted by Asrat and Mekonnen (2020) on the effect of using the guided inquiry teaching method in improving grade eight students' concept of photosynthesis in primary school in Ethiopia revealed that the guided inquiry teaching method

is more effective than the lecture method in improving students' conceptual understanding of photosynthesis. Also, the findings of the study conducted by Adugna (2017) depict that the teachers working in the target schools are aware of the importance of practical-based learning that promotes the acquisition of long-lasting knowledge and skills at the preparatory school level. However, the aforementioned researchers focused on the importance of the inquiry-based teaching method, and their investigation overlooked the teachers' perceptions and their performance regarding the inquiry-based teaching methods. Hence, this study differs from the others in that it focuses on investigating teachers' perceptions and performance concerning inquiry-based teaching methods in secondary school.

In addition, from the researchers teaching experiences and their observations, a number of gaps exist between theories and practices in relation to performing inquiry-based teaching methods in the natural sciences. Therefore, the researchers were motivated and inspired to examine science teachers' perception and performance of inquiry-based teaching methods in the secondary school of Hawassa University Technology Transfer Villages.

The study was aimed at investigating science teachers' perception and performance of inquiry-based teaching methods in secondary schools in Hawassa University technology transfer villages. The study helps to:

1. Examine science teachers' perception and utilization inquiry-based teaching methods in their instruction.
2. Evaluate the extent to which the science teachers are performing inquiry-based teaching methods.
3. Test statistically significance of differences across sciences teachers' performance of inquiry-based teaching methods.
4. To identify major challenges hinder teachers in their attempt to integrate inquiry-based teaching methods in science instruction.
5. Evaluate the professional and technical collaboration between school of teacher education in HU and secondary school science teachers to improve their competencies of practicing IBT methods.

2.1 Research questions

In line with the objective of the study, the following research questions were raised and answered. These are:

1. How do science teachers perceive and practice the use of inquiry-based teaching methods in the science instruction?
2. To what extents are teachers using inquiry-based teaching methods in their science teaching/learning?
3. Does the use of inquiry-based teaching methods shows a statistically significant differences between: (a) male and female teachers; and (b) among teachers of various disciplines?
4. What are the major challenges facing science teachers in their attempt to integrate inquiry-based teaching methods?
5. How well do secondary schools science teachers work in collaboration with college of teacher education to improve their pedagogical competencies of using IBT method?

2.2 Significance

The study helps secondary school natural science teachers to undertake self-assessments regarding their perception and performance of inquiry-based teaching in natural science classes. Therefore, the researchers' serves as a framework for curriculum designers and planners who might want to conduct further study on natural science teachers' perceptions and inquiry-based teaching of natural sciences in secondary schools.

3 Research Methodology

3.1 Research Design

In order to meet the main purpose of the study, a mixed method with embedded mixed (QUQN+qual) design were employed. An embedded mixed design was utilized to examine the current perception and practices of respondents on the issue under investigation in which the researchers collect data at one point in time (Creswell, 2014).

3.2 Sources of data

This study is limited to the investigation of science teachers' perception and the performance of inquiry-based teaching methods aligned to natural science education in secondary schools, and the researchers limited this study to five words. From Dore Bafeno (Hawassa Langano High School), Yirgalem town (Yirgalem High School), Boricha (Yorba High School), Wondo Genet (Wondo Genet Secondary School), and Habela Lida (Habela High School) of Hawassa University Technology Transfer Villages. Therefore, the primary sources of data were secondary school principals, heads of departments of natural sciences, and natural science teachers from sampled government secondary schools in the study area.

3.3 Sample and sampling technique

There are 7 administrative town woredas and 30 woredas in Sidama Regional State. Since the size of the population is large, all the woredas and their respective secondary schools were not included in the study. Only five Woredas, which are found in Hawassa University Technology Villages, were selected using the availability sampling technique. The target secondary schools were selected using purposive sampling technique, that one school from each woreda to obtain adequate information about the technology villages. The sample size of participants was determined based on Cohen et al. (2018) sample size, confidence level, and confidence interval for the random sample table; 135 teachers (at 95% confidence level) out of the total population of 204 teachers from five secondary schools using stratified sampling technique followed by simple random sampling technique to select from each stratum.

