Original Article

INQUIRY-BASED LEARNING APPROACHES: THE BEST PRACTICE FOR BASIC SCIENCE TEACHERS

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ABSTRACT

This paper provides information obtained from Junior Secondary School teachers on their orientation towards the use of inquiry-based approach for teaching Basic Science in Ekiti State, Nigeria. The population of the study comprises all the Basic Science teachers in the State. A sample of one hundred and eighty (180) teachers was selected from the three (3) senatorial districts of the State using multi-stage sampling technique. A fifteen-item scaled response questionnaire was used as an instrument. The items addressed teachers' related beliefs, orientation and difficulties in implementing IBL in Basic Science classrooms. The four-scale, adopted likert-scale questionnaire was distributed by the researchers to the participants in their schools. The instrument was validated by experts in the fields of language, science education and evaluation while the reliability coefficient of 0.74 was obtained for the questionnaire. Data collected were analyzed using the mean score and standard deviation of each statement while the only hypothesis formulated was tested using t-test statistics at 0.05 level of significance. The result showed that many teachers had no knowledge of IBL as reflected in their responses, but they have a strong belief that IBL has the potential to overcome learning problems of students in Basic Science. The study also revealed that teachers suffer from lack of resources, unequipped laboratory, too large class size and lack of time allocation in the school time-table for implementing IBL. The study also revealed that the opinion of male and female teachers in the use of IBL did not differ significantly. It was recommended that practicing science teachers should endeavor to employ IBL in their teaching because of its great benefits to students as it allows them to reflect on their own ideas in an effort to build their knowledge, understanding and interpretation of ideas.

Key words: Inquiry-based learning, basic science teachers, junior secondary school and teachers' orientation

INTRODUCTION

Inquiry-based learning (IBL) approaches have been gaining significant influence among the science educators. It is an approach to teaching and learning that places students' questions, ideas and observations at the centre of the learning experience. Inquiry-based learning ranges from a rather structured and guided activity, particularly at lower levels where the teacher may pose the questions and give guidance in how to solve the problem, through an independent research. IBL draws on constructivist ideas of learning in which learners construct new ideas or concepts based upon their experiences and prior knowledge (Kanselaar, 2002). Similarly, IBL is a student centered approach that encourages participants to draw on prior knowledge and experience in exploring their inquiries (Kahn and O'Rourke, 2005).

In IBL, the student is responsible for constructing his/her own meaning and understanding from the learning activities. According to Scardamailia (2002), educators play an active role throughout the process by establishing a culture where ideas are respectfully challenged, tested, redefined and viewed as improvable, moving children from a position of wondering to a position of enacted understanding and further questioning. For students to be able to engage actively in the inquiry process, they need specific skills. These are:

(i) identify causal relationships;

(ii) describe the reasoning process;

(iii) use data as evidence and;

(iv) evaluate. (Scardamailia, 2002)

Being aware of these skills, students have the opportunity to develop in self-directed inquiry, develop and diagnose problems, formulate hypothesis, identify variables, collect data, document their work and finally, interpret and communicate the results (Wu and Hsied, 2006).

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Research has shown that there are three types of IBL, structured, guided and open inquiry-based learning (National Research Council, 2000), and the usage depend on the specific needs in the science classroom. Inquiry spans from more student-centered types of inquiry to more teacher-centered types. Understanding the different aspects of inquiry can help educators vary the types of teaching and learning experiences to better meet the needs of all science students. Studies on IBL revealed that teachers have responsibility of finding creative ways to introduce students to ideas and to subject matter that is of interest to them and offers "inquiry potential" or promise in terms of opportunities for students to engage in sustained inquiry of their own (Scardamalia, 2002). Another role of teachers is to provide the most valuable questions that lead to other questions and provide germs for future investigations (Lucas, Broderick, Lehrer, and Bohanan, 2005). However, there are times when inquiry begins not with a question or problem, but with a shared experience. Teachers are to support students' engagement in inquiry and engage them in constructing meaningful understandings. The kind of support needed by the students strongly depends on the type of problem at hand and on the experience students have already got with IBL.

It is worth nothing that, teachers have to provide the precise support to facilitate student learning. According to De Garcia (2013), the following practices are crucial to the teachers:

(i) anticipate student responses to challenging mathematical tasks;
(ii) monitor and support students' work on and engagement with the tasks;
(iii) select particular students to present their mathematical work;
(iv) the student responses that will be displayed in specific order; and
(v) different students' responses and connect the responses to key ideas.

Teacher questioning skills have a great influence on IBL culture and on students learning. Teachers have the ability to encourage their students to put forward their ideas, explore and discuss their point of view while using dialogic, critical and thought-provoking questions and giving students time to think and answer (Chin, 2007). Teacher as a key factor in a classroom must possess certain attitudes and skills to encourage student success in the inquiry-based classroom. According to Colburn (2000), teacher must support inquiry-based instruction; he must believe in the value of students having some element of control over what they will do and how they will behave. Hence, inquiry-based learning shifted the role of teacher as a source of knowledge to a facilitator of learning, made the students more responsible and self-directed in the learning process.

