Teachers' Decisions on the Practice of Inquiry-Based Practical Work in School Chemistry as Mediated by Learner Population Characteristics

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Abstract

Numerous factors reportedly impede the successful implementation of inquiry-based practical work in school science. Some of these factors are related to learner population characteristics. This study explored how learner population characteristics influenced the way teachers facilitated inquiry-based practical work in the school chemistry laboratory in some South African schools. Using a qualitative study, data was collected by means of semi-structured interviews with teachers, focus group interviews with learners, practical work observations and field notes. Data were analysed through conventional content analysis and constant comparative techniques analysis methods. Findings revealed that in determining the extent of learner autonomy during inquiry activities in the chemistry laboratory, teachers considered the characteristics of learner populations. Learners' limited knowledge and skills in laboratory work, negative attitudes towards inquiry activities and a lack of discipline caused teachers to avoid risk and limit learner autonomy.

1. Introduction

The success or failure of inquiry-based practical work implementation in school science has reportedly been linked to a wide range of factors. The factors are numerous and complex in nature [1]. The factors serve to promote or impede meaningful inquiry practice. The factors may be context related, teacher related or learner related [2]. Some studies consider the management of learners in science classrooms as a cause for concern and constraint in the practice of inquiry [3]. Learner population characteristics vary considerably across different school contexts. The nature of learner population characteristics in high schools warrants special attention in efforts to ensure meaningful learning experiences. Inquiry-based chemistry syllabi are developed at national levels to be implemented in varied school contexts in terms of learner populations. This study found it worthy to investigate the nature of inquiry experienced by learners as it is mediated by learner population characteristics and consequently teachers' decisions.

Accordingly, the study sought to explore how learner characteristics influence the way in which teachers facilitate the inquiry actions of question formulation, experiment procedure design and solution articulation. The study was conducted in the context of the Curriculum Assessment Policy Statement (CAPS), which was put in place as part of continued efforts in curriculum innovation in post-apartheid South Africa [4]. CAPS espouses an inquiry-based science education by emphasising the development of practical scientific inquiry and problem-solving skills, constructing and applying scientific knowledge and developing the Nature of Science (NOS) and its relationship to technology, society and the environment [5][6].The curriculum is also considered by the Department of Education (DoE) in South Africa as a way of equitably providing access to science education to all learners [6]. The findings of this paper has the potential to provide points to consider in the debates on how the goals to provide equitable access to learning experiences such as inquiry-based practical work are being achieved. Chemistry is taught in secondary schools as part of Physical Sciences (chemistry and physics).

2. Research questions

This paper sought to answer the following research question: *How do learner population characteristics influence the manner in which teachers facilitate inquiry-based practical work in school chemistry?* Accordingly, the following secondary research questions were formulated: (1) which learner population characteristics play a significant role in influencing teachers' decisions in the practice of inquiry-based practical work? (2) How do the learner population characteristics promote or impede the successful practice of inquiry-based practical work?

3. Literature review

Three decades ago, scholarly debates had already established the importance of studying the influence and role of the diversity of human characteristics in the implementation of inquiry-based science education [7], [8]. One of the recommendations made after research efforts to evaluate the success of inquiry in science education was to consider the role and influence of the diversity of human characteristics. This placed teachers and learners' characteristics as important elements in the fray of debates on inquiry. In the design of inquiry-based science curricula, teachers and learners are positioned at the forefront of implementation because they are directly placed in the classroom. This study is important because it enriches the debates by focusing specifically on how learner population characteristics influence the practice of inquiry-based practical work in the school chemistry laboratories where learners are exposed to chemicals that are potentially hazardous.