In addition, while undertaking interview, 5 school principals and 5 head department heads of natural sciences were selected from sample secondary schools (one from each) using availability and purposive sampling techniques respectively. Overall, 145 participants; 135 respondents for a questionnaire and 10 informants for an interview were included in this study for triangulation and enrichment of data (Cohen et al., 2018). The distribution of population, sample size and sampling techniques is illustrated in Table 1 below:

Table 1: Total Population, sample size, and sampling techniques

Study subjects	Department Head		Natural Science Teachers		Principals	
	Sample	%	Population	Sample	%	Population
Hawassa Langano	3	1	33	38	25	66
Yirgalem	3	1	33	65	43	66
Yorba	3	1	33	28	18	64
Wondo Genet	3	1	33	42	28	66
Habela	3	1	33	31	21	67
Total	**15**	**5**	**204**	**135**	**55**	

3.4 Data collection instruments

Using multiple data collection instruments (Creswell and David, 2018), relevant data for the study was collected from the study subjects in the study area. Evidence helps provide answers to the research questions or hypotheses (Creswell, 2014). To this end, to answer the research questions, both quantitative and qualitative data were collected using a questionnaire, an interview, and observation.

For the questionnaire, questions that are related to science teachers' perception of the use of inquiry-based teaching methods, extent of science teachers' performance of inquiry-based teaching methods, and major challenges that science teachers are facing when integrating inquiry-based teaching methods were developed by the researchers from an extensive review of various literature and previous studies. The types of questions included were more closed-ended items and some open-ended questions. Accordingly, the format for items is based on a Likert scale. The Likert scale for teachers perceptions of the use of inquiry-based teaching methods is valued as strongly agree (5), agree (4), undecided (3), disagree (2), and strongly disagree (1); for teachers performance on the inquiry-based teaching methods, it is valued as always (5), usually (4), sometimes (3), rarely (2), and never (1). Likewise, the challenges facing teachers range from 1 (the least challenging), 2 (more challenging), and 3 (most challenging). The questionnaire was structured into two main parts.

Concerning the interview guide, a semi-structured interview guide was used to obtain in-depth and detailed information from the participants (Yin, 2018). The interview was held with school principals and natural science department heads. The major themes of the interview guide natural science teachers' perceptions and the performance of inquiry-based teaching methods in natural science education. The interview was conducted in Amharic to make it easy for interviewees to understand, and then the data was transcribed into English.

Moreover, each sampled secondary school's laboratories (Biology, Chemistry, and Physics) were critically observed. The observation was conducted in each sampled school's laboratories by preparing the details of the observation checklist that enable researchers to describe whether the labs were functional and the availability of chemicals for science instruction through IBT methods.

3.5 Procedure of data collection

Regarding the data collection procedure, before collecting the data, the researchers explain the purpose of the research to the school principals. After permission is secured, the researchers and the principal of the selected secondary schools arrange the time and place to get the participants. Participants were informed about the objective of the study

and asked to participate as scheduled. In the first phase, quantitative data gathering was conducted. Accordingly, the required data was collected through the prepared questionnaire to obtain the necessary information. While quantitative data was collected, qualitative data was gathered to triangulate findings from quantitative data sources, which were conducted through semistructured interviews and observation (Cohen et al., 2018). Therefore, the required data was collected step by step through prepared semistructured interview guides and observation checklists. As the interview guide is semistructured, other important questions were generated during the interview, and leading questions were introduced ahead. Observations were made according to the checklists prepared.

3.6 Validity and reliability

After preparing instruments for data collection, validation of the instruments was done using expert review on contents, face, and formats. Here, some irrelevant items were discarded, and some of the items were modified as per the comments given by experts. Then, the issue of reliability was addressed by pilot testing of the instruments on 30 teachers in a non-sample secondary school, which was not part of the main study. To meet this, the researchers calculated Cronbach's alpha coefficient (α) to measure the internal consistency of questionnaires since it is applicable to test a coefficient of inter-item correlation of Likert scale items. Accordingly, the results of the study found out that $\alpha_1 = .78$ for the scale to measure teachers perception of the use of inquiry-based teaching methods, $\alpha_2 = .80$ for the prepared scale to measure teachers performance of inquiry-based teaching methods, and $\alpha_3 = .76$ for the prepared scale to measure challenges to implementing inquiry-based teaching methods. Finally, with the average value of alpha coefficient (α) 78 found above the expected measure to be possibly utilized, as Muijs (2004) evidenced, a coefficient of $\alpha.70$ and above is internally consistent (acceptable) for the purpose of the study.

