RESEARCH ARTICLE

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Inquiry-Based Teaching Produces Better Results Than Traditional Teaching Method, a Quasi-Experimental Design Study Using the Topic ‘‘Measurement of Heat and Temperature’’ in Basic 8

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ABSTRACT

The purpose of this study was to help determine the effectiveness of inquiry-based learning (IBL) over the traditional method. It was also to identify difficulties associated with the use of the inquiry-based learning method This was investigated using the two methods of teaching to teach the concept of measurement of temperature to Basic 8 students of K.O Methodist Junior High School ‘B’ in Kumasi, Ghana. The research design was quasi-experimental. Tests on the concept of heat and temperature (TCHT) were used to obtain responses from Sixty students who were sampled purposively from all students in Basic 8 and were divided into control and experimental groups. Five teachers were interviewed on the challenges of teaching science through the IBL approach. Data was collected under two stages: the pre-experimental, experimental, and post-experimental stages. It was recorded from the independent sample T test that, there was significant difference between the use of the inquiry-based method of teaching and learning and the traditional method of teaching in favour of the inquiry-based method at a confidence interval of 95%. Students who were taught using the inquiry-based method of teaching and learning performed better than those who were taught with the traditional approach. The research, however, concluded that due to factors such as lack of technical know-how, space on timetable etc. among others, teachers are unwilling to use the inquiry method. The study recommended among other things that teachers should adopt the improvisation technique if they want to use the IBL.

Keywords: heat, inquiry method, traditional method, temperature, measurement.

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I. Introduction

A. Background of the Study

The inquiry method is a teaching and learning strategy that is focused on the learner. This approach emphasizes knowledge about “how” rather than “about,” or how knowledge is acquired rather than knowledge itself. The goal of the inquiry approach is to pique people’s interest in a topic. With this approach, the student must challenge the veracity and accuracy of the information gleaned. Students must make sense of what they have studied in order to understand the significance of this approach. Beyer B.K. asserts that one approach to making sense of our experiences is through inquiry. Thinking is necessary, and students must derive meaning from their experiences Beyer (1971, p. 6). Beyer the inquiry method’s perspective is process-focused rather than content-focused. The emphasis is on concepts rather than facts. It is centered on the pupil, not the teacher. It is not passive; it is active. (Beyer, 1971, p. 159). The normal body temperature of a healthy person is 37-degrees Celsius, 98-degree Fahrenheit and 310-kelvin. It is significant to note that some processed food industries require a certain temperature to get the food processed. Thus, measuring body temperature will help us to know our bodies’ temperature as well as the temperatures of other things are equally forming the basis of our survival as human beings.

We are unable to determine an object’s temperature just by touching it since our sense of touch only allows us to determine whether an object is hot or cold, not its actual temperature. Instead, we must utilize a thermometer, a device that can measure an object’s temperature precisely. This skill involves a real practical experience that has to do with handling the thermometer and also manipulating it to take the temperature of the object under investigation.

It is clear that the inquiry approach places a strong focus on four key elements: student-centeredness, non-passive learning, process orientation rather than content. Reflective research and intriguing discoveries are also emphasized in the teaching and learning process using the inquiry approach. The emphasis in this approach is on students helping one another to learn the proper knowledge rather

than just accepting what the teacher offers. It's crucial that students participate in the inquiry method as active thinkers, searchers, inquisitors, and processors of knowledge they acquire around them. For pupils to make choices or find solutions relating to their guidance, this strategy is crucial. Students must apply their critical thinking abilities to identify pertinent facts while determining solutions to challenges. The process of reasoning is also a part of the inquiry method. Atan Long (1980) claims that this approach is a means of arriving at findings or arriving at conclusions based on several examples or comparable techniques discovered via observation and the gathering of information or data. It is possible to draw conclusions or develop a notion on the subject from the specifics of the cases. Atan Long (1980). It is intended that by using this strategy, pupils would develop a sense of curiosity. When a topic or event initially piques their attention, students will also make an effort to learn pertinent details about it. They will look for evidence, compile evidence, categorize evidence, discover pertinent data, and ultimately draw conclusions. The goal of the inquiry approach is to help students think critically about topics, problems, or information and then apply that knowledge to the situation at hand. (Rashid, 1989, p. 148) The inquiry technique generally aims to achieve three major objectives. The first step is to determine what constitutes a valid intellectual enquiry. In this regard, we'll consider how someone approaches an issue or their capacity for methodical thought in response to a prompt. Second, to strengthen the instructional tactics created for the procedure. The objective is to identify instructional approaches that can support the development of a framework for daily instruction and the planning of teaching units or courses. Third, to examine some of the effects of employing such tactics on instructors, classrooms, and the suitability of the curriculum. 148 (Rashid, 1989).