Evaluation reports on the implementation of inquiry in the science laboratories by scholars reflect a practice fraught with challenges [9]. This has generated lively scholarly debates and research drives over decades on the complexities of implementing inquiry in science classrooms. Voices in literature are united in asserting that there are significant discrepancies between the goals of inquiry in national science curricula and the actual practice of inquiry in science laboratories [10]. Some of the voices have been quick to castigate the inquiry practice efforts through practical work as not being useful and beneficial as it is allegedly reported [9]. However, other voices consider this an unfair criticism by claiming that not all variables, factors and issues have been considered when research projects to evaluate the success of inquiry-based science education were conducted. Whole host of variables, factors and issues, which include teacher attitudes and behaviour, content and nature of laboratory activities, instructional goals, social variables and management, inundates the laboratory environment [8]. Furthermore, teachers are encouraged to consider the uniqueness of learners seriously, when they plan inquiry-based activities in the science laboratories [7]. In this study, learner populations are considered as the enrolled groups of learners who can be identified by their socio-cultural backgrounds in the different schools. The socio-cultural backgrounds can be similar or diverse. Learner population characteristics such as skills level in inquiry, problem solving and literacy in mathematics, reading and equipment and material manipulation are crucial to the successful and meaningful practice of inquiry-based laboratory work [8]. Teachers also have to attend to issues such as learner populations' behaviour and attitudes as they work to facilitate inquiry in the chemistry laboratory [8]. Practical work in the chemistry laboratory comes with a monumental responsibility pertaining to safety issues and precautions. The teachers and learners have to work safely with the different chemicals and materials, some of which are hazardous. Hence, learners should develop favourable attitudes that promote successful inquiry [8]. Learner behaviour in the chemistry laboratory should be in strict adherence to a disciplined culture of maintaining order and observing safety procedures [11].

4. Conceptual frameworks

A construct and a conceptual framework have been used to guide this study. First, the construct of inquiry in the context of the school chemistry laboratory had to be clearly defined for the study. The inquiry concept in science scholarship is characterised by ambiguities in meaning because of its complex and multi-faceted nature [12]. Secondly, a socio-cultural perspective was used as a lens through which to examine how learner population characteristics influence teachers as they facilitate inquiry in the school chemistry laboratory.

4.1. Inquiry in school chemistry

In terms of interpretation, inquiry for school science has been a subject of contentious debate. However, scholars agree that the nature of inquiry for science teaching and learning is not fixed [10]. A synthesis of literature and national curricula results in a long list of actions that are considered inherent to inquiry [12]. Consequently, school science teachers have a wide variety of inquiry skills at their disposal to choose from as they engage learners in practical work. This study focused on three inquiry actions, namely question formulation, experiment procedure design and solution articulation [13]. Teachers have the leeway to structure inquiry activities in the school chemistry laboratory in such a way that learners may have autonomy over some or all of the inquiry actions. Consequently, learners may be engaged in inquiry to varying degrees and complexities [10].

4.2. Socio-cultural perspective

In spite of what national curricula promulgate about inquiry for science classrooms, the only real inquiry is the one implemented by teachers and learners [12]. This is the inquiry practised by teachers and learners as a product of their interactions, which interface at multi-dimensional levels. From a socio-cultural perspective, people jointly construct meanings, values and norms and develop emotional understandings during social activities such as inquiry-based laboratory work in school chemistry [14]. It is posited that classrooms worldwide are increasingly becoming diverse [15]. Furthermore, learner population characteristics are more complex, reflecting the rapid transformations that characterise their socio-cultural backgrounds. Learner populations may exhibit certain characteristics that teachers need to take into account as they plan inquiry activities in the context of a chemistry laboratory. Chemistry practical work is one practice that is fraught with challenges in terms of safety and precautions. Furthermore, inquiry entails active participation of learners as they closely collaborate, co-operate and communicate in the laboratory. The nature of learner population characteristics in terms of attitudes, knowledge and skills for laboratory work and discipline are brought to the fore. Inquiry-based science education that has a chance at success should accommodate the needs of the learner populations [7].

5. Methodology

The study adopted an interpretive design in the form of a case study. The case study sought to explore the manifestation of a phenomenon [16]. The phenomenon was how learner population characteristics influenced teacher decisions on whether or not to give learners autonomy over inquiry actions in the school chemistry laboratory. In order to investigate how learner population characteristics influenced the manner in which teachers facilitated question formulation, experiment procedure design and solution articulation, the study was taken to seven schools. The schools were drawn from seven school-contextual settings as defined by different sociocultural backgrounds. School ATS was an African township school. The learner enrolment comprised both boys and girls, all of African origin. It is an example of the schools that were formerly reserved for learners of African cultural backgrounds during the apartheid era. The same applied to school ARS, which was an African rural school with learner enrolment comprising both boys and girls of African origin only. School FMC was a former Model C girls’ school enrolling girls from multi-cultural backgrounds. However, white girls formed a significant majority. Former Model C schools were schools reserved for whites only during apartheid [17]. School FCS was a former coloured school with a learner enrolment comprising boys and girls from multi-cultural backgrounds. However, learners of mixed race were proportionally higher, compared to the other races. This school was formerly reserved for coloured learners during the apartheid era in South Africa. School FIS was a former Indian school with a learner enrolment comprising boys and girls from multi-cultural backgrounds. Although it was a former Indian school, there were large numbers of learners from African cultural backgrounds. The school was formerly reserved for learners from an Indian cultural background during the apartheid era. School INS was an independent school with its learner enrolment comprising boys from multi-cultural backgrounds. However, white learners formed a significant majority. Learners from the school write examinations administered by the Independent Examinations Board (IEB) in South Africa. This is in contrast to the situation in other school contexts where learners write examinations administered by the Department of Basic Education (DBE). School PPS was a private school with boys and girls from multi-cultural backgrounds. African learners constituted a significant majority. These school contextual settings emerged after the dawn of democracy when policies and laws dividing education along racial lines were abolished [18]. During apartheid, learners of different races were schooled separately and individual departments were in charge of their education [4]. The significance of conducting the study in the different school contexts mentioned above was to ensure that the sample comprised of different learner populations. Taking the study to different learner populations also served as a measure to ensure trustworthiness of the study findings.