Spronken-Smith, Angelo, O'Steen, and Robertson (2007) provide a review of the potential benefits for teaching personnel that use an IBL approach. They cite a strengthening of teaching-research links, the rewarding aspect of seeing students being so engaged and gaining improved understanding and skills. Another benefit for teachers is the increased interaction with students and the induction into a wider community or practice of IBL practitioners (Slatta, 2004). Like students, teachers can have difficulties adjusting to the approach and IBL can be challenging and involve emotional turmoil (Spronken-Smith et al., 2007).

Evidence from researches have shown that IBL is generally more effective than traditional teaching for achieving a variety of student learning outcomes such as academic achievement, student perceptions, process skills, analytic abilities, critical thinking and creativity (Prince and Felder, 2006). For example, Berg, Bergendahl, and Lundberg (2003) compared the learning outcomes of an open-inquiry and an expository version of a first year chemistry laboratory experiment. Data on student experiences of the two approaches were gained from interviews, questions during the experiment and students' self-evaluations. The key findings of this study were that students taking the open-inquiry experiment version had more positive outcomes including a deeper understanding, higher degree of reflection, the achievement of higher order learning and more motivation. In a similar study, Justice, Rice, Warry and Laurie (2007) used five years of data to examine whether taking a first year IBL course made a difference in students' learning and performance. In a comparative study between students taking an IBL course and those who did not, and, taking into consideration factors such as age, gender, high-school grade point averages etc., they found that students who took the inquiry course had statistically significant positive gains in passing grades, achieving honours and remaining in the university.

Despite the benefits of IBL, there were divergence views on the use of IBL, for instance, Justice et al. (2003) show that students perceived an increased workload in IBL courses while Plowright and Watkins (2004) noted student difficulties in coping with group dynamics. The most valuable way by which teachers can effectively assist their students to appreciate science values and applications is to engage them in constructing meaningful understandings using inquiry-based approaches.

STATEMENT OF THE PROBLEM

The deplorable state of the secondary school education in Nigeria with recorded poor performance in science examinations have called for an urgent attention of the stake holders in education. This poor performance in science examinations may be attributed to inappropriate teaching method and approaches used by science teachers and lack of teaching resources among other factors. Considering the fact, that acquisition of scientific skills is a requirement for technological development of any nation, there is need to improve students' science-based knowledge and enthusiasm to learn the subject. For Nigeria to actualize her goal of industrialization by the year 2020, it is imperative to apply a more pragmatic approach to teaching of science using IBL model that would improve science-based knowledge of students. It is on this note that this study is out to examine how practicing science teachers applied IBL in Basic Science classrooms in Ekiti State Junior Secondary Schools with the aim of making science enjoyable and interesting to students. From the above problems, one general question was raised to guide the study:

What are the feelings of teachers to the use of inquiry-based learning approach for teaching basic Science in the Junior Secondary Schools?

RESEARCH QUESTION

Is there any difference in the opinion of male and female teachers in the use of inquiry-based learning approach for teaching basic science in the Junior Secondary Schools?

RESEARCH HYPOTHESIS

There is no significant difference in the opinion of male and female teachers in the use of inquiry-based learning approach for teaching basic science in the Junior Secondary Schools.

METHODOLOGY

The study adopted a descriptive research of the survey design. It is a survey because it involved drawing appropriate information from the existing situation and the beliefs of teachers in relation to the use of inquiry-based learning approach. The population of the study comprises all Basic Science Teachers in public secondary schools in Ekiti State. There are 184 secondary schools in Ekiti State with a population of 2,050 science teachers (Source: Research and Statistics Department, Ekiti State Ministry of Education, Ado). The sample for the study was drawn from the three senatorial districts of the State using multi-stage sampling technique. At the first stage, simple random sampling technique was used to select 20 public Junior Secondary Schools each from the three senatorial districts of the State. The second stage was the selection of 3 Basic Science teachers from each school, making a total of 60 teachers from each senatorial district. The last stage was a stratified random selection of 100 male teachers and 80 female teachers. In all, a total of 180 teachers were used for the study.

In collecting the data, a fifteen-item scaled response questionnaire adapted from the IBL literature (OECD/PISA, 2009 and PRIMAS, 2007-2013) baseline survey were used as an instrument. The OECD/PISA and PRIMAS items were developed based on a multi-faceted understanding of IBL, which were not only the process of inquiry but also the classroom atmosphere and the rule of the teachers. The statement addressed teachers' related beliefs, orientation and difficulties in implementing IBL in Basic Science classrooms. The questionnaire was distributed by the researchers to the participants in their schools. Each item was scored according to the rule by assigning a number for each point of the scale: Strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1). In order to ensure the reliability of the instrument, the researcher carried out a trial test for the instrument using 30 non participating teachers from 10 schools in Ondo State, Nigeria. The instrument was employed once and the scores from the single administration of the instrument was subjected to Alpha Cronbach reliability estimate and the value obtained for the questionnaire was 0.74 which was considered high enough for this study according to Alonge (2004). The face, content and construct validity of the instrument was ascertained by experts in the fields of language and science education and evaluation for proper scrutiny. The data collected from the respondents were analyzed using the mean score of each item and t-test statistics at 0.05 Alpha levels.