Inquiry-based learning is one approach to strengthen scientific education (IBL). (Pedaste,2015) IBL strives to involve students in an actual scientific discovery process. The IBL is an educational model in which students develop knowledge using methodologies and practices derived from professional science (Keselman, 2003). It is a learner-centered, active method that emphasizes inquiry, critical thinking, and problem-solving. (Chu,2017) The learner is actively involved in the creation of the question and its response. The use of ICT in IBL is a positive step forward in the process, rather than a goal. It is seen as a different way of learning and comprehending scientific subjects. The process of inquiry is crucial in IBL (Van Uum, 2016). It offers a one-of-a-kind chance to incorporate meaningful insights into well-known facts about the natural world (Vlaardingerbloek, 2017). The IBL is designed to be as similar to current science's methodologies and procedures as feasible. The scientific experiment is a necessary component. The experiment aids students in grasping the core of actual research and acquiring fresh information. Learning takes occur in scenarios that teachers have purposefully established, allowing students to witness genuine natural phenomena, manipulate specific items, perform experiments, participate in live conversations, and help solve actual problems (Bagalová, 2016).

Basic school students are naturally interested and eager to learn (Trundle, 2021). Environmental factors have a crucial role in early childhood development, according to research in cognitive and developmental psychology. Several researchers have proposed that scientific instruction begin in the early years of schooling (Watters, 2001; Piaget 1928). However, in order to effectively teach scientific principles, it is vital to first comprehend the nature of children's views about the world around them. Poor scientific education in early life can lead to unfavorable student attitudes and underperformance in later years (Mbamalu, 2001). Early exposure to science, on the other hand, can help youngsters develop scientific thinking abilities, establish favorable attitudes toward scientific subjects, and lay a solid basis for future academic study.

The traditional method of teaching science is expository in nature. It has two primary merits which includes control and time. Teachers are the center of attraction while learners become mere recipients of knowledge. The disadvantages that are linked to this method of teaching include the fact that they lead to lecture monologues and the use of convergent questions which do not permit learners to express their hidden talents. The use of the method has various dimensions as it largely depends on the teacher concerned. However, some major preparations have to be carried out for its successful implementation. These include:

1) Identifying the topic: This is usually dependent on curriculum guides and textbooks. Topics to be treated are usually handled at different levels of specificity.
2) Specifying objectives: this allows the teacher to determine what he/she wants his/her students to take out of the lesson by way of achievement with regards to the topic.
3) Selecting or preparing examples: this stage of the lesson in this method allows the teacher to relate examples to everyday life. The choice is quite simple conceptually, but in practice, it can be difficult to achieve. When chosen appropriately, it allows the teacher to make a good generalization of what has been taught.

It is worth noting that even though this method is not learner friendly, when good practices are put in place, students benefit to some extent from this type of teaching method. Some of the measures that are regarded as good practices that are most likely to yield good fruit include Writing the objectives on the marker board or displaying it on the overhead projectors for students to monitor during the course of teaching and learning. According to Ouyang (1998), the written or displayed information gives the students the direction to focus their attention on when the lesson is in progress. Jacobsen *et al*. (1993) also advanced the point that clarifying the terms in the definition of words used during the lesson in this method allows students to identify terms in their own words or to cite examples of the terms in their everyday lives. They further stated that teachers using this method should provide positive/negative examples. According to them, it is the most critical step to help students understand the concept that is being taught. In a similar contribution toward the use of the traditional method of teaching, McLaughlin *et al*., (1999) suggested that making a KWL chart can be another step in the in using the traditional method of teaching. They believe that the

chart shows what the students already know (K), what they wish to learn (W), and what they may learn at the end of the unit (L). Thus, children can connect their past knowledge to new information through this practice. Many teachers employ this method while instructing students in a number of areas, and it seems to be highly effective in assisting students in connecting the new information they are reading with what they already know. Staying with the traditional approach to teaching science has the additional benefit that it is frequently more difficult to arrange and manage than hands-on science.

It has been referred to in other quarters of teaching as the conventional approach to teaching and learning and has been linked to several benefits. Some benefits of a teacher lecturing from the textbook to students include items like much information being taught in one location, the instructor providing current information to students so skipping through unimportant details it helps to enhance the ability of learners to listen once the student is interested in what is being taught (Giltrap *et al*., 1975). Other benefits include the ability to memorize what has been taught (textbook information). Saul and Newman (1986) noted that the majority of learners at the elementary level around age eight who are capable of reciting the alphabet possess the knowledge of the noble gases in the periodic table. They continue by stating that despite memorizing this vital information, learning done in this context is not necessarily useful considering how easily information can be distorted and manipulated. Facts can be significant because they provide our understanding of certain concepts shape and accuracy.