Data were generated in the form of narratives through semi-structured interviews with teachers and focus group interviews with learners. The observed inquiry-based practical activities and other on-site observations and reflections by the researcher resulted in other textual data. One teacher from each of the seven schools was selected using purposive sampling techniques. Accordingly, seven teachers were interviewed. The teachers had to be using inquiry-based practical work as one of the teaching and learning strategies. Three of the teachers were identified through word of mouth. The researcher used the information provided by colleagues in the communities of practice. Teachers know how their colleagues teach in terms of level of expertise. The researcher identified the other four teachers through visits to several schools to conduct initial investigations, which led to teacher selection. This process was much more time and resource consuming than word of mouth. The schools were also selected using purposive sampling techniques because varying school contexts was important for the study. Selection of the learners was done through convenience sampling. These learners had to belong to classes taught by the selected teachers. Consequently, focus group interviews (n=7) were conducted with a group of about six learners from each of the seven schools. Furthermore, inquiry-based laboratory activities (n=7) facilitated by the teachers for the learners were observed and videotaped. Two teachers were observed teaching grade 10s. These were from schools FCS and INS. Five teachers from ATS, FMC, ARS and FIS were observed teaching grade 11 learners. One teacher in school PPS was observed teaching grade 12 learners. Data were analysed using the conventional content analysis techniques and constant comparative analysis techniques [19], [20].

6. Findings of the study

This section discusses the findings of the study. Initially, the findings regarding each school setting are presented separately. Next, emerging themes from the findings of the study are pointed out. It was interesting to observe how teachers from four different contexts facilitated inquiry in a similar way. The teachers provided learners with investigative questions and steps of the experiment procedures. Learners were given autonomy over solution finding. This observation was made in the former Model C School (FMC), African rural school (ARS); former coloured school (FCS) and the independent school (INS).

FMC is a former Model C School. Learners have regular exposure to practical work. The result is that they have well-developed manipulative skills. However, the learners expressed reservations about working in groups. They claimed that it was a waste of time, since they found it difficult to agree on how to do things. After being asked to explain why group work is difficult one learner said, “Because we all have different opinions. Everybody has different opinions on how fast it should be done or how accurately you have done it and some people will think that she didn’t do it well enough now I must redo it and then the other person says oh but you are wasting time”.

The teacher also complained that they normally tried to work as friends and she discouraged that by selecting the groups herself when they did the practical work. Learners were provided with the question and steps of the experiment procedure. However, the learners worked to analyse the data collected and make interpretations. They drew conclusions in which the solution to the question was articulated. Group work is very important for inquiry. The learners’ negative attitudes to collaboration and co-operation stood in the way of effectively implementing inquiry-based practical work.

ARS is an African rural school without a science laboratory. For practical work, equipment and materials were set up in a classroom. Furthermore, a teacher who worked as an external agent and brought the equipment and materials with him facilitated the practical work. The result was that learners were rarely exposed to practical work and consequently their knowledge and skills on inquiry and laboratory work were limited. The teacher incorporated the use of computers and software as he facilitated practical work. Learners felt very anxious because they were not familiar with the use of a computer. Some learners claimed they did not always know what was happening while the experiments were conducted. When the researcher asked the learners about the challenges they faced when conducting experiments one of the learners said, “One thing that gives me fear is the computer.” Learners did not have prior experiences with computers. Under the circumstances, the teacher claimed that he used the practical activities as a way of consolidating learners’ conceptual development. He perceived the learners’ conceptual development to be very low. He saw it as a way of helping learners understand concepts better after the concepts had been taught to them in previous lessons using explanations. Consequently, learners were provided with questions for the investigations and the steps of the experiment procedures. Learners were left to analyse and interpret the data so that they could provide solutions to the questions.

