Chapter # 41

APPLYING INQUIRY-BASED LEARNING INTO PRACTICE: A CASE STUDY OF ONE RURAL SOUTH AFRICAN PHYSICAL SCIENCES TEACHER

Nomzamo Xaba[1], & Aviwe Sondlo[2]
University of Zululand, South Africa

ABSTRACT
The South African secondary school curriculum expects teachers to adjust their ways of teaching to include activities that involve learner participation. However, there is little to no support that is aimed at developing in-service teachers' effective inquiry-based practises from the Department of Basic Education (DBE). Therefore, this mixed-method research aimed to investigate whether Physical Sciences teachers' beliefs about inquiry-based learning transpired in their teaching. A quantitative method was used to determine the teachers' beliefs about inquiry and a qualitative method was used to analyse the selected teacher's classroom pedagogical practices and provide insights into whether their beliefs about inquiry translated into their teaching practices. An adopted version of the Science Curriculum Implementation Questionnaire (SCIQ) was used to determine the teachers' beliefs while an Electronic Quality of Inquiry Protocol (EQUIP) was used to evaluate the selected teacher's pedagogical practices. The findings of this study indicate that the Physical Sciences teachers in the Zululand District generally had a positive belief about inquiry-based learning. However, the selected teacher's pedagogical practices did partially reflect their beliefs about inquiry. The qualitative method it was found that the selected teacher was centred within developing inquiry (Level 2).

Keywords: inquiry-based learning (IBL), in-service teachers, professional development.

1. INTRODUCTION

Over the past two and a half decades, the South African school curriculum underwent numerous reforms. The first official post-democratic curriculum was called Outcomes-Based Education (OBE)/Curriculum-2005, followed by a revised national curriculum statement (RNCS) and currently the curriculum assessment policy statement (CAPS) (Russell, Sirota, & Ahmed, 2019). All these curriculum changes over the years had different expectations for science teachers' pedagogical practices. Despite these curriculum changes, the country continues to perform worse in Physical Sciences and Mathematics annually (Naidoo & Sibanda, 2020). In the year 2021, only 18% of the Physical Science Grade 12 cohort who wrote their final year examinations passed and out of which only 15% passed with over 60%. This means, 4 out of every 100 Physical Sciences Grade 12 learners got 60%. This raises concerns because Physical Sciences is one of the subjects essential for STEM careers globally. As an attempt to alleviate the situation, the DBE through the CAPS document developed specific aims that are intended to encourage teachers to modify their teaching strategies. The inquiry-based approaches are used to advocate or to stimulate learner participation with the hope to improve the secondary school pass rate. Specific aims are teachers' guidelines on preparing learners to meet the challenges of society (DBE, 2011). CAPS comprises of three Specific Aims and inquiry-based learning is under specific aim 2 and the purpose of specific aim 2 as stipulated in the CAPS, is to encourage teachers and learners to develop (i) the construction and application of scientific and technological knowledge (ii) promote knowledge and skills in scientific inquiry and problem-solving, (iii) and an understanding of the nature of science and its relationships to technology, society, and the environment (DBE, 2011). All the above-mentioned skills are considered core skills for scientifically literate citizens (Mokiwa, 2014; DBE, 2011) and the adoption of inquiry-based learning is viewed as one of the possible solutions when teaching Physical Sciences as stipulate by the CAPS curriculum. Several countries support the adoption of inquiry-based learning (IBL) approaches by teachers as a pedagogical approach. The approach is suitable to motivate and stimulate learners' interest in science, develop their conceptual understanding, and motivate teachers to teach science and the nature of science (Minner, Levy, & Century, 2010).