The needs of the twenty-first century demand that education continue to develop the next generation's life skills. Through the educational process, life skills are developed, and students' learning outcomes are used to identify them. Once teachers are able to identify the learning models that will shape the potential of their students, they must be able to select appropriate teaching methods to facilitate the learning model identified. One of the contributing causes to poor learning outcomes in the classrooms has been the difference between the teaching methods and the learning styles of the students we teach. It is very instructive to note that when teachers can make a connection between their teaching methods and the learning styles of the students they teach, the years of wasted efforts in the classroom by teachers will come to a halt. It will help to minimize boredom in class and go a long way to whet the appetites for learners in science. The measurement of temperature is just one of the topics that lean itself to the inquiry-based learning that teachers must turn their attention to in the 21st century classroom. The process of learning how to locate and arrange concepts and principles into an order of relevance based on the student's perspective is known as inquiry. Inquiry fosters the growth of all prospective pupils, including their emotional and skill development in addition to their academic talents.

B. Statement of the Problem

Heat and temperature are challenging concepts for basic school children in Ghana to grasp because of their abstractness. (Atkins, 2006) Heat is defined as energy transferred from a hotter location to a cooler one. Thermal motion of atoms and molecules is where heat originates. It's a thermodynamic quantity with symbols and mathematical formulae to express it. Heat, according to Tang and Tan (Tang, 2017), is described as "a network of semantic meanings constructed across many representation modalities." Previous research (Paik,2007; Pelinek, 2021) showed that young children struggled to make semantic connections between various scientific topics. The scientific words heat, and temperature are often misinterpreted. (Alwan, 2011; Prince, 2012).

During a lesson observation with basic 8 students at a school in Kumasi in the Ashanti Region we found out that students have the following misconceptions about heat and temperature:

1) There are two types of heat, cold heat, and hot heat.
2) Heat is a material substance such as air or steam; and
3) The temperature of an object is related to its size. Some pupils thought of temperature as a material's property or physical instrument for heat measurement.

A paper and pencil test were conducted at the end of the lesson and indeed the students' performance was very poor to say the least the researcher acknowledges that few pupils could be assisted to be at par with their colleagues through the use of the Inquiry-Based Learning (IBL) activities. It must be stated that this research is not about the content of heat and temperature but solely based on pedagogical issues.

C. Purpose of the Study

The purpose of the study was to use the performance of the students taught under the two teaching methods, the inquiry-based learning, and the traditional method to declare which method produces the best conceptual change among students under the topic "heat and temperature." It was to determine factors that make it difficult for teachers to use the inquiry-based method of teaching.

D. Hypothesis

H0: There will be significant difference in performance when students are taught with the inquiry-based method of teaching and learning and the traditional method of teaching and learning.

H1: There would be no significant difference between the performance of students taught with inquiry-based teaching and those taught using the traditional method of teaching.

E. Research Questions

The research question that was put up to investigate the subject matter include but not limited to:

1) What is the effectiveness of the inquiry-based method of teaching the concept of "Measurement of heat and temperature to basic 8 students as against the use of the traditional method of teaching the same topic?"
2) Which instructional activities make the inquiry-based method of teaching more difficult than the traditional method of teaching?

F. Significance of the Study

Most science students always find it difficult to study, understand and pass exams right from basic schools to the

higher levels of education. "We're losing an alarming proportion of our nation's science talent once the students get to college," says Mitchell J. Chang, an education professor at U.C.L.A. who has studied the matter. "It's not just a K-12 preparation issue."

Therefore, the significance of the study cannot be over-emphasized since it marks an invaluable contribution in the following area.

The study will provide clear and practical activity for the teaching and learning of the topic "Measurement of Heat and Temperature" at the basic level which will form the foundation for higher level science.

It would serve as reference materials for future researchers who may handle this topic as well as improve and enhance the students, conceptual understanding of measurement of heat and temperature.

II. Methodology

A. Research Design

The quasi-experimental design was adopted in this study. Here, the aim was to immediately alter classroom interactions for effective and maximum performance among learners. The collaborative nature of players in this design, which allows the researcher and the other participants or stakeholders to take an active role in the research activity, must be emphasized in this design. As a result, the participants have the opportunity to get a greater understanding of the causes and effects of actions or inactions they engage in.

B. Sampling and Sampling Procedure

The study obtained a sample size of 60 students drawn purposively from 88 students in Basic 8. The Sixty (60) students were divided into two student groups of which 30 represented the control group who were taught with the traditional method and 30 students representing the experimental group who were taught with inquiry-based method. Five science tutors were interviewed on the difficulties associated with use of the inquiry-based teaching method and activities that makes the method better suited for the level of the students involved.

