TEACHERS' PERCEPTIONS AND IMPLEMENTATION OF INQUIRY-BASED LEARNING IN RURAL SCHOOLS

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ABSTRACT

An inquiry approach is a student-centered approach that seeks to enhance learners' conceptual understanding of scientific concepts and acquisition of scientific process skills. This study explored how Chemistry teachers perceive and implement the inquiry approach in rural schools. Guided by the pragmatist philosophy, the study adopted the mixed-method approach and utilized the sequential explanatory design. Data were collected from 15 chemistry teachers in the Gweru district using questionnaires, interviews, classroom observations, and document analysis. Quantitative data from the questionnaire were analyzed descriptively while qualitative data were analyzed thematically. The results of the study revealed that chemistry teachers have positive and favorable perceptions about the implementation of the inquiry approach however, its enactment in the classroom is limited extent due to a number of constraining contextual factors. In addition, chemistry teachers are still hesitant to shift from the transmissive paradigm of teaching toward a more learner-centered approach. Furthermore, the teachers were shown to have limited knowledge and skills in the practical implementation of inquiry instruction. The study recommends professional development training and support of chemistry teachers on the practical implementation of inquiry-based learning to enhance their pedagogical content knowledge and skills. *[African Journal of Chemical Education—AJCE 14(1), January 2024]*

INTRODUCTION

One of the most effective pedagogies to teach chemistry at the secondary school level is inquiry-based learning (IBL). [1] explained that the linchpin of this student-centered pedagogy is that it allows and encourages learners to be actively engaged in the scientific construction of new knowledge.

As a pedagogical approach gaining new traction in contemporary science teaching and learning, IBL requires that chemistry teachers undergo a paradigm shift in how they teach [2]. They should transition from a transmissive approach where learners are passive to an engaging pedagogy that encourages learners to be actively involved in the learning process by asking questions, designing investigations, and gathering data to formulate answers [3].

According to [4], IBL is a pedagogical approach where students actively practice several scientific processes in their quest to become knowledgeable about what science is, what science looks like, how science is done, and how it is communicated. IBL can therefore be seen as a teaching and learning approach that allows learners to actively engage in scientific practices to construct their scientific knowledge [5].

With this perspective, it means that a variety of scientific pedagogical approaches that include designed-based approaches, experimental investigations, guided discovery, hands-on,

problem-solving, project-based activities, and laboratory work; as well as conducting actual research can be used to allow learners to acquire scientific literacy [1]. As noted by [6], chemistry teachers, therefore, need to incorporate IBL in their pedagogical practices as the approach improves the interest of learners in science.

The Zimbabwean Ministry of Primary and Secondary Education (MOPSE), in its quest to address the relevancy of education for the 21st-century context, designed and developed a competence-based curriculum where learners develop an understanding of a new set of competencies that goes beyond basic knowledge and skills [7]. These sets of competencies are required by all learners so that they can be able to work collaboratively and creatively in the development of new knowledge as well as innovative products in this industrialized economy. As such, inquiry-based science learning becomes the basis for the incorporation of this new set of competencies in Zimbabwean schools. The Zimbabwe science curriculum stipulates that inquiry skills are learned through practical work where learners apply and hence understand scientific concepts. As such, learners should employ scientific skills in solving real-life problems. This study aims to determine the teachers' perceptions regarding implementing IBL for teaching and learning Chemistry at the Ordinary level in rural secondary schools in Zimbabwe.

It is critical to inquire into teachers' perceptions about IBL as a pedagogical approach within the Zimbabwean context since the epistemological perceptions of teachers and their practices are key in providing pedagogical solutions that lead to their professional development and increasing learner interest in science.

Furthermore, [8] observes that investigating teachers' thinking patterns about IBL gives potential insights into how teaching and learning can be improved for the learner's benefit. Thus, engaging in evaluating teachers' perceptions of IBL will go a long way in enacting the best pedagogical practices that promote improved learner motivation in chemistry pedagogy.