Although there has been growing advocacy for IBL, teachers in South Africa are still struggling to implement this approach due to the variety of factors including not enough teaching time, dilapidated infrastructure, and lack of school resources to mention just a few. In South Africa, almost 60% of schools are poorly resourced. As part of the DBE's classification system, schools are categorised based on their socio-economic factors which fall under five quantiles (Hall, Leatt, & Rosa, 2009). Generally, schools which fall under quantile one to three do not charge tuition and are usually in impoverished areas (60%), while those in quantile four to five are private schools and are normally located in affluent areas (40%). This study was conducted in the Zululand District which accounts for 16% of the Kwa-Zulu Natal province territory, making it the largest District in the province. It is a predominantly rural district, about half of the area is under the jurisdiction of traditional authorities, whereas the rest is privately owned or protected. Due to this, most of the schools in the Zululand District are classified under the quantile one to three and they do not have adequate resources and/or infrastructure. Therefore, this is one of the reasons we decided to investigate the study of this nature in the rural areas because there are limited studies conducted in the rural areas in South Africa.

A study conducted by Ramnarain and Hlatshwayo (2018) in the rural schools of Mpumalanga province in South Africa with similar contextual and socio-economic factors to this study found that the Physical Sciences teacher had positive beliefs about the implementation of IBL. However, they did not know where to start, and contextual factors were among factors that hindered them to adopt inquiry-based learning. To solve this challenge, we decided to develop and facilitate a two-day cycled teacher training workshops in the Zululand District as an attempt to assist science secondary school teachers on how to implement IBL in their teaching environments. On the first day of the workshop, teachers were asked to respond to a questionnaire which aimed at eliciting their beliefs about IBL. Then they remaining time were spent training teachers on how to adopt inquiry-based pedagogies in their lessons using a repertoire of strategies which extensively drew from the improvisation framework, as we were considering their poorly resourced teaching contexts. To provide rich insights for the purpose of this research, we selected one teacher to conduct classroom observations as a follow-up method to establish whether their beliefs were in line with their classroom practices. As a result, this research mainly focused on IBL questions and pedagogical practices. Thus, the following research questions sought to guide this study:

i. What are the Physical Science teachers' beliefs about the implementation of inquiry-based learning in their classrooms in the Zululand District?
ii. Do the classroom teaching practices of the Physical Sciences teacher in the Zululand District reflect their beliefs about inquiry-based learning?

1.1. Defining Inquiry-Based Learning (Ibl)

IBL is a widely researched area across various disciplines (NGSCC Lead States, 2013; National Research Council, 2012). Thus, the National Research Council (NCR) (1996) defines IBL as activities where learners develop knowledge, understand scientific ideas, and understand how scientists study the natural world in their everyday lives. In an IBL environment, learners use experimental evidence to review what is already known. To achieve this, they use tools to gather, analyse and interpret data, propose answers, explanations, predictions, and communicate the results (NRC, 1996). IBL as an approach involves asking questions, coming up with hypotheses, empirical data collection, and making inferences and conclusions based on the data (NRC, 2007). The NCR (2011) listed five IBL features in a science classroom, these features include: (i) learner participates in scientifically orientated questions, (ii) prioritises evidence in responding to questions, (iii) uses evidence to formulate explanations, (iv) connects explanations to scientific knowledge, and (v) communicate and justifies explanations. That is why the 5E cycle learning model (CLM) has been widely used within science education research and in other fields as well (Asrizal, Yurnetti, & Usman, 2022). The 5E CLM contains the five key components of inquiry-based instruction which include: Engage, Explore, Explain and Extend/Elaboration and Evaluation which are all deemed crucial in fostering inquiry-based teaching and learning practices. Recently, there has since been advancements leading to development of the 4E X 2 Model. The 4E X2 Model was conceptualised using three key learning theories which involve (i) reflective practises (ii) inquiry-based instruction and (iii) formative assessments, which all have been proven effective in improving learners' conceptual development of scientific concepts during inquiry-based practises (Poti, Dudu, & Sebatana, 2022; Marshall et al., 2016).