C. Research Instrument

The study made use of Test on the concept of heat and temperature (TCHT) and Interview as instruments to collect date from both students and teachers. The tests were used before and after the two teaching methods were used to teach the concept of measurement of heat and temperature to both control and experimental groups. However, the interview was conducted to know the challenges that teachers face in using the inquiry method of teaching and learning. It was also used to elicit activities that give inquiry-based learning better than the traditional method.

D. Data Collection Procedure

Data were collected at the pre-experimental, experimental and post experimental stages of the study. The data for the study were gathered over a period of six weeks. One week for the pre-experimental stage, four weeks for the experimental stage and one week for the post experimental stage.

E. Pre-Experimental Stage

A pre-test on TCHT was given to both control and experimental groups to ascertain their entering behavior prior to teaching the two groups separately using the inquiry-based teaching and the traditional method. The performances of the groups were compared after making the students' scripts.

F. Experimental Stage

Teaching of the concept of measurement of heat and temperature lasted for four weeks in different classrooms for each group at 1 hour 20 minutes per day and three days in a week. The control and experimental groups were taken through series of lessons separately using the traditional methods and inquiry-based method respectively during this stage. Lesson plans used for the lessons were basically aligned to the four stages of teaching science: introduction, presentation, application, and closure as shown in Table I below. Samples of lesson plan have been attached to the appendix session of this study.

TABLE I: Comparison between Stages of Lesson for Traditional and Inquiry-Based Learning

Stages of lesson	Traditional Method	Inquiry Based Method
Introduction/ Starter	✓ Teacher reviews relevant previous knowledge of students through questioning ✓ The teacher presents a topic to students by writing on the board.	✓ Teacher reviews relevant previous knowledge of students by asking students to demonstrate or role play about experiences that students have gone through in previous lessons or everyday experiences. ✓ Students formulate inquiries that they are eager to explore more under the day's topic.
Presentation/ Phase I	Teacher presents content to students with students taking down notes for memorization and some level of mastery	✓ The teacher assigns tasks to students with directives and asks students to seek for solution from available resources within or outside the classroom. ✓ Students utilize class time to conduct research. ✓ Have students present what they've learned.
Application/ Phase II	✓ Little is said about it, or teacher makes comments on some applications ✓ draws students' attention to salient points	✓ Teacher asks students to relate what they have learnt to everyday life with demonstration of this acquired knowledge including reflections on what worked or what did not work.
Closure/ Phase III	Teacher asks oral questions which are usually convergent in nature / Evaluation	Teacher assigns tasks to students based on their findings from the lesson and usually linked to the learning styles of students. Questions here are usually divergent in nature / Evaluation

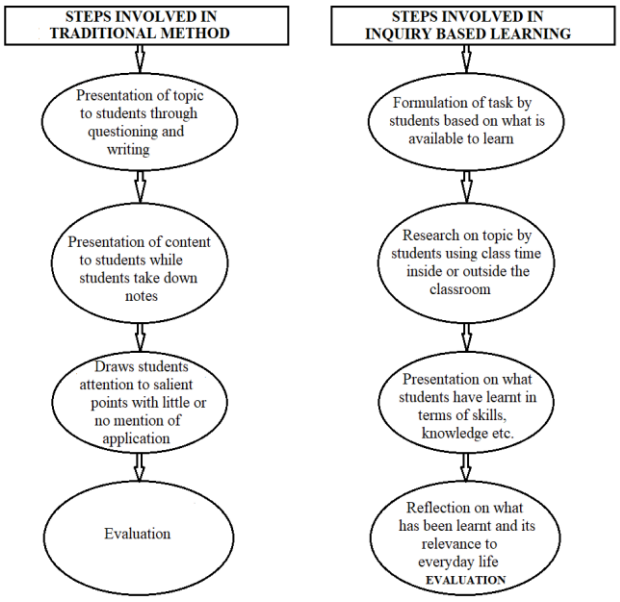

Fig. 1: Stages of teaching for traditional and the IBL.

G. Post Experimental Stage

The effectiveness of each teaching method was measured by how well the students performed on the TCHT that was conducted after the teaching had been done. The TCHT used for the post test was identical to that of the pretest except that the post test was reshuffled to give a new face to the questions. The 30-minute exam was conducted for both groups in separate rooms with similar sitting arrangements and examination conditions.

H. Data Analysis Procedure

The information gathered from the study was presented in descriptive statistics. Various statistical tables and figures were used to explain differences in mean values for the various tests conducted. The independent sample T test was also conducted to ascertain if there was any significant difference between the control and experimental groups. In addition to this, responses from the interview conducted on the five teachers to tell how difficult it is to deliver a lesson using the inquiry-based method were also collected and analyzed in matters of simple frequencies and histograms. The standard activities suggested by teachers under the inquiry-based learning were also recorded.

III. Results and Discussions

A. Results

The results from the study have been analyzed according to the research question and have been presented as follows.