3.7 Method of data analyses

Based on the nature of the data gathered, both quantitative and qualitative methods of data analysis were applied using SPSS-26 and NVivo-14 software respectively. Quantitative data gathered using a questionnaire was analyzed using both descriptive and inferential statistics using software. Descriptive statistics such as frequencies, percentages, means, and standard deviations were computed. Besides, inferential statistics from an independent sample T-test were made to compare the means of two groups of male and female teachers on their performances in inquiry-based teaching methods. Similarly, to examine whether there is (a) a significant difference among teachers of various disciplines as well as (b) a difference among teachers of various disciplines on the extent of their performance of inquiry-based teaching methods, a one-way ANOVA was computed. With regard to qualitative data that was gathered using interview and open-ended questions and observation checklist content analysis in narration form under their main themes, Interview and observation data were mainly used for triangulation, with quantitative data gathered using questionnaires, which helps confirm its reliability.

3.8 Ethical practices

Ethical approval for this study was obtained from College of Education to avoid the research misconduct because harm is narrated in the context of institutional characteristics, policies, procedures, guidelines and work environment (Petousi and Sifaki, 2020). Before distributing the instruments to the participants for data collection, permission was sought from education administration offices and secondary school participants

4 Results and discussion

In this part, the researchers report the general characteristics of the respondents and the major findings of the study based on the evidences. Data collected using different instruments from multiple sources was presented according to the main research questions of the study. Questionnaire was employed for teachers. From the total of 135 questionnaires administered to teachers, 132 were properly filled out and returned, providing a 97.7% response rate. For triangulation, an interview was made with total of 10 principals and science department heads. In addition, observation was held in the school laboratory.

4.1 General characteristics of respondents

Table 2: Participants number by school, sex, and educational background

Variables	Category	F	%
School	Hawassa Langano	24	18.2
	Yirgalem	39	29.5
	Yirba	16	12.1
	Wondo Genet	33	25
	Habela Lida	20	15.2
	Total	132	
Sex	Male	79	59.8
	Female	53	40.2
	Total	132	
Academic qualification	College Diploma	11	8.3
	Bachelor's Degree	112	84.8
	Master's Degree	9	6.8
	Total	132	

As it is shown in Table 2, of the 132 teachers who participated in the study, the highest were Yirgalem and Mondo Genet 39 (29.5%) respectively, and the lowest was Yirba 16 (12.1%). Regarding the sex composition, the proportion of male teachers outnumbered female teachers: 79 (59.8%) males and 53 (40.2%) females. The data shows that there were a low proportion of female teachers in selected secondary schools, which contrasts with the Education Sector Development Program IV (Ministry of Education, 2010).

Concerning the academic qualifications, 112 (84.8%) were Bachelor's Degree holders, 11 (8.3%) were College Diploma holders, and the remaining 9 (6.8%) were Master's Degree holders. As per MoE policy, teachers of secondary schools are expected to have at least a first degree to teach in Ethiopian secondary schools (Ministry of Civil Service, 2011). Thus, having qualified with the first degree of the majority of the participants in the level of education contributes to corresponding resemblances in positive perceptions and the performance of inquiry-based teaching methods in teaching natural science subjects.

Table 3: Participants services in year and subject teach

Variable	Category	F	%
Services in Year	1-5	28	21.2
	6-10	60	45.5
	11-15	35	26.5
	16-20	7	5.3
	21 & above	2	1.5
Subject teach	Biology	31	23.5
	Mathematics	33	25
	Chemistry	29	22
	Sport	14	10.6
	Physics	25	18.9

Table 3 illustrates that based on their experiences in teaching; teachers have been grouped into five. Thus, 28 (21.2%) have below five years of teaching experience, 60 (45.5%) have between 6 and 10 years, 35 (26.5%) have between 11 and 15, 7 (5.3%) have between 16 and 20, and the remaining 2 (1.5%) have greater than 20 years of teaching experience. This can show that a considerable number of teachers have teaching experiences that would help them implement inquiry-based teaching methods. Moreover, of the participating teachers, 33 (25%) were in mathematics, followed by 31 (23.5%), 29 (22%), 25 (18.9%), and 14 (10.6%) in biology, chemistry, physics, and sport, respectively.