Adopting IBL in a science classroom allows teachers to act as facilitators while learners become more self-directed. Learners are encouraged to come up with new knowledge independently, formulate and test hypotheses (Ramnarain & Hlatshwayo, 2018), promote autonomy and encourage learners to actively construct knowledge (Ramnarain & Hobden, 2015; Levy & Petrulis, 2012). Ramnarain and Hlatshwayo (2018) shows the importance of IBL and why it is strongly endorsed by the South African secondary school curriculum. However, in South Africa, IBL is still an unfamiliar territory and teachers are uncomfortable implementing this approach in their lessons (Ramnarain & Hlatshwayo, 2018; Ramnarain, 2016). Therefore, this research thought it was vital to establish the Zululand District Physical Sciences teachers' beliefs about IBL and their pedagogical practices since the CAPS endorses this approach in science lessons. Furthermore, inquiry-based learning can be adapted to address cultural relevance, incorporate local cultural knowledge and perspectives, which can make the learning more relevant and meaningful to learners in the rural areas.

2. TEACHER BELIEFS ABOUT INQUIRY-BASED LEARNING

The purpose of this research was to explore science teachers' beliefs regarding the use of IBL in the Zululand District. Calderhead (1996) defines beliefs as "suppositions, commitments, and ideologies that teachers have about their learners' learning of the subject matter" (p.715). Research on beliefs is important for the implementation of IBL since they influence teachers' pedagogical reasoning and instructional practices (Sikko, Lyngved, & Pepin, 2012). It is generally impossible to observe or measure beliefs directly, therefore, only what people say and do can be used to infer their beliefs (Pajares, 1992). If teachers' core beliefs are incompatible with inquiry-based pedagogies, they may serve as barriers to the use of inquiry as a teaching and learning strategy in their classrooms (Binns & Popp, 2013).

Correia and Harrison (2020) examined how secondary science teachers' beliefs about inquiry-based learning influence their formative assessment practices. They found that teachers who positioned themselves as facilitators adopted more open-guided inquiry-based approaches, whereas teachers who positioned themselves as shepherds adopted direct or traditional inquiry-based approaches. Hence, Ramnarain, Nampota and Schuster (2016) insinuate that how teachers teach is usually embedded in their belief systems. Although teacher beliefs and classroom practices appear to have strong links, the relationship between them is not linear (Correia & Harrison, 2020). This study was conducted because of this reason, to find out if the teachers' beliefs about inquiry-based approaches also manifested in their classroom practices.

3. INQUIRY-BASED APPROACH IN PRACTICE

As previously stated, there is a push in South Africa for more flexible school-based curriculum that draw on inquiry-based pedagogies rather than rigid, fixed curricula. As compared to other pedagogies, the IBL approach is believed to have more advantages (Correia & Harrison, 2020). According to Tan, Ong, Ng, and Tan (2022), there are four distinct types of IBL-related practices namely: (i) structured inquiry approach (a sequential process approach to inquiry-based learning) (ii) open-ended inquiry approach (a more learner-led approach to inquiry-based learning), (iii) problem-based inquiry approach (a problem-solving approach to inquiry-based learning) and (iv) guided inquiry approach (a more teacher-led approach to inquiry-based learning). Researchers active in this field have frequently reported that most teachers believe that these various IBL approaches would benefit their teaching and professional development (Correia & Harrison, 2020; Ramnarain & Hobden, 2015). Some studies have shown that teacher beliefs and classroom practices do not always align, which means that teaching science is not always translated into practice because of intrinsic and extrinsic factors (Friedrichsen & Dana, 2003). A study by Dai, Gerbino and Daley (2011) sought to determine whether Chinese middle and high school teachers follow an inquiry-based approach. They found that teachers are open to inquiry-based pedagogy, but they faced practical challenges when implementing it. Ramnarain and Hlatshwayo (2018) also examined teacher beliefs about IBL and their practice of inquiry in Grade 10 Physical Science classes in South Africa. In their survey, teachers were reported to have a positive attitude toward inquiry, however, various extrinsic and intrinsic factors contributed to challenges in enacting inquiry-based approaches in their teaching and learning contexts.