Empirical research studies have demonstrated the benefits associated with the implementation of IBL. Studies by [5] have shown that the implementation of IBL motivates and stimulates the interest of learners in science. In addition, [9] observed that the use of IBL is critical in fostering students' conceptual understanding of science.

Furthermore, [10] noted that implementation of IBL is very effective in improving the achievement and learning outcomes of students in science, students' content knowledge, higher-order thinking skills, problem-solving skills, and science process skills.

[1] summed up the benefits of IBL when they say that its implementation optimizes students' understanding of science concepts, thus leading to the acquisition of scientific literacy.

Moreover, the consistent implementation of IBL is critical in promoting students' attitudes toward science and enhancing their curiosity to learn. This will eventually reduce learners' misconceptions about science and enhance their abilities in reaching and making correct conclusions in scientific experiments [5].

Despite consensus regarding the efficacy of inquiry-based teaching, there is a low level of adoption of this pedagogy in Zimbabwean science classrooms. Instead, many Zimbabwean science teachers continue to teach science using the transmissive approach [11]. Research studies that have been conducted elsewhere also reveal a similar trend.

For instance, studies by [5] in South Africa as well as [10] in Ghana revealed that IBL is rarely adopted and used in science classrooms in these countries. [12] observed that most teachers still find it difficult to implement IBL as a result of circumstantial factors, which include inadequate resources, large class sizes, and lack of confidence and competence, that negatively affect the implementation of the approach in science teaching.

Since Chemistry teachers have the responsibility of implementing the curriculum, the views they hold about IBL are critical since they reveal insights that are important in enhancing the motivation and interest of learners in science [13]. Investigating Chemistry teachers' perceptions

about IBL will go a long way in enhancing the quality of teaching and learning and hopefully stimulate learner interest in science.

Understanding how Chemistry teachers perceive the provision and implementation of IBL in chemistry teaching at Ordinary Level could stimulate the MOPSE to develop and implement novel policies geared towards promoting better and more effective learning opportunities for learners to learn scientific inquiry [14]. The purpose of this study, therefore, was to explore how Ordinary Level rural Chemistry teachers perceive IBL and the extent to which they implement it in their classrooms.

RESEARCH QUESTIONS

The study was carried out to answer the following research questions:

1. What are Ordinary Level Chemistry teachers' perceptions towards the implementation of the inquiry-based learning approach in Chemistry teaching and learning?
2. To what extent do Zimbabwean Chemistry teachers implement inquiry-based learning practices in their classrooms?
3. What difficulties do rural chemistry teachers encounter as they implement inquiry-based learning practices in their classrooms?

MATERIALS AND METHODS

Research design

The pragmatist philosophy and the mixed methods approach were adopted and applied to guide this study. [15] explains that the mixed methods approach merges the qualitative and quantitative methods of collecting data. The merging of these two forms will enable the researcher to address the weaknesses inherent in one method by concentrating on the strengths inherent in the other method in a bid to offset biases in one method [1].

Consistent with the mixed methods approach, a sequential explanatory design was then used to collect quantitative and qualitative data [15]. This design was implemented in two phases. The first phase involved collecting quantitative data. After collecting the quantitative data, it was analyzed, and the results were used to plan for the second phase in which qualitative data was collected [15]. The qualitative data collected was then used to explain and understand the quantitative data [5].

As argued by [16], the sequential explanatory design gathers two different but complimentary strands of data consecutively. The use of qualitative data in the subsequent interpretation and clarification of the quantitative findings helps to ensure the authenticity of the

findings. The first phase of data collection involved collecting quantitative data using a survey questionnaire distributed to Chemistry teachers in the Gweru district in Zimbabwe.

The second phase of the study involved the collection of qualitative data that provided a more in-depth explanation of some of the findings that emerged from the survey questionnaire. In this regard, lesson observations, document analysis, and interviews were conducted with the teachers who participated in the survey.

Population, sample, and sampling procedures

The population of the study comprised chemistry teachers from rural secondary schools in the Gweru district, Zimbabwe. The 15 teachers who were chosen to complete the questionnaire were selected using the simple random sampling method. The researcher distributed the questionnaire to all 15 teachers in the district. Twelve teachers responded to the questionnaire.