RESULTS AND DISCUSSION

The general question raised was subjected to descriptive analysis using mean scores and standard deviation of the items as follows:

Question 1: What are the feelings of teachers to the use of inquiry-based learning approach for teaching Basic Science in the Junior Secondary Schools?

In addressing this question, the mean score and standard deviation of each item regarding the teachers' responses was calculated and interpreted as follows: 1.00-2.49 = Rejected and 2.50-4.00 = Accepted. The data collected from the teachers were organized and discussed as follows:

Table 1: Teachers' Orientation towards IBL

Statement	N	Mean	Std Deviation	Decision
I have good knowledge of IBL	180	2.47	.841	Rejected
I would like to implement more IBL practices in my lesson	180	3.22	.719	Accepted
I would like to have more support to integrate IBL in my lessons	180	3.35	.501	Accepted
I do not know the principles guiding the use of IBL for teaching basic science	180	2.86	.785	Accepted

Table 1 showed the mean of the items regarding teachers' orientation towards IBL technique. It could be seen that teachers opinion on the knowledge of IBL was not accepted which indicated that many teachers had no knowledge of IBL as reflected in their response to item 1 while responses were positive to all other items. The moderate mean score of 2.86 in item 4 was an attestation to the fact that teachers' lack good knowledge and principles guiding the use of IBL.

Table 2: Teachers' hands-on-activities with students

Statement	N	Mean	Std Deviation	Decision
My students do engage i practical work	180	3.46	.500	Accepted
My students do engage in experiments by following my instructions	180	3.53	.501	Accepted
My students are allowed to design experiments and draws out conclusions on experiment conducted	180	1.73	.641	Rejected
My students are given opportunities to express their own ideas	180	3.41	.515	Accepted
I discuss variations in data collected by students following their experiments	180	3.36	.480	Accepted

Table 2 showed the teachers' hands-on-activities with students. From the mean of the score, it was apparent that the responses about the teachers' hand-on-activities were all accepted with the exception that students were denied of designing experiments and draw out conclusions on the experiments conducted by them. This aspect of teaching is important in achieving the goal of basic science teaching.

Table 3: Teachers' Difficulties in Implementing IBL

Statement	N	Mean	Std Deviation	Decision
I do not have sufficient teaching resources to implement IBL	180	3.00	.897	Accepted
I do not have well equipped laboratory for effective implementation of IBL	180	2.80	.899	Accepted
Basic science curriculum does not encourage the use of IBL	180	2.17	.761	Rejected
There is no enough time in the school time-table for successful implementation of IBL	180	2.95	.867	Accepted
The number of students in my class is too large for me to use IBL	180	2.72	.959	Accepted
The task involved in IBL approach is too much	180	2.72	.993	Accepted

Table 3 showed the difficulties encountered by teachers in implementing IBL with students. It was clear that teachers suffer from lack of resources in schools, unequipped laboratory, too large class size and lack of time allocation in the school time-table for implementing IBL.

TESTING OF HYPOTHESIS

$Ho_{1:}$ There is no significant difference in the opinion of male and female teachers in the use of inquiry-based learning approach for teaching basic science in the Junior Secondary Schools.

Table 4: t-test difference in the mean opinion of male and female teachers in the use of inquiry-based learning approach for teaching basic science

Variable	N	Mean	SD	df	t_{cal}	t_{tab}
Male Teachers	100	18.72	4.35	178	1.13	1.96
Female Teachers	80	19.50	4.78			

Result is not significant at $P < 0.05$.

From table 4, the result showed that at $p < 0.05$, t–calculated value was 1.13, df was 178, and t–table value was 1.96. It could be seen that the t-calculated value was less than the t-table value at 0.05 Alpha levels; this implies that there was no significant difference in the opinion of male and female teachers in the use of inquiry-based learning approach for teaching basic science at the Junior Secondary Schools in Ekiti State, Nigeria. Hence, the hypothesis which states that there is no significant difference in the opinion of male and female teachers in the use of inquiry-based learning approach for teaching basic science Schools is upheld.

CONCLUSION AND RECOMMENDATIONS

The study reported that there are major problems confronting the successful implementation of IBL which have to be taken seriously by the major stakeholders in education if the objectives of teaching basic science is to be realized. The study observed that many teachers had no knowledge of IBL as reflected in their responses, but they have a strong belief that IBL has the potential to overcome learning problems of students in basic science. To spread the benefit of IBL, it would be useful to seek the assistance of teachers that have already had initial understanding of IBL and have an open mind towards developing their teaching technique and practices. Those teachers then could help to spread the implementation of IBL. From the study, there was no significant difference in the opinions of male and female teachers in the use of inquiry-based learning approach in teaching Basic Science. This finding showed that both male and female teachers had that same view in the use of inquiry-based learning approach. It is recommended that practicing teachers should endeavor to employ IBL in their teaching because of its great benefit to students as it allows them to reflect on their own ideas in an effort to build their knowledge, understanding and interpretation of the matter at hand.

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