The influences of intrinsic and extrinsic factors are explained by Bronfenbrenner's ecological theory of development (1979). The extrinsic factors include cultural and physical aspects of the location where people live, as well as social aspects. The factors listed above are related to contextual factors found at school or in the curriculum implementation processes, and these are lack of resources, time, school culture, professional support, classroom management, class size, school type, and content coverage (Ramnarain et al., 2016; Lewthwaite, 2006). Intrinsic factors are associated with personal attribute factors, they are professional science knowledge, science teaching efficacy, science teaching interest and motivation, teacher content knowledge, and pedagogical beliefs (Ramnarain et al., 2016; Lewthwaite, 2006), subject matter knowledge (Abell, 2007; Gess-Newsome, 1999). Therefore, contextual factors can greatly influence the implementation of inquiry-based learning by teachers at schools.

4. METHODOLOGY

This research adopted a sequential mixed method approach (Creswell, 2014). During the teacher development workshop in Zululand District, KwaZulu Natal, South Africa, a questionnaire comprising different items was administered to Physical Sciences teachers. The questionnaire was completed by twenty-three (23) Physical Sciences teachers, with an average teaching experience of a few years to more than twenty-five (25) years. All the teachers taught in overcrowded classrooms and in schools where there were no laboratories. Figure 1 shows how the workshops were conducted.

Figure 1.
Example of how the physical science teachers work collaboratively in one of the workshops.

The workshops were specifically designed using an inquiry-based approach where teachers were positioned as learners so they could experience the benefits of this approach first-hand. The study purposefully and conveniently selected one 'novice' or beginning teacher, 'Mr. Motsapi' (pseudonym) for two classroom observations (two months apart) since his school was more easily accessible to us. Mr Motsapi has a Bachelor of Education degree and two (2) years teaching experience.

As earlier mentioned, an adapted version of the Science Curriculum Implementation Questionnaire (SCIQ) was used for quantitative data (Lewthwaite, 2001), now called the Scientific Inquiry Implementation Questionnaire (SIIQ). Several research publications have used the SCIQ to evaluate factors affecting science program delivery in Australian, New Zealand, and Canadian schools (Lewthwaite, 2004; Ramnarain, 2016). The SCIQ has forty-nine items, but only fifteen were selected as they were more aligned to the study's objectives. The fifteen selected SCIQ item statements which the teachers had to respond were on a 5-point Likert scale that ranged from 1 (strongly disagree) to 5 (strongly agree). Taking into consideration that the same instrument was used in South Africa by Ramnarain (2016), therefore, a piloting study was not obligatory. So, to determine the general trends in the Physical Sciences teachers' beliefs about inquiry, descriptive statistics, i.e., mode/median scores and percentages, were computed.

To evaluate teachers' classroom practices qualitatively, an electronic quality of inquiry protocol (EQUIP) was adopted (Marshall, Smart, & Horton, 2010). The EQUIP consist of four underlying constructs: Instruction, Curriculum, Interaction, and Assessment. This instrument was then used to observe Mr Motsapis' recorded classroom pedagogical practices. The EQUIP tool was particularly deemed as a suitable instrument because they are considered a reliable and valid instrument that supports inquiry-based practises (Poti, Dudu, & Sebatana, 2022; Marshall et al., 2010). Poti et al. (2022) ascertain that teachers can use EQUIP as a framework to make their instructional practice more intentional as they strive to increase the quality and quantity of inquiry instruction. In evaluating professional development projects, researchers can use EQUIP as an instrument to analyse the quantity and quality of inquiry being conducted. Since the instruments were used in different countries and by the authors, there was no need to validate them (Marshall et al., 2010). Cronbach's alpha coefficient for the instrument ranged between 0.880 and 0.888, indicating a strong internal consistency. Additionally, Cohen's Kappa internal reliability averaged 0.61, and the scale fell between moderate and substantial agreement (Marshall et al., 2010).