Their teaching experience ranged between 5 to 20 years and all the teachers had an undergraduate degree in chemistry education. From the survey respondents, the researcher purposively selected 6 chemistry teachers to engage in the interviews and lesson observations. The 6 were selected on the basis that their schools were easy to access.

Data collection instruments

In this study, the main data collection instrument was a researcher-made closed questionnaire. The questionnaire was designed to obtain data on inquiry-based learning and teaching (IBL) [17]. The survey instrument was pilot tested with four chemistry teachers who did not make the sample of participants for the study. The objective of the pilot testing was meant for the teachers to identify and make comments on any items that were not clear.

The teachers did not identify any issues regarding readability allowing the questionnaire to be used in its original form. The items on the questionnaire required teachers to respond on a four-point Likert-type scale, 1 (strongly disagree), 2 (disagree), 3 (agree), and 4 (strongly agree). The items that constituted the questionnaire were structured in three main dimensions namely, teachers' perceptions about inquiry-based learning, teachers' classroom practices regarding inquiry-based learning, and teachers' difficulties in the implementation of inquiry-based learning.

Semi-structured interviews were conducted to provide data on how the teachers perceived the use the inquiry in chemistry classrooms. This enabled the researcher to collect large amounts of rich data through verbal interaction with the participants. The interview enabled the researcher to probe the participants for more detail and to seek more clarification from the participants on issues that were being discussed.

Document analysis of schemes of work and lesson plans, as well as lesson observations, were done to determine the extent to which Chemistry teachers implement inquiry-based learning practices in their classrooms. The use of multiple data collection methods as outlined by [18] facilitated the triangulation of data making the findings more reliable and valid. The data were collected after getting authority from the Ministry of Primary and Secondary Education as well as the consent of the participating teachers.

Data analysis techniques

The data that were collected using the questionnaire were analyzed descriptively by calculating the mean (average) and standard deviation for each item to determine the trends in the responses as well as establish the degree of consistency among the respondents. The qualitative data from lesson observations, document analysis, and interviews were analyzed thematically to establish themes, norms, and patterns from the respondents.

The quantitative data were integrated with the qualitative data into predetermined postulations that addressed the research questions. These were: teachers' perceptions regarding the inquiry approach, enactment of the inquiry approach in chemistry classrooms, and difficulties encountered by teachers as they enact inquiry-based learning practices in their classrooms.

RESULTS

Teachers' Perceptions of inquiry-based learning

The study obtained the perceptions of the participating teachers regarding the implementation of the inquiry approach from the responses given related to the first ten items on the questionnaire. The teachers responded to item statements on a four-point Likert scale that ranged from 1 (strongly disagree) to 4 (strongly agree). The results are shown in Table 1.

Table 1: Teachers' Perception of Inquiry-based Learning

	SA	A	D	SD	Total	mean
IBL encourages active participation and collaboration in chemistry education.	10	4	1	0	15	3.6
IBL develops learners' experimental skills.	11	2	1	1	15	3.5
Using IBL enhances creativity, innovation, and critical thinking.	12	2	0	1	15	3.7
IBL practical activities and open-ended tasks increase retention rate.	11	3	0	1	15	3.6
IBL is important because it motivates all types of students.	12	2	1	0	15	3.7
IBL enhances the design of meaningful learning experiences by learners.	10	3	1	1	15	3.5
IBL promotes conceptual understanding in chemistry.	11	1	1	2	15	3.4
IBL instills confidence in the learner.	12	1	1	1	15	3.6
IBL gives learners opportunities to apply learned chemistry content.	11	3	1	0	15	3.7
IBL makes chemistry more enjoyable.	13	1	1	0	15	3.8

The above findings demonstrate that most chemistry teachers hold positive perceptions about the implementation of inquiry-based learning in chemistry classrooms. The participating teachers agreed that inquiry implementation is an effective learning approach that encourages critical thinking, creativity, and innovation, *M =3.7*, item 2; motivates all types of students, *M=3.7*, item 5 and makes chemistry more enjoyable, *M = 3.8*, item 10.