4.2 Science teachers' perception of the use of IBT methods

Teachers' perception and views on the use of inquiry-based teaching methods have had a profound effect on their performances when using these methods in teaching natural science teachers to describe their perception using a subjects. Accordingly, items related to Likert scale ranging from 1 (strongly disagree) assumptions about inquiry-based teaching to 5 (strongly agree). methods and their advantages were presented for

Table 4: Frequency and Means of Teachers' Perception of Inquiry-Based Teaching Methods ($n = 132$)

No.	Items of Teachers' Perceptions of IBTM	Mean	SD
1	Inquiry-based methods help learners develop experimental skills.	4.32	0.68
2	Feel confident when students perform practical work collaboratively.	4.33	0.72
3	Prefer learners to design their own inquiries.	3.55	0.85
4	IBTM encourages active participation of students.	4.17	0.73
5	IBTM encourages creativity and innovative ideas of students.	4.08	0.76
6	IBTM imparts problem-solving skills and higher-order thinking.	4.18	0.78
7	Inquiry activities facilitate group work in natural science.	3.80	0.90
8	IBTM is a learner-centered strategy where learners construct knowledge.	3.86	0.84
9	Students learn best when given opportunities to explore problems.	3.92	0.83
10	IBTM enhances conceptualization and contextualization of science content.	3.58	0.79
11	Secondary schools are motivated to collaborate with HU School of Teacher Education.	3.29	0.57
	Grand Mean	**3.97**	–

Note. Scale: < 1.49 Strongly Disagree; 1.50–2.49 Disagree; 2.50–3.49 Undecided; 3.50–4.49 Agree; > 4.50 Strongly Agree.

Source: Field survey, 2023

1.5-2.49 Disagree, 2.5-3.49 Undecided, 3.5-4.49 Agree, > 4.5 strongly Agree

As shown in Table **??**, the mean scores of teachers' responses for items 1 and 2 were (M = 4.32, SD = .68 and (M = 4.33, SD = .72) respectively. They agreed that IBT methods help learners develop experimental skills and feel confident when they perform practical work collaboratively in natural science subjects.

Besides, the mean score of the respondents for item number 3 was (M = 3.55, SD = .85), which shows that the respondents agreed that they prefer learners to design their own inquiries. Likewise, the participants mean scores for items 4 and 5 were (M = 4.17, SD = .73) and (M = 4.08, SD.76), respectively. This infers that the participants agreed that the use of IBT methods encourages active participation, creativity, and innovative ideas among students in natural science subject learning.

Moreover, the participants mean scores for items 6, 7 and 8 were (M = 4.18, SD = .78), (M = 3.80, SD = .90) and (M = 3.86, SD = .84) respectively. This revealed that the participants agreed that the use of IBT methods imparts problem-solving skills in learners and higher-order thinking in natural science subjects, facilitates students working in groups, and makes students construct knowledge under the guidance of teachers.

Furthermore, the participants mean scores for items 9 and 10 were found to be (M = 3.92, SD = .83) and (M = 3.53, SD = .79) respectively. This indicates that the teachers agreed on the perception that IBT methods make students learn best when they get opportunities to explore problems and enhance their conceptualization of contents in science.

As it could be understood from the above computed mean values, the grand mean (GM = 3.79) shows that teachers have a positive perception of the use of IBT methods in teaching natural science subjects. Across all items, teachers have a similar level of agreement on their perception of IBT methods. The interview results also align with the survey response, reporting that teachers have positive perceptions of the use of IBT methods in teaching natural science subjects. For instance, one of the mathematics department heads replied that:

"I believe that inquiry-based teaching methods facilitate teachers' ability to impart problem-solving skills to learners through higher-order thinking activities, which contribute to students' deep understanding of concepts in science subjects. Our teachers developed positive attitudes towards using IBT methods in the teaching and learning of natural science subjects" (DH2, April 2023).

Furthermore, one of the interviewee suggested that

"The secondary schools are expected to work in collaboration with school of teacher education pertaining to active learning, continuous assessment, classroom management, and action researches. However, as technology transfer village school, my school is not supported both technologically, professionally and technically (DHL3, April 2023).

The results of this study is consistent with those obtained from previous studies (Ruzaman, 2020), which explained that teachers need to have a constructive perspective through the proper use of inquiry-based learning and that learners are expected to construct their knowledge under the guidance of the teacher.