To increase validity, the authors repeated the coding process twice using EQUIP (Marshall, Smart, & Alston, 2016). A teacher's pre-recorded teaching video transcript was segmented into five-minute segments. Each five-minute interval was assessed using 20 different indicators that support inquiry-based teaching and learning. These indicators were considered across four factors, namely: discourse, instruction, assessment, and curriculum factors. According to the level of inquiry, each indicator was individually assessed before a holistic score was assigned. There were four inquiry levels, with a score of 1 given to Pre-inquiry, 2 to Developing Inquiry, 3 to Proficient Inquiry, and 4 to Exemplary Inquiry. At the end of the instrument, there is an overall summative mark and justification for the mark given.

5. FINDINGS

There are two sections under the findings, and they correspond to the two research questions that guided this study. We used an inquiry-based approach as a framework for implementing instruction as this study sought to examine how teacher beliefs about the implementation of inquiry-based learning reflected in their teaching practices.

5.1. Research Question 1: What are the Physical Science teachers' beliefs about the implementations of IBL in their classrooms in the Zululand District?

To get an understanding of the general trends in the Physical Sciences teachers' belief about inquiry-based learning of each item, the mode scores and percentage scores were computed. The results were grouped by item, and table 1 shows which item and overall mode contributed to the results.

Table 1.
The overall mode for each item.

Statements	**Mode**
IBL takes up too much of my teaching time	4
It is difficult to maintain control of learners during IBL	3
I prefer my learners to *design* their own inquiries	3
IBL helps my learners to develop experimental process skills	4
My head of department supports the way in which teaching is done in my class	4
The purpose of doing an inquiry is to confirm a theory	4
I feel confident teaching lessons where learners do science inquiries	4
Science inquiry activities are difficult to manage	2
The management of my school could do more to support me in implementing the inquiry-based approach to practical work	4
I borrow apparatus from other schools	4
The lesson time allocated is adequate for my learners to do practical work/Inquiry activities	2
My learners take a lot of time to settle down before starting with the inquiry activities	4
When I need lab equipment and chemicals the management of my school makes funds available for the purchase of these	2
With the new curriculum, I now include more practical activities in my teaching	3
My learners are well-behaved when they are doing practical work	3
Overall, Mode scores	**4**

Key: 1=Strongly Disagree; 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Table 1 shows that all the teachers who attended this workshop had an overall mode of 4, which signifies they had positive beliefs about IBL. Nevertheless, 65% and 26% of the teachers agree and strongly agree respectively that IBL approaches take up too much of their teaching time. Under item *'When I need lab equipment and chemicals the management of my school makes funds available for the purchase of these'*, some teachers disagreed, because 22% of teachers selected 'Strongly Disagree', 30% selected 'Disagree' and 36% selected 'Neutral' option. The results show that many school management teams still do not believe in practical work, which is the 'heart' of IBL as they do not give science teachers support by purchasing the required materials. Finally, 26% selected 'Strongly Disagree' while 35% selected Disagree on the item "*The lesson time allocated is adequate for my learners to do practical work/Inquiry activities"*. This shows that teacher believe the time allocated for Physical Sciences to adopt inquiry in their lessons is not enough. Considering the results, the Zululand District Physical Science teachers are positive about inquiry-based learning, however, there are factors they perceive hinders their teaching, despite the overall mode score of 4 'Agree', which implies they had a positive belief about IBL.

5.2. Research Question 2: Do the pedagogical practices of the Physical Sciences teachers in the Zululand District reflect their beliefs about inquiry-based learning?

The data shows that classroom pedagogical practices of the selected Physical Sciences teacher were partially in line with the overall group's beliefs about IBL. Following a thorough analysis of the EQUIP instrument's four factors as tabulated in table 2 the results show that Mr Motsapi's inquiry is still developing (Level 2).

Table 2.
Mr Motsapi overall EQUIP scores.

Factors supporting Inquiry	**Mr Motsapi's lesson one**	**Mr Motsapi's lesson two**
Inquiry Instructional Factors	2	1
Discourse Factors	2	2
Assessment Factors	2	2
Curriculum Factors	3	3
Mean Level of Inquiry Score	2.25	2
Overall Level of Inquiry	**2**	**2**

NB! 0=non-instructional time; 1=Pre-inquiry; 2=Developing inquiry; 3=Proficient inquiry; 4=Exemplary inquiry.