The interview responses also revealed that participants have positive views and attitudes towards inquiry-based learning. This is affirmed by the following interview excerpts.

> *"Inquiry-based learning is useful and very effective in enhancing students' learning since it motivates all students and makes them very active during learning."*
>
> *"It is valuable as it allows learners to reflect on what they understand in chemistry experiments, think critically about how and why things are happening in chemistry, and enable them to solve problems.*
>
> *"Inquiry-based learning makes chemistry learning more interesting and enjoyable resulting in the enhancement of learners' knowledge and understanding of chemistry concepts that are abstract."*

In the interviews, the participating teachers maintained that inquiry-based learning enables learners to apply learned chemistry content through conducting practical investigations. This is affirmed aptly by the following two interview excerpts:

> *"Inquiry-based learning engages learners in hands-on experiences with scientific or natural phenomena thus increasing conceptual learning,"*
> *"Giving students opportunities to carry out practical investigations contributes to significant gains in science literacy, science process skills, and experimental skills thus leading to better acquisition of chemistry concepts."*

Teachers' Enactment of the inquiry approach in their classrooms

To determine the extent to which chemistry teachers enact inquiry-based learning practices in their classrooms, they were requested to give responses to items that addressed the practical implementation of the inquiry approach in the classroom. The responses to the items indicated that their teaching practices were at variance with the expectations of this approach. Epistemologically, the transmissive approach is still the order of the day in their lessons. The findings are shown in Table 2 below.

Table 2: Teachers' enactment of inquiry-based learning practices in their classrooms

	SA	A	D	SD	Total	Mean
Learners work collaboratively in pairs or small groups.	1	8	5	1	15	2.6
Learners are given opportunities to explain their ideas.	3	7	4	1	15	2.8
Learners discuss and debate on the topics we are working on.	4	6	4	1	15	2.9
Learners to carry out practical activities.	1	3	4	7	15	1.9
Learners conclude from experiments they have carried out.	3	6	4	2	15	2.7
Learners do experiments by following teachers' instructions.	10	2	2	1	15	3.4
Learners design their experiments.	0	2	7	6	15	1.7
Learners test their ideas by conducting investigations.	0	4	6	5	15	1.9
Learners can work with little or no guidance.	0	4	7	4	15	2.0

These findings reveal that though chemistry teachers have favorable perceptions of the inquiry approach, they are less inclined to implement it in their classrooms. Considering item 14, "learners to carry out practical activities", item 17 "learners design their experiments" and item 19 "learners have opportunities to work with little or no guidance", mean scores of 1.9, 1.7, and 2.0 were obtained respectively. This indicates that the learners have limited independence, opportunities, and responsibilities to plan scientific investigations. Thus, the participating teachers still drive and control the learning process.

To gain insight into the participating teachers' epistemological orientation, the researcher conducted some lesson observations. Most of the lessons observed were content rich and the teachers used transmissive teaching methodologies that were geared towards enhancing the performance of learners in examinations. The results of the study, therefore, revealed that the majority of chemistry teachers are still to adjust and shift from transmissive pedagogies to learner-centered teaching methodologies.

It can also be noted that a few teachers are trying to enact the inquiry approach in their classrooms, hence there is a need to provide chemistry teachers with pedagogical training so that they can adopt and adapt to the expectations of this teaching pedagogy.

Difficulties teachers encounter in enacting inquiry-based learning practices in their classrooms

Regarding the difficulties they encounter, as they implement inquiry-based learning practices in their classrooms, the chemistry teachers highlighted: a lack of adequate teaching materials, equipment, and facilities (*M = 3.4*); limited IBL lesson preparation time (*M = 3.3*); large class sizes (*M =3.1*); limited knowledge, skills, and experiences in inquiry-based learning (*M = 2.9*) as the main constraints. The results are shown in Table 3.