FCS is a former coloured school. The teacher expressed some frustration about the learners’ behaviour. He indicated that generally it was difficult to control learners in the school because they were usually rowdy and noisy. He said, “Normally when they come in they are chaotic. I have to shout to keep them quiet”. This was not the only situation that he had to deal with. He further said that learners had a tendency to vandalise and remove equipment from the laboratory. Consequently, he kept the materials and equipment in a locked storeroom and only took out the things they needed for specific practical activities. During the laboratory work he facilitated for learners, he mounted one apparatus for the experiment and the groups of learners took turns to conduct the experiment while he watched them closely. The teacher also mentioned that learners were not very keen to participate when they were required to conduct hands-on activities. They lacked interest in the practical work. Under these circumstances, learners were provided with the question and steps of the experiment procedure. The learners analysed and interpreted the results, and came up with solutions for the posed question.

INS is an independent school. Learners regularly have opportunities to conduct practical work in the laboratory. The teacher uses the laboratory as her base; therefore, learners always attend chemistry lessons there. The teacher mentioned that they always tried to instil in learners good conduct values of how to behave in a chemistry laboratory so that they would not try to do things that they were not supposed to. She said, “I think it takes quite a while to teach them how to behave in a laboratory because they are learning manners and they are boys; they want to empty everything together”. She further mentioned that learners found chemistry very abstract when it was taught through expository methods that heavily relied on explanations. She argued that engaging them in practical work was a way of consolidating conceptual understanding and dispelling misconceptions that might have developed as the teacher was explaining. Evidently, in the practical activity learners were required to predict the electrical conductivity of a number of materials and write down their predictions. The learners then worked in groups to set up apparatus to test the conductivity of the materials. Learners were able to collect the materials and mount the apparatus with minimal help from the teacher. However, the steps of the experiment procedure were available in workbooks for learners to use. After collecting the data, learners worked in groups to analyse and interpret. They then compared their predictions and results from the experiments. Therefore, learners were provided with the question and the steps of the experiment procedures and they figured out the solutions.

In the remaining three schools, the African township, the former Indian and the private school, learners were given more autonomy over inquiry actions. Learners were allowed to explore question posing and designing of steps of experiment procedures.

ATS is an African township school. Learners in the school share one scarcely resourced science laboratory. Consequently, learners do not have the opportunity to conduct chemistry practical work on a regular basis. Evidently, the development of learners' manipulative skills and inquiry skills is compromised. In the laboratory activity that was observed, the teacher first had to conduct a demonstration on how to execute the steps of the experiment procedure before the learners could conduct their own experiments in groups. What was also significant was that the teacher set up the apparatus for each group. He did not allow them to touch anything before he instructed them to do so. It was evident that the teacher provided learners with the steps of the experiment procedure. However, he encouraged the learners to use the information provided about the experiment, which included the problem and the aim, to formulate the question for the investigation. After data had been collected, learners were allowed to analyse it and reach conclusions by themselves, thereby providing the solution to the question. The teacher also complained about the tendency of learners to remove equipment and materials from the laboratory without permission and at times vandalise the equipment. This could explain why he set up the experiment apparatus for them and made protracted efforts to show them how to execute the steps of the experiment. Consequently, learners were allowed to formulate the question from information provided and articulate solutions while the teacher provided them with the steps of the procedure.

FIS is a former Indian school. The teacher uses the science laboratory as her base; therefore, she does not have to share it with other teachers. The teacher mentioned that the learners were excited about opportunities to conduct practical work. She said they would not let her conduct a demonstration without offering to help her. Consequently, she planned the practical activities that provided hands-on opportunities for learners. She said, "I see continued value in practical work especially with these grade 10s that I have groomed; they are itching and they don't even want me to demonstrate for them they want to handle things themselves…" During the laboratory activity, learners were required to design steps of an experiment procedure to prepare an insoluble salt, copper (II) carbonate. In previous lessons, learners had been exposed to the topic of solubility through explanations and other practical activities. Learners worked in groups to design the steps of the procedure and select materials. Accordingly, although learners figured out the procedure for conducting the experiment, the question and the solution was available to the learners.