Table 2 shows the EQUIP four constructs, each factor had five sub-constructs to score which were then used to calculate the overall mean score. The overall mean score shows that Mr Motsapi was centred within the developing inquiry approach (Level 2). When comparing the teachers' overall mean score to the entire group's overall score about their inquiry there is a discrepancy in their scores. We then scrutinised each of the four constructs from each lesson to determine and justify the overall score of each lesson.

The inquiry instructional factors*:* Mr Motsapi was firstly observed teaching grade 10 class about the 'Equations of Motion'. The teacher spent the first 15 minutes of the lesson explaining the equations of motion and instructing learners, which resulted in this segment being extensively teacher centred. He then asked closed questions such as *"what is acceleration class? what are its units?"* these were closed questions. In the second quarter of the lesson, learners were deriving formulas following teachers' instructions. It was towards the end of the lesson, there were a few incidents that resulted in teacher-to-learner discussions. An example of such an incident manifested when the teacher wrote questions on the board and these sparked questions among learners. This indicates that there were a few aspects of inquiry that manifested in the first lesson. The same pattern was observable in the second lesson that was based on grade 11 Doppler Effect. Again, this lesson promoted passivity amongst learners as the teacher spent most of the time explaining concepts and asking closed-ended questions such as "*…what is the frequency and what is wavelength…?*" from time to time instead of asking open-ended questions that foster critical thinking and learner interactions as they are crucial components of inquiry-based learning. It was evident that the teacher was preparing the learners for the next grade because he often reminded them that "*…this is grade 12s work*", and they need to keep this information in their long-term memory. These are some of the reasons we decided to locate Mr Motsapi for this construct to be between pre and developing inquiry levels.

Discourse factors: In both lessons, the teacher leaned towards developing inquiry, his questions were rarely challenging to learners as they were mostly close ended in nature, as exemplified above. The communication between the teacher and learners was typically controlled and directed by the teacher with occasional input from learners in both lessons.

The assessment factor: In relation to this construct, in both lessons, the formal and informal assessment activities had few noticeable characteristics of inquiry as stipulated by the NRC (2011), and learners were mostly verifying pre-determined questions. The IBL characteristics were noticeable in the second lesson where the teacher used smart board and projected simulations to promote discussions. This segment involved both learners and the teacher critically analysing the given scenarios about Doppler Effect based on given scenarios.

Curriculum factor**:** The teacher showed signs of a good understanding of the secondary school curriculum. He understood the content covered in each grade and was making a connection between the previous grade, the current grade, and the forthcoming grades' content. However, the lessons had poor integration of content with practical work. In both lessons, the teacher did not go beyond the scope of the curriculum in terms of questioning. Based on our observations, for this construct we agreed that Mr Motsapi was centred on proficient inquiry (level 3).

The overall data emerged from the two lesson observations shows that Mr Motsapi was mostly in control of the teaching and learning for both lessons. The teacher often did not take into consideration some of the learners' contributions, and there were limited occurrences when class discussions were allowed. Both lessons were centred within the 'Developing Inquiry' (Level 2) construct as they were teacher-centred, with prescriptive questioning but not entirely inquiry. The teacher dominated the lesson and at times he was a facilitator and a giver of knowledge at the same time in both lessons.

6. DISCUSSION

To respond to the research question **'What are the Zululand District Physical Sciences teachers' beliefs about inquiry-based learning?'** The findings show that the sampled Physical Sciences teachers from the Zululand District displayed a positive belief about inquiry-based learning where the overall mode was 4 points. The score of 4 points 'Agree' show a strong belief in inquiry and this is a noteworthy finding since the CAPS documents advocate the implementation of inquiry-based learning at school. The findings of this study are in line with (Ramnarain & Hlatshwayo,2018) that teachers from the rural district had a positive attitude towards inquiry in the teaching and learning of Physical Sciences. These teachers also recognised the benefits of inquiry, for example, inquiry motivates and supports learners in the understanding of abstract science concepts. Hence, when compared to other pedagogies, the inquiry-based learning approach is believed to have more advantages (Correia & Harrison, 2020).