Table 3: Difficulties in implementing inquiry-based learning

	SA	A	D	SD	Total	Mean
IBL is not promoted in the curriculum.	1	4	5	5	15	2.1
The time to prepare IBL lessons is not adequate.	7	6	1	1	15	3.3
Teaching materials, equipment, and facilities are not adequate.	9	4	1	1	15	3.4
I have limited knowledge, skills, and experience in IBL.	6	4	3	2	15	2.9
IBL is difficult to assess.	1	4	8	2	15	2.3
I am not confident with IBL.	1	5	4	5	15	2.1
The class sizes are too large for IBL to be effective.	6	6	2	1	15	3.1

The teachers raised the concern that they had limited time to plan, prepare and conduct inquiry investigations. They indicated that more time is required to prepare inquiry-based lessons, and this is not readily available since they had heavy teaching loads. This concern raised is evident from the following interview excerpts:

> *"Implementation of inquiry-based learning needs a considerable amount of time."*
>
> *"We do not have adequate time to carry out all experiments as we are rushing to finish the syllabus."*

This leaves chemistry teachers with no alternative but to drill learners so that they get good grades during examinations. It can thus, be noted that while the Zimbabwean chemistry

competence-based curriculum promotes the implementation of inquiry-based learning, in reality, it gives teachers limited autonomy to teach through inquiry.

Teachers also felt that their class sizes are too large to effectively teach through inquiry. Because of this, their zeal to implement this approach is reduced as a result they resort to teacher-centered approaches for their overcrowded classrooms. The following interview excerpts help to illustrate this.

> *"I have many learners in my class, the class is overcrowded, and this hinders effective learning to take place".*
> *"It is difficult for me to implement inquiry-based learning because classes are too large, classroom management and disciplinary issues as well as plenty of time spent for preparation of materials and arrangement of the classroom".*

The effective implementation of the inquiry approach was found to be constrained by the lack of adequate teaching materials, equipment, and facilities. If schools lack material resources and facilities, teachers are forced not to implement inquiry learning effectively and consistently in their classrooms.

> *"Our schools are poorly resourced, we do not have sufficient resources, apparatus, and chemicals to conduct inquiry practical work".*

"My teaching using the inquiry approach is affected by lack of appropriate textbooks and infrastructures such as laboratories".
"Lack of laboratories and finances to purchase chemicals limits the use of the inquiry approach in chemistry classrooms".

Another concern revealed in the study was that teachers have limited knowledge, skills, and experiences in inquiry-based learning. The teachers raised the concern that they do not have sufficient knowledge and skills to prepare inquiry-oriented lessons.

"I lack skills on how to plan, prepare and implement inquiry-oriented lessons".
"My knowledge and skills in implementing the inquiry approach in science teaching are limited, therefore I need the training to enhance my knowledge and skills."

DISCUSSION OF FINDINGS

The results show that the participating rural teachers have favorable perceptions towards inquiry-based teaching and learning chemistry. The findings affirmed the usefulness of this approach in chemistry education. This is because its use is advantageous in that it promotes creativity, innovation, and critical thinking, motivates all types of students, makes chemistry more

enjoyable, actively engages learners, and enhances learners' knowledge and understanding of abstract chemistry concepts.

Researchers such as [19], [1]; [20]; [5]; [21] have also highlighted similar benefits of inquiry-based learning. For instance, [21] pointed out that inquiry-based learning develops creativity, innovation, communication, collaboration, critical thinking, and problem-solving skills in learners.

Consistent with the study's findings, [5] observed that inquiry-based science education is key to making science learning interesting and enjoyable, increasing learners' conceptual understanding of science and developing their experimental skills.

While chemistry teachers have favorable perceptions toward the inquiry approach, they are reluctant to adopt and enact it in their classrooms. The limited adoption of inquiry-based learning in the classroom was due to several constraining factors. Studies by [22], [5], [23] have shown a similar trend of hesitancy to adopt the inquiry approach in science classrooms.

For instance, [22] noted that even if teachers consider IBL an important and valuable approach, they still refrain from implementing it in their science classes. [24] have also observed that contextual and situational factors affect teachers' adoption of inquiry-based learning. This affirms that curriculum implementation is context specific. The findings also reveal a negative

association between teachers' beliefs inquiry-based learning and its actual implementation in the classroom.