PPS is a private school. The teacher uses the laboratory as his base station, which he does not share with other teachers. Learners regularly have the opportunity to work in the laboratory. During the practical activity that was observed the teacher planned the activity in such a way that groups of learners worked together to design the steps of the experiment procedure to verify the experiment. They did not receive help from the teacher and they had to figure out everything for themselves. Accordingly, the laboratory session lasted three hours. After the learners had finished their experiment, they called the teacher to come and test the gases produced from the chemical reactions as a way of checking whether the procedures the learners devised were appropriate. If the tests failed learners would start all over to design another procedure and conduct the experiment. The learners demonstrated that they possessed developed manipulative skills. They could select equipment and materials on their own. The teachers also allowed the learners to use all the information provided to formulate a possible question for the investigation. Accordingly, using the solution, learners formulated the question and designed steps of the experiment procedure.

The analysis of the findings reveal three learner population characteristics that played a significant role in influencing teachers as they facilitated inquiry in the chemistry laboratory. The three characteristics are learners' knowledge and skills in inquiry-based laboratory work, learners' attitudes towards inquiry in the chemistry laboratory and issues of learner discipline in the chemistry laboratory.

7. Discussion

The seven teachers all followed the basic structure of the scientific method as shown by the laboratory reports written by the learners. The reports were organised in sub-headings that includedthe experiment problem, experiment aim, question, hypothesis, materials to be used, steps of the experiment, apparatus diagram, tables of results/observations, analysis and interpretation and conclusions. However, the study focused only on how the teachers facilitated the formulation of the question, the design of the steps to execute the experiments and articulation of the solution. Articulation of the solution was contained under the conclusions section of the experiment report. The three inquiry actions were used as a yardstick to measure the extent to which learners engaged in inquiry [13]. The study findings point to three characteristics of learner populations that influence teachers' decisions when they plan inquiry activities for their learners. These are the learners' knowledge and skills in inquiry-based laboratory work, learners' attitudes towards inquiry and learners' tendencies to display unfavourable behaviours.

7.1. Learners' knowledge and skills in inquiry-based laboratory work

Open inquiry in which learners exercise autonomy over the whole process of inquiry in terms of question formulation, experiment procedure design and solution articulation is rare in school chemistry classrooms. It is important that learners be presented with essential information in response to their level of cognitive development [21]. However, learners have been known to engage successfully in open-inquiry activities such as science-fair projects [22]. The reality is that schooling provides the premise for learners to develop the necessary practical and inquiry skills [8]. The process can be relatively gradual and may take some time before learners can acquire the necessary skills to take complete control of their own learning in the chemistry laboratory. Despite this reality, teachers are there to ensure that practical work and inquiry is implemented in the chemistry classrooms as stipulated by the national science curricula. Inquiry and practical work knowledge and skills are gained gradually as the learners pass through the years of schooling. For this reason, teachers may conduct a learner's needs assessment on knowledge and skills formally or informally for inquiry-based laboratory work before the activities. Poor development of knowledge and skills in laboratory work and inquiry result in teachers taking control of most of the inquiry actions. Teachers believe they should provide learners with the necessary support during inquiry activities [23]. This study was conducted in high schools and teachers believe that learners come from middle school (grades 8 and 9) ill prepared for inquiry-based practical work. The teacher from PPS shared opinions on why learners lack the necessary knowledge and skills. He said,

> *The learners' lack of exposure from early stages to the laboratory setup and to that type of learning where they have to be involved with experiments is one thing that hinders or that acts as a setback and then coupled with that you find even up to Matric they don't know some of the apparatus even by name and to make it worse even if they know them they don't know what they should use them for so that is a problem. So it all goes back to the early stages like grade 8, grade 9 such that when they come to grade 10 they only think 'No we can just do this (learn science) without practicals (practical work)'. Now when you want to introduce practical work they tend to resist.*

Learners find it easier to work with the data collected during the experiments as they attempt to analyse and interpret. Therefore, teachers usually let the learners complete this task on their own. Furthermore, by providing the question and the steps of the experiment procedures teachers ensure that practical work is successfully conducted in the chemistry laboratories. In extreme cases for low achieving classes learners are engaged in practical work through methods such as teacher demonstrations supported by explanations [3].