1) Research question one: What is the effectiveness of the inquiry-based method of teaching the concept of "Measurement of heat and temperature to basic 8 students as against the use of the traditional method of teaching the same topic?"

This question was answered through the descriptive statistics below.

TABLE II: Group Statistics for Experimental and Control Groups on Pretest

	Pretest	N	Mean	Std. Deviation	Std. Error Mean
Marks of Students in Pre-Test	Experimental Group	32	4.19	1.203	0.213
	Control Group	32	3.50	1.078	0.191

Table II illustrates group statistics on pretest for both control and experimental groups. The mean values for the two groups were recorded as 4.19 and 3.50 respectively for experimental and control groups. The standard deviation for the groups equally were recorded as 1.203 and 1.078 respectively.

The independent sample tailed test (T-test) indicates that there was no significant difference between the pretest scores for both experimental and control groups at a confidence interval of 95% between the lower and the upper limits as indicated in Table III below.

Table III shows group statistics on posttest for both control and experimental groups. The mean values for the two groups were recorded as 8.00 and 4.50 respectively for experimental and control groups. The standard deviation for the groups equally were recorded as 0.916 and 1, 391 respectively.

TABLE III: Independent Samples Test for Pretest

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	95% Confidence Interval of the Difference	
									Lower	Upper
Marks of Students in Pre-Test	Equal variances assumed	0.004	0.951	2.408	62	0.019	0.688	0.286	0.117	1.258
	Equal variances not assumed			2.408	61.262	0.019	0.688	0.286	0.117	1.258

TABLE IV: Group Statistics for Experimental and Control Groups on Posttest

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Post Test Marks	Experimental Group	32	8.00	0.916	0.162
	Control Group	32	4.50	1.391	0.246

TABLE V: INDEPENDENT SAMPLES TEST FOR POSTTEST

		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	95% Confidence Interval of the Difference	
									Lower	Upper
Post Test Marks	Equal variances assumed	2.492	0.120	11.887	62	0.000	3.500	0.294	2.911	4.089
	Equal variances not assumed			11.887	53.619	0.000	3.500	0.294	2.910	4.090

Table IV shows that the mean mark for the experimental group (8.00) is almost double that of the control group, an indication of a significant difference to show that the IBL is better. The standard deviation from the table confirms this.

The independent sample tailed test (T-test) indicates that there is significant difference between the posttest scores for both experimental and control groups in favour of the experimental group who were taught with the inquiry-based learning approach as against those who were taught with the traditional method of teaching. This happened at a confidence interval of 95% between the lower and the upper limits as indicated in Table V above. The above data shows that the experimental group has performed better than the control group.

2) Research question two: Which instructional activities make the inquiry-based method of teaching difficult than the traditional method of teaching?

TABLE VI: TEACHERS' OPINION ON INADEQUACY OF TLMS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	5	100.0	100.0	100.0

Table VI exposes teachers' opinion on how the availability of teaching and learning material influences the success of teaching using the inquiry-based learning method of teaching. All 5 teachers representing 100% agreed that inadequacy of TLMs is one of the challenges facing the use of the inquiry-based learning method by most teachers. The views of the teachers have been graphed below (Fig. 2).

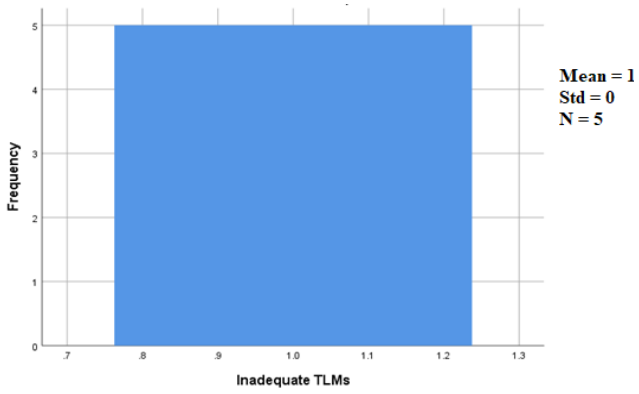

Fig. 2. Teachers' opinion on inadequacy of TLMs.

TABLE VII: TEACHERS' OPINION ON TECHNICAL KNOW-HOW

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	4	80.0	80.0	80.0
	Disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Table VII shows teachers' opinion on how the technical know-how of the teacher is necessary in the use of the inquiry-based learning method of teaching. Four teachers representing 80% of the total sample size. However, one person representing 20% said he did not see how technical know-how could affect teaching through the inquiry method. The histogram below (Fig.3) represents the information above.