To respond to Research Question 2: '**Do the classroom teaching practices of the Physical Sciences teacher in the Zululand District reflect their beliefs about inquiry-based learning?'** The findings from the data show that Mr Motsapi was centred on developing inquiry (Level 2) when observed teaching two lessons. These results shows that Mr Motsapi's pedagogical practices are not entirely line with the overall class beliefs. The teacher is still navigating his way in the implementation of inquiry-based approaches in his classrooms. The results resonate with Ramnarain et al. (2016, 2018), Dai et al. (2011) that teachers are receptive to inquiry-based pedagogies, but they experience difficulties in fully implementing this approach due to different factors such as contextual factors. It shows that context plays an important role in influencing teachers' implementation of inquiry approaches in their classrooms. Based on the results of this study, we suggest that Physical Sciences teachers at school especially in rural areas should not be dismissive of inquiry-based learning as a possible teaching approach to adopt. Furthermore, there is a need for more professional development for teachers as they are limited in rural areas to make it easy for them to acquire the necessary skills and knowledge to implement inquiry-based learning effectively.

7. CONCLUSION

The findings based on this study have implications for practice for both in-service and pre-service science teachers who are teaching in rural areas where IBL is not supported. Firstly, facilitators who are running teacher development programs need to understand that teachers, especially novice teachers, bring along images about teaching construed from their previous secondary school teachers or mentors and they do not have images of IBL in practice and are often teacher-centred (Cross, & Ndofirepi, 2013). Therefore, they will take time to understand and master this approach. Even though the Physical Sciences teachers had a strong belief in inquiry, several factors determined what approach to adopt. Often, these teachers revert to direct approaches when they do not know how to proceed. We recommend professional teacher development program facilitators, especially in rural areas, to expose teachers to different instructional approaches that promote learner-centred activities, and they need to be aware of contextual factors influencing teachers. The workshops need to prepare teachers on how to teach in contexts where inquiry is not supported. The study experienced few limitations, the number of participants was only limited to twenty-three who answered the survey. This was not enough to generalise our findings but gives indications and insights on teacher trainers. The classroom observations were conducted to only one teacher and we cannot make swiping generalisation about the findings. Therefore, we suggest future research complement the current research by further focusing on how teachers implement IBL in their science classroom that are situated in rural areas. The next focus needs to be based whether learner situated in the rural areas achieve better scores or pass rate when are taught Physical Sciences through IBL.

REFERENCES

Abell, S. K. (2007). Twenty years later: Does pedagogical content knowledge remain a useful idea? *International Journal of Science Education*, *30*(10), 1405-1416 https://doi.org/10.1080/09500690802187041

Asrizal, A., Yurnetti, Y. & Usman, E. A. (2022). ICT Thematic Science Teaching Material with 5E Learning Cycle Model to Develop Students' 21st-Century Skills. *Journal Pendidikan IPA Indonesia*, *11*(1), 61-72. https://doi.org/10.15294/jpii.v11i1.33764

Binns, I. C. & Popp, S. (2013). Learning to teach science through inquiry: 8. *Science & Mathematics Education*, *17*(1).

Bronfenbrenner, U. (1979). Contexts of child rearing: Problems and prospects. *American Psychologist*, *34*(10), 844. https://doi.org/10.1037/0003-066X.34.10.844

Calderhead, J. (1996). Teachers: Beliefs and knowledge. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 709–725). Macmillan Library Reference USA; Prentice Hall International.