7.2. Learners' attitudes towards inquiry-based laboratory work

Similar studies have established relationships between learners' attitudes towards inquiry-based practical work and the subsequent success or failure of the practice. Attitudes were linked to whether or not learners would benefit from the inquiry activities [24]. Learners who are excited about practical work encourage teachers to allow them more autonomy over inquiry processes such as planning of experiment procedures. Negative attitudes towards inquiry in the chemistry laboratory result in teachers providing enough information in the form of questions and steps of experiment procedures so that the practical activities can be completed. When learners are not motivated towards the inquiry activities they find it very difficult to formulate questions and procedures of experiments in limited periods such as laboratory sessions. Consequently, teachers will only allow learners autonomy over data analysis and interpretation so that they can draw conclusions. Similar research findings suggest that some learners do not take practical work seriously and consider it as an opportunity to play [2].

7.3. Issues of discipline in chemistry laboratory work

It is very risky to facilitate inquiry in the chemistry laboratory if good behaviour on the part of learners cannot be guaranteed. Knowledge of safety issues and necessary precautions that have to be put in place are crucial in the chemistry laboratory [2]. However, teachers have a duty to facilitate inquiry for all types of learner populations according to science curricula stipulations [10]. Teachers as classroom managers have the responsibility to maintain order. The task of maintaining order becomes paramount in contexts where learners are rowdy and chaotic. The efforts of maintaining order would then override consideration for effective learning such as successful implementation of inquiry-based practical work [3]. Consequently, if teachers perceive that the learners' behaviour does not support the practice of inquiry sufficiently, they tend to avoid risk and limit learner autonomy over most inquiry actions. They simply ensure that learners collect data under close supervision so that they can be left to work with the collected data and draw conclusions.

8. Conclusion and recommendations

Learner population characteristics play a crucial role in the way teachers facilitate question posing, experiment procedure design and solution articulation. According to the findings, learners' knowledge and skills in inquiry-based practical work, learners' attitudes towards inquiry and learners' behavioural issues in the chemistry laboratory significantly influence teachers' decisions to allow learners autonomy over inquiry actions. Limited learners' knowledge and skills in laboratory work, poor learner behaviour in the chemistry laboratory that disregards safety and precautions and a lack of interest and motivation towards inquiry practice result in the perpetuation of teacher control over inquiry processes. If learners are motivated, possess developed skills in inquiry-based practical work and comply with safety measures and precautions in the school chemistry laboratory, teachers do not feel constrained to allow them to explore most inquiry actions.

The inquiry actions investigated in this study were question posing, designing experiment procedures and solution articulation. The findings of the study seem to suggest that under unfavourable learner population characteristics teachers maintain control over question formulation and the designing of the steps of the experiment procedures in order to avoid risk and ensure that practical work is conducted successfully. Teachers feel comfortable allowing learners to take control of solution finding by using collected evidence to provide explanations for scientific phenomena. At this point, it is appropriate to follow up on the topic discussed earlier in this paper on how the goals of providing equitable access to inquiry-based practical work in South Africa are being achieved. It is worth noting that the varied learner population characteristics across the school contexts results in differential experiencing of inquiry by learners. In some school contexts, learners' inquiry experiences are limited while in other contexts they are more enhanced as determined by learner population characteristics. Efforts to provide equitable access to inquiry-based practical work in school science laboratories are being challenged. In some school contexts, teachers genuinely struggle to get learners to participate meaningfully in learning activities due to negative attitudes and behaviours. The teacher from school FMC said the following about his school, "For me, for them to get that culture of learning, to create that culture of learning I battle really with these learners so that they can get that culture of learning so much that we have educators that are quite despondent here". This demonstrates how severely negative learner population characteristics can affect the successful implementation of curriculum innovations such as inquiry-based practical work in chemistry. While this paper focused on learner population characteristics as factor that significantly influence the implementation of inquiry-based practical work in the school chemistry laboratory, it is important to acknowledge that more factors are involved. Previous studies affirm that the factors are numerous and of a complex nature [1].

It is recommended that issues and situations that are beyond teachers' control and result in the poor development of learners' knowledge and skills due to limited exposure to laboratory work should be addressed in schools. These include the lack of laboratory facilities and equipment in some school contextual settings. It is also recommended that schools work with different stakeholders such as parents to deal with learners' poor behavioural attitudes that do not support the practice of inquiry in the chemistry laboratory. Finally, teacher professional development directed at how teachers can address limited learner knowledge and skills, attitudes and learner disciplinary issues should be considered.

9. References

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