4.3 Science teachers' performing of the use of IBT methods

Teachers' effective practices of IBT methods during the teaching and learning of natural sciences subjects are paramount in the 21st century, which allow teachers to collaborate

with students in their constructing knowledge, solving problems, and understanding the concepts of science. In view of this, to describe the extent to which natural science teachers perform IBT methods during their instruction, teachers were asked to provide their responses using a questionnaire designed on a Likert scale ranging from 1 (never) to 5 (always) perform.

Table 5: Frequency of Teachers' Performance in Integrating IBT Methods ($n = 132$)

No.	Items of Teachers' Performance of IBTM	Mean	SD
1	Prepare and show practical demonstrations for students.	2.62	0.69
2	Allow students to perform hands-on and minds-on practical activities.	2.95	0.80
3	Encourage student participation in discussion and argument.	2.84	0.81
4	Prompt students to propose solutions for practical problems.	2.99	0.80
5	Ensure students actively participate in inquiry-based learning.	2.28	0.75
6	Provide laboratory practices, projects, and assignments.	1.93	0.73
7	Follow safety precautions and test practical work prior to lessons.	2.78	0.80
8	Provide clear instructional guidelines for practical activities.	2.74	0.79
9	Direct learners to analyze and synthesize experimental data.	2.17	0.67
10	Facilitate learning through collaborative and independent problem-solving.	2.47	0.75
11	Collaborate with the School of Teacher Education to improve pedagogical skills.	2.39	0.68
	Grand Mean	**2.57**	–

Note. Scale: < 1.49 Never; 1.50–2.49 Rarely; 2.50–3.49 Sometimes; 3.50–4.49 Often; 4.50–5.00 Always.

Source: Field survey, 2023
Scale of Interpretation: Never $<$ 1.49, Rarely = 1.5-2.49, Sometimes = 2.5-3.49, Often = 3.5-4.49, Always = 4.5-5.0

As indicated in the above Table **??** for items 1 and 2, the mean scores of the teachers' responses were = 2.62, SD = .69 and M = 2.9, SD = .80) respectively. This is evident from the fact that they sometimes prepare and show practical demonstrations for students and allow them to perform hands-on and mind-on practical activities in science teaching. Likewise, the mean scores of teachers for items 3 and 4 were M = 2.84, SD = .81 and M = 2.99, SD = .80) respectively. This indicates science teachers sometimes encourage students' participation in discussion and argument in learning and make students propose solutions for practical problems.

Yet, as it is clearly indicated from items 5 and 6, the mean values of teachers responses were M = 2.28, SD = .75 and M = 1.93, SD = .73) respectively. This is evident from the fact that sciences teachers rarely make students actively participate in inquiry-based learning and provide students with laboratory practices, projects, and assignments to improve their learning potential.

Again, the mean scores for item 7 and 8 teachers responses were M = 2.78, SD = .80 and M = 2.74, SD = .79 respectively. This shows that teachers sometimes follow safety measures and try the practical work them when preparing for the lesson and give learners a guideline with clear instructions they follow while they are doing practical activities.

However, from items 9 and 10, the mean scores of the teachers' responses were = 2.17, SD = .67 and M = 2.47, SD = .75 respectively. This reveals that natural science teachers rarely make learners analyze and synthesize experimental data and make students learn by finding solutions to problems through working collaboratively and independently. Therefore, the aggregated grand mean value (GM = 2.57) of teachers' responses to performing IBT methods in the teaching and learning process of natural science falls in the range of "sometimes". Across most items, teachers reported a similar level of frequency.

However, the results of interviews with school principals and department heads differ from the survey responses from teachers, who informed us that teachers rarely integrate IBT methods in their teaching and learning of natural science. For example, one of the school principals reported that:

"In my school, teachers are unable to implement IBT methods in the teaching and learning of natural sciences because of different reasons. To mention some of them: large class size, lack of teachers' skill to integrate IBT methods, absence of lab and chemicals, etc." (SP2, April 2023).

In addition to this, one of the chemistry department heads added that:

"Frankly speaking, in our school, teachers hardly utilize IBT methods during instruction of natural science subjects. They simply use the tradition of teacher-centered teaching methods during teaching and learning of natural science subjects the same to other subjects' (DH3, April 2023).