This is consistent with the findings of [25] who observed that tension exists between the teachers' positive beliefs in favor of inquiry-based learning and the translation of these into actual practice due to internal and external concerns. Such tension hinders the successful implementation of the inquiry approach.

Several variables inhibiting the successful implementation of inquiry-based learning were identified in this study. The most frequently mentioned factors were lack of adequate teaching materials, equipment, and facilities, limited preparation time, large class sizes, as well as limited knowledge, skills, and experiences in using the inquiry approach. The findings are consistent with [23] who noted that the availability of adequate teaching materials, equipment, and facilities enhances the effective implementation of the inquiry approach.

[26] also observed that a lack of resource materials and facilities such as science laboratories, hurts the confidence of teachers to enact inquiry-based approaches in their science classrooms. On the other hand, researchers such as [27], [5] as well as [6], have pointed out that the enactment of inquiry-based learning in science teaching and learning has been hindered by the lack of laboratories in schools.

Regarding the issue of limited time for preparing inquiry-oriented lessons, [12] argued that science teachers face challenges related to inadequate time while enacting the inquiry-based learning approach. On the other hand, [28] have observed that lack of time for lesson preparation, and difficulties in classroom management complicate the process of inquiry-based learning implementation in classrooms.

The results of this study are confirmed by [29] who argues that teachers need more time to extensively prepare and implement inquiry-oriented learning activities. Because of the lack of time for conducting inquiry-oriented learning activities and the fear of not achieving educational achievements, many teachers resort to frontal teaching, traditionally the fastest way to convey information to all students. However, such information transfer does not guarantee a successful learning process.

The study revealed that large class sizes are still a factor that influences teachers' implementation of inquiry-based learning pedagogy in chemistry classrooms. The finding is consistent with [14] who observed large class sizes are tremendous constraints that challenge the ability of science teachers to implement inquiry-based learning pedagogy. [12] noted that large class sizes are a hindering factor for implementing inquiry-based learning.

In an overcrowded classroom, inquiry-based learning is hindered since the teacher is not able to assist individual students and small groups thus, the teacher resorts to the transmissive pedagogies, which are more effective and enable the coverage of curriculum content in a given time. Moreover, [22] argue that large classes can be a constraint in conducting practical experiments since inquiry-based learning requires more support for individual needs than traditional laboratory work. Such a constraint can result in predictably difficult student behaviors and result in teacher burnout.

The results of the study further show that the process of planning and implementing inquiry-based learning requires appropriate teachers' professional knowledge, skills, and experiences in inquiry-based learning. [23] argued that science teachers do not have sufficient knowledge and skills to plan and practically implement inquiry-oriented learning activities. The implication is that a positive attitude toward inquiry-based learning held by the participating teachers does not translate into actual practice in chemistry classes.

Furthermore, [29] argues that only a teacher who has the appropriate theoretical knowledge about the rudiments of the inquiry approach and has developed pedagogical-didactic-methodical competencies for its implementation in the teaching practice will realize it in a quality way and thus achieve all the benefits of such learning. Due to a lack of adequate knowledge about inquiry-

based learning, teachers often resort to traditional forms of teaching in which they participated during their formal education because they feel competent in it.

CONCLUSION

Chemistry teachers have favorable perceptions about the implementation of the inquiry approach however, they are implementing it in their classrooms to a very limited extent due to several constraining contextual factors.

Chemistry teachers still prefer the traditional teaching mode, and it is an arduous task to shift them from this transmissive approach to an engaging learner-centered one. Moreover, the chemistry teachers' knowledge and skills related to inquiry instruction are limited.

RECOMMENDATION

The study recommends professional development training and support of chemistry teachers on the practical implementation of inquiry-based learning to enhance their pedagogical content knowledge and skills.

LIMITATIONS

The study has some limitations in that the participants were drawn from rural schools in one district therefore the findings of the study cannot be generalized to urban schools and other districts in the country. Future recommendations are that a similar study be carried out including participants at urban, peri-urban, and private schools in several districts, to yield findings that will represent a variety of contexts.

In addition, the perceptions of chemistry learners about inquiry-based learning could be investigated in future research.

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