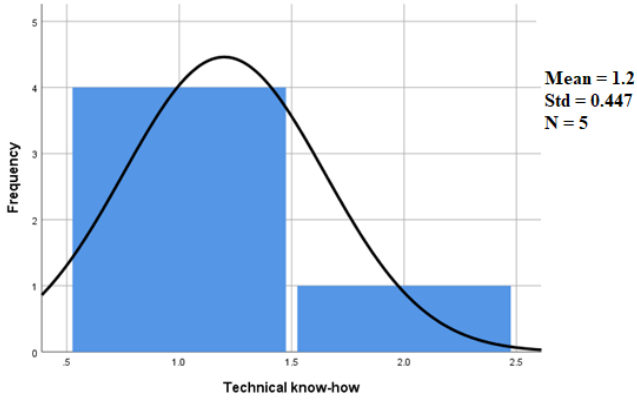

Fig. 3. Teachers' opinion on technical know-how.

TABLE VIII: TEACHERS' OPINION ON PREPARATION TAKES TIME

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	4	80.0	80.0	80.0
	Not Sure	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

From Table VIII, eighty percent of the teachers opined that preparation towards inquiry teaching is time consuming. They suggested that a lot of time is needed to be able to teach using the inquiry method. Furthermore, 1 teacher representing 20% of the sample size agrees that the use of the inquiry method does not require a lot of time for preparation. This result has been presented in Fig. 4 below.

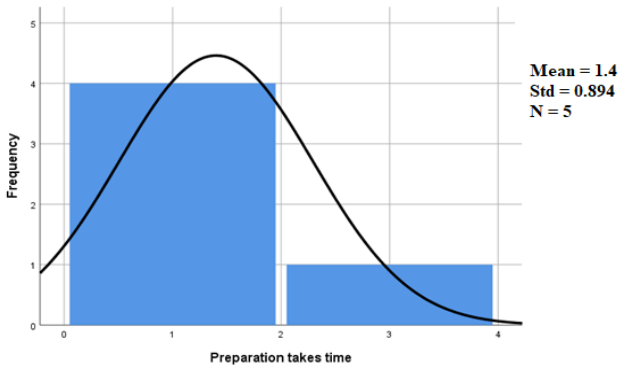

Fig. 4. Teachers' opinion on preparation takes time.

TABLE IX: TEACHERS' OPINION ON LACK OF SPACE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	4	80.0	80.0	80.0
	Disagree	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

Table IX re-echoes the voice of 80% of the teachers declaring their support for lack of space on the timetable for inquiry work. However, 1 teacher representing 20% of the sample size voted against lack of space for inquiry-based learning, citing that one does not need a lot of space on the school timetable to handle a lesson through inquiry-based learning. He was of the view that lessons could always be continued on any day thus, one does not need a whole day by way of space on the timetable to have an inquiry-based learning lesson for their students. This result has been presented in Fig. 5 below.

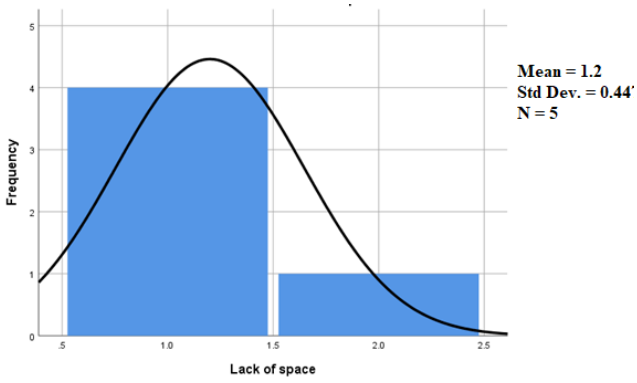

Fig. 5. Teachers' opinion on Lack of space.

TABLE X: TEACHERS' OPINION ON ENERGY SAPPING

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	3	60.0	60.0	60.0
	Disagree	1	20.0	20.0	80.0
	Not Sure	1	20.0	20.0	100.0
	Total	5	100.0	100.0	

In the case of whether inquiry method of teaching is energy sapping or not, 3 teachers representing 60% of the sample size voiced out that they agree with the statement. They further indicated that preparation, delivery and post-delivery using the inquiry-based learning method entail a lot of energy work. On the contrary, one teacher representing 20% held the view that the inquiry-based learning method was just like any other teaching method which requires equal preparation hence, saps energy like any other teaching method. One teacher, however, did not take a stand thus, remaining neutral. The above information from Table X is illustrated in Fig. 6 below.

B. Discussion

The inquiry-based learning method of teaching science like many learner-centered teaching methods has numerous advantages than its disadvantages. The results of the posttest revealed that the experimental group who were taught with inquiry method performed far better than their counterparts who were taught with the traditional method. Student questions, ideas, and analyses are given priority in this teaching and learning approach.