The findings are in agreement with the findings of the previous study by Zafu and Wudu (2018), who described that the majority of teachers had awareness of IBTM; they believed that IBTM was useful for students learning but did not use it in their classroom instruction.

4.4 Comparison between male and female and teacher of various disciplines

In this section, comparisons between male and female teachers' and teachers teaching different subjects were examined on their performance of IBT methods.

4.4.1 Comparison between male and female teachers

The significance differences among secondary school teachers were checked using the independent variable sex, and the result given is illustrated in Table 6 below.

Table 6: Group Statistics on integration of IBT methods by sex

Dependent Variable	Sex	N	Mean	Std. Deviation	Std. Error of the mean
Teachers performing of IBT methods	Male	72	2.64	.336	.037
	Female	52	2.53	.313	.043

Source: ANOVA output

As presented in Table 6, the mean and standard deviations of the scores on the IBT method of the two groups revealed that the integration of IBT method score of male teachers is (M = 2.64) and the standard deviation is (SD = .336). In the same way, the integration of IBT methods score of female teachers is (M = 2.53), and the standard deviation is (SD = .313).

The results of Leven's test for equality of variance and the 95% confidence interval were computed, and the obtained result is presented in Table 7 below.

Table 7: Independent Sample T-test between male and female teachers

Sex	N	Mean	SD	Std. Error Mean	t	p-value
Male	79	2.64	0.336	0.037	1.831	0.069*
Female	53	2.53	0.313	0.043		

Note. Equal variances assumed ($F = 0.044, p = 0.835$). Mean difference = 0.10654, 95% CI $[-0.008, 0.221]$. *Difference is not statistically significant ($p > .05$).

Source: ANOVA output

* = there is no significant difference, p > .05

The Levene's test for equality of variances in Table 7 illustrated that the variances are not equal since the p value of .835 is not statistically significant. The implication is that the first row's equal variance assumed value was utilized. The difference between integration of IBT method scores for male teachers (M = 2.64, SD = .336) and for female teachers (M = 2.53, SD = .313) is .106. The 95% confidence level for this difference is .008-221. Since, this confidence interval include 106, there is no statistically significant difference at the two-tailed 5% level. This infers that female teachers are similar to their respective male teachers in their performance of IBT methods in secondary schools.

4.4.2 Comparison within teachers teaching different science subjects

To examine whether there are significant differences between teachers teaching different subjects on the implementation of IBT methods, a one-way ANOVA was computed, and the result is presented in the following Table 8 below:

Table 8: ANOVA Summary of differences on the integration of IBT methods among teachers

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig. (p)
Between Groups	0.857	4	0.214	2.021	0.095*
Within Groups	13.472	127	0.106		
Total	**14.329**	**131**			

Note. *Not statistically significant at $p > .05$.

Source: ANOVA output * = there is no significant difference, p > .05

As illustrated in Table 8, the probability of the F-ratio is .095. Since this value is greater than the critical p value of .05, There was no a statistically significant difference. Because the mean scores of teachers teaching different subjects using IBT methods are similar. This infers that there is no statistically significant difference among teachers of different subjects on the practice of IBT methods in their instruction of sciences.

4.5 Major challenges those hinder teachers to integrate iBT methods

In the course of teaching and learning natural science subjects, there are challenges raised by teachers, school principals, and other educational experts that impede teachers from integrating IBT methods into natural science instruction. Teachers questionnaires were presented using a three-level Likert scale ranging from 1 (least challenging) to 3 (most challenging). In addition, qualitative data were gathered using open-ended questions for teachers, interviews with the principal as well as the department head, and observation of the secondary school lab. The results are presented in Table 9, ordered from most challenging to least challenging.

Table 9: Major challenges to teachers in the integration of IBT methods (n=132)

No.	Possible Challenges	Mean	SD
1	Lack of instructional materials	2.81	0.43
2	Absence of laboratory equipment, chemicals, and manuals	2.70	0.47
3	Large class size	2.66	0.55
4	Lack of creativity and innovation among teachers	2.62	0.53
5	Dominance of traditional lecture methods over IBTM	2.61	0.54
6	Lack of teachers' competencies in implementing IBTM	2.59	0.61
7	Lack of technical/professional support from school principals	2.10	0.64
8	Ineffective cooperation/interaction among teaching staff	1.69	0.68
9	Shortage of instructional time	1.37	0.51

Note. Scale: < 1.49 Least challenging; 1.50–2.49 Moderately challenging; 2.50–3.00 Most challenging.