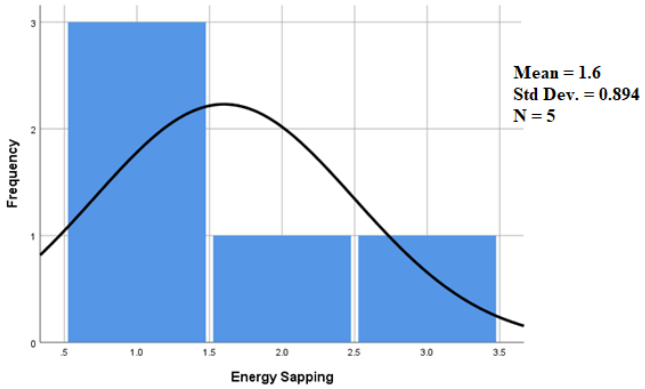

Fig. 6. Teachers' opinion on Energy Sapping.

It's crucial to characterize inquiry-based learning from both the learner and teacher perspectives in order to highlight the subtleties of the approach. From the perspective of the learner, inquiry-based learning is centered on examining an unsolved question or issue. They must arrive at a conclusion and defend or articulate it using evidence-based reasoning and original problem-solving. Inquiry-based teaching, from the perspective of the teacher, aims to take pupils beyond simple curiosity and into the realms of critical thinking and comprehension. You must help students while they do investigations and encourage them to ask questions by knowing when to start and how to organize an inquiry activity. This method's objective is to help students develop their investigative and critical-thinking abilities while also teaching them how the particular method functions in scientific investigation. Given the difficulties associated with inquiry-based learning as per the responses of the teachers in this research work, we arguably contend that most teachers prefer to use other teaching methods especially, the traditional method that would be less costly, less stressful, and basically allows for less time for preparation and delivery and probably less involving in terms of the use of teaching and learning resources or materials. According to Bottiani *et al*. (2019), when teachers stand in front of a class of 20 to 30 students each day, they must deal with the students' needs, the lesson plan, and a shortage of resources. Along with the potential effects of the labor itself, teaching in a classroom with insufficient resources might cause teachers to lose their passion, they maintained. Anytime this happens, the expenditure must be covered by the students. It is therefore not a surprise to see the majority of teachers using the traditional method to deliver their lessons to the unfortunate disadvantage of the majority of students whose learning styles may not conform to this approach.

The negative implication of these identified stumbling blocks to teaching science in the classrooms in Ghana cannot be overemphasized. If our quest to attaining sustainable growth and development through scientific advancement as per the dictates of the new science curriculum is to be realized, then stakeholders including government should find the most appropriate method of solving the problems identified by the teachers in this study. In addition, teachers have agreed to the call by Parasuraman (2020) that certain aspects of inquiry teaching must be adequately tackled to ensure effective use of the method in the science classrooms. According to him, there are aspects

of planning in the inquiry method of teaching which all teachers must adhere to before going to the classroom. He categorized this into five components, but Assem (2022) has included an element of assessment of learners based on what has been investigated thus has redesigned it as in the diagram below:

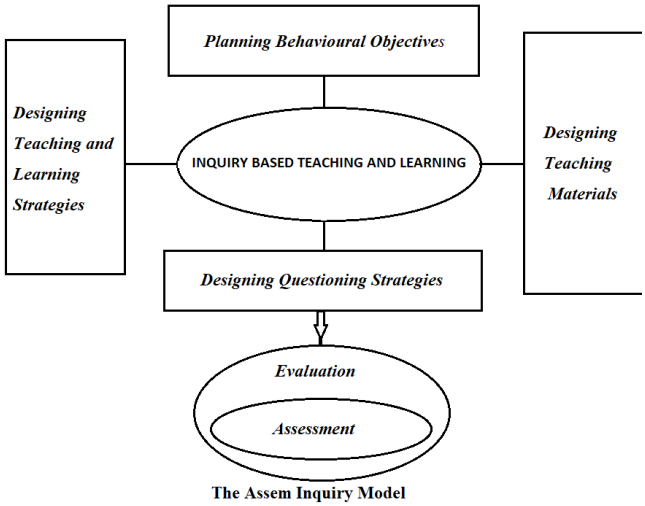

Fig.7. The Assem Inquiry Model.

1) Planning behavioral objective

Teachers should plan the inquiry technique while considering the students' capacities. In this situation, the teacher should be aware of the students' educational backgrounds and their capacity for engaging in the inquiry method's activities. This is important because teachers need to be aware of the skills of the students in their respective classrooms and because each student must follow certain steps in the inquiry process that may even depend on their learning styles.

2) Designing teaching materials

Students must receive the proper literature from their teachers. The materials in the textbook should be sufficient, and the teachers should supply the resources required to put them into practice. For instance, professors can give pupils the necessary research resources so they can perform their own independent studies. Among other things, reference books, textbooks, papers, maps, newspaper and magazine clippings, and other resources are examples of reference materials.

3) Designing questioning strategies

The questioning technique is more significant in the inquiry approach than the answers the teacher expects students to provide. In this situation, the teacher must prepare the inquiries that will direct the pupils toward the desired learning results. The questions they propose must challenge students to think critically and creatively. Students' intestinal reasoning is examined with challenging problems. There are three basic types of questions: high-level queries that call for speculative responses from students, questions that call for interpretation, and fact-recall questions. Typically, the questions are asked in the following sequence: "why," "how," etc.

4) Designing teaching and learning strategies

Teachers must be extremely clear about the goals and lessons they want their pupils to acquire before adopting the inquiry technique. Then, teachers must create a schedule of rules for the activities they assign to their students. Teachers must also explain what needs to be done to students. Teachers in this situation have the choice of doing the research alone or in groups. Before assigning group assignments, teachers should consider a variety of aspects, such as group size, gender balance, potential challenges the group might face, etc. Teachers must organize courses more democratically using this method. The methods and techniques that will be applied in teaching and learning should also be taken into account by teachers.

5) Evaluation

The inquiry method needs to be evaluated by teachers. It is feasible to assess pupils' ability to manage information, participate in learning activities, and ask probing questions. Visual, aural, and analytical media and audiovisual techniques can all be used in evaluation.

Science as a discipline naturally lends itself to the process of inquiry. As new discoveries are produced, established "scientific facts" and ideas are constantly being challenged, illustrating how swiftly scientific knowledge is evolving. Supporters of inquiry-based education argue that teaching through inquiry increases student engagement in science learning and builds deep conceptual understanding of scientific issues because it exposes students to a learning style that "parallels the activity of practicing scientists" (Capps & Crawford 2013; Hodson 1992). Students' knowledge constructs, whether made individually or collectively, are ambiguous, subjective, and frequently open to peer evaluation. One of the primary qualities of real education is its ability to assist and reinforce students' learning. Formative assessment components, which are prevalent in practical education, play a significant role in the development of students' subject-matter comprehension. Another essential component of true education is the effect on student engagement. In their study on students' interest in physics, Murphy *et al*. (2006) presented three convincing arguments for the use of real education to deliver the physics curriculum.

The following findings were made from the study:

1) The study revealed that there is a great impact on the use of Inquiry Based Learning Methods of teaching and learning science especially in the area of the teaching of measurement of heat and temperature than in the use of the traditional method.
2) The study again revealed that, factors that hinder teachers to use of Inquiry Based Methods of teaching and learning includes lack of teaching and learning materials, lack of technical know-how and most importantly, the fact that it consumes a lot of time and energy.

There are still many schools that use traditional teaching methods, sometimes known as conventional teaching methods. Teachers typically assign students to memorize and recite the lessons and course content they are taught in class. When it is their turn to talk, they also instruct pupils to recite the lesson one at a time. With the exception of the students who are reciting, the other students listen and wait for their turn. Students finish the whole class in this way.

Then, based on the students' memorization of the lecture, professors assign homework, write examinations, or administer oral exams. Students are rewarded for the work they put forth in class within each subject's given time through the utilization of traditional teaching methods in the classroom. By enforcing rules and regulations, students' behavior is managed in the classroom. Owing to the reasons above, teachers should be guided on how to use this method to be used to the advantage of students for in the absence of nothing, anything could be fallen on to save lives.

IV. Conclusion

Due to the small sample size, any results from this study must be considered tentative. According to the findings of this study, there was a noticeable difference in the academic success of students who learned the concept of measurement of head and temperature through the use of the inquiry-based method of teaching and learning than those who learned it under the traditional method. It should be emphasized that, in contrast to the group taught using traditional method, the group taught using the inquiry-based learning method all grouped around a very high mean score of 82%. Their scores were significantly more dispersed from the mean. Despite the similarity of the information delivered to both groups, the posttest results show a considerable difference between the two groups. It can also be concluded that about 95% of the teachers believe that the use of the inquiry-based teaching and learning method is highly laborious as it requires a great deal of input in terms of TLMs, time, space, technical know-how, preparation and other resources as opposed to the traditional method of teaching.

Recommendations

Based on the findings of the study, I recommend the following:

1) Inquiry-based teaching and learning methods need to be used in the foundational lessons of curriculum in order for it to be rich and relevant. Because they will regard themselves as contributors to their own classrooms, students who are actively involved in courses will have a sense of ownership over the group.
2) Adequate in-service training should be organized for teachers on the field and also for student teachers in the initial teacher training program, inquiry-based learning must be integrated into the training program to get them abreast with its usage at the basic school.
3) Government and all stakeholders who matter should support teachers to acquire adequate teaching and learning resources and materials for the science classrooms.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

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