Source: Field survey, 2023 Scale of Interpretation $<$ 1.49 Least challenging, = 1.5-2.49 Moderate challenging, and 2.5-3.0 Most challenging.

As shown in Table 9, the major barriers to teachers integrating IBT methods were lack of instructional materials, absence of laboratory equipment, chemicals, and manuals, large class size, lack of creativity and innovation among teachers, dominance of traditional lecture method over inquiry-based teaching methods, and lack of teachers' competence in implementing inquiry-based teaching methods.

Besides, using an open-ended question, teachers were asked to add if there were other major challenges to performing IBT methods. Most of the respondents pinpointed the lack of students' interest and motivation, the amount of content expected to be covered, and the lack of instructional resources.

Secondary school principals and department heads were interviewed about the major challenges that affect the integration of IBT methods in their schools. The results extracted from the interview transcripts were analyzed to substantiate the quantitative data gathered from teachers. Secondary school principals reported that a lack of instructional materials was one of the major challenges hindering teachers' practice of IBT methods. For example, one school principal reported that:

"Lack of instructional equipment, particularly for biology, chemistry, physics, and sports, is a challenge. The absence of laboratory chemicals and equipment affected teachers and students' ability to actually practice performance-based activities in their instruction of natural science subjects" (SP2, April 2023).

In addition to this, one of the physics department heads added that:

"Lack of laboratory equipment and skilled technicians, lack of instructional media and technologies, and limited school facilities are the big challenges for secondary school teachers to perform IBT methods and make students do practical activities in natural science subjects" (DH5, April 2023).

Besides this, the results of observation show that most of the school labs observed lack lab equipment's, trained technicians, and chemicals for science teaching and learning in relation to this Trautmann et al. (2010) indicate that teachers doubt their ability to engage in inquiry learning in classroom practices. Likewise, Ramnarain (2016) established that the absence of professional training and insufficient resources negatively affected proper implementation of IBL. This finding is in line with the findings of Girma (2023) which suggested that collegiality is essential in teachers' professional competency development because teachers make communication and interactions in small groups at the department level when supported with mentoring and coaching practices

5 Conclusions

Based on the findings of the study, the following conclusions were drawn in light of the basic research questions: The use of IBT methods is paramount in the teaching and learning of natural science subjects. Interestingly, inquiry-based learning seemed to be effective for the acquisition of practical skills and the development of higher-order thinking skills in students. The findings of the study revealed that natural science teachers have a positive perception of the use of IBT methods in the target secondary schools. These help teachers to be motivated to implement IBT methods. The findings of the study also show that natural science teachers rarely perform IBT methods in their instruction of natural science subjects; the results of the T-test and one-way ANOVA revealed that there is a statistically significant difference between teachers because of sex and teaching different subjects. From this, it is concluded that teachers' quality teaching and

learning could not be achieved without regular use of IBT methods in natural science subjects. Thus, it was concluded that in-service training would be given to teachers to equip them with the necessary skills for implementing IBT methods.

6 Recommendations

In line with the major findings obtained and conclusions reached, the following recommendations were forwarded for the betterment of IBT methods in secondary schools in Hawassa University technology transfer villages.

1. Secondary school science teachers should integrate IBT methods regularly to provide quality instruction for the students.
2. Secondary school science teachers should collaborate and share experiences on the practical integration of IBT methods into natural science instruction.
3. Hawassa University's College of Education should provide in-service training for teachers to enhance their use of IBT methods in natural science instruction.
4. Sidama Educational Bureau, Hawassa University school of teacher education, and support secondary schools in applying IBT methods by providing instructional materials like laboratory equipment and chemicals.
5. Principals and supervisors should work on teachers' capacity building practices of using inquiry based teaching methods in classrooms.
6. Policymakers, student textbook writers' secondary school administrators, and teachers themselves should advocate IBT methods that develop students' scientific reasoning, problem solving, and creative skills.

7 Limitations and further research

This study has not accomplished without limitations and the researchers tried to provide clear picture through making proper analysis of the different variables associated with implementation of IBT method in secondary school it requires further interventions through design based study lesson studies.

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Data Availability

Data can be made available on the behavior of the request

Declaration of interests' statement

The author declare no competing interests.

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