Correia, C., F. & Harrison, C. (2020). Teachers' beliefs about inquiry-based learning and its impact on formative assessment practice. *Research in Science & Technological Education*, 38(3), 355-376. https://doi.org/10.1080/02635143.2019.1634040

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE publications.
Cross, M. & Ndofirepi, E. (2013). On becoming and remaining a teacher: rethinking strategies for developing teacher professional identity in South Africa. *Research in Education,* 1-19. https://doi.org/10.1080/02671522.2013.851729
Dai, D. Y., Gerbino, K. A., & Daley, M. J. (2011). Inquiry-based learning in China: Do teachers practice what they preach, and why? *Frontiers of Education in China*, *6*(1), 139-157. https://doi.org/10.1007/s11516-011-0125-3
Department of Basic Education (DBE) (2011). *National Curriculum Statement Grades R-12*. Retrieved from http://www.education.gov.za
Friedrichsen, P. M. & Dana, T. M. (2003). Using a card-sorting task to elicit and clarify science-teaching orientations. *Journal of Science Teacher Education*, *14*(4), 291-309. https://doi.org/10.1023/B:JSTE.0000009551.37237.b3
Gess-Newsome, J. (1999). Pedagogical content knowledge: An introduction and orientation. In *Examining pedagogical content knowledge* (pp. 3-17). Springer, Dordrecht.
Hall, K., Leatt, A., & Rosa, S. (2009). The Means to Live. Targeting poverty alleviation to realise children's rights.
Levy, P., & Petrulis, R. (2012). How do first-year university students experience inquiry and research, and what are the implications for the practice of inquiry-based learning? *Studies in higher education, 37*(1), 85-101. https://doi.org/10.1080/03075079.2010.499166
Lewthwaite, B. (2006). Constraints and contributors to becoming a science teacher-leader. *Science Education, 90*(2), 331-347. https://doi.org/10.1002/sce.20093
Lewthwaite, B.E (2001). *The development, validation and application of a primary science curriculum implementation questionnaire*. (Unpublished ScEdD Thesis). Curtin University of Technology, Perth.
Lewthwaite, B.E. (2004). "Are you saying I'm to blame?" Exploring the Influence of a Principal on Elementary Science Delivery. *Research in Science Education, 34*, 137-152. https://doi.org/10.1023/B:RISE.0000033763.12967.15
Marshall, J. C., Smart, J. & Horton, R. M. (2010). The design and validation of EQUIP: An instrument to assess inquiry-based instruction. *International Journal of Science and Mathematics Education*, *8*(2), 299-321. https://doi.org/10.1007/s10763-009-9174-y
Marshall, J. C., Smart, J., & Alston, D. M. (2016). Development and validation of Teacher Intentionality of Practice Scale (TIPS): *A measure to evaluate and scaffold teacher effectiveness. Teaching and Teacher Education*, *59*, 159-168. https://doi.org/10.1016/j.tate.2016.05.007
Minner, D. D., Levy., A. J., & Century, J. (2010). Inquiry-Based Science Instruction-What is it and does it Matter? Results from a Research Synthesis Year 1984 to 2002. *Journal of Research in Science Teaching 47(4*), 474–496. https://doi.org/doi:10.1002/tea.20347
Mokiwa, H. O. (2014). Exploring the teaching of Physical Science through inquiry. *International Journal of Educational sciences*, *7*(1), 21-27. https://doi.org/10.1080/09751122.2014.11890166
Naidoo, J. & Sibanda, D. (2020). Examining science performance of South African grade 9 learners in TIMSS 2015 through a gender lens. *South African Journal of Education*, *40*(2), S1-S10. https://doi.org/10.15700/saje.v40ns2a1717
National Research Council (1996). *National Science Education Standards*. Washington, DC: National Academy Press. Retrieved from http://www.csun.edu/science/ref/curriculum/reforms/nses/nses-complete.pdf
National Research Council (2011). *A Framework for K-12 science education: Practices, crosscutting concepts and core ideas*. Washington, DC: National Academy Press. Retrieved from https://nap.nationalacademies.org/read/13165/chapter/1#iii
National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K-8*. Washington, DC: The National Academics. Retrieved from https://www.nsf.gov/attachments/117803/public/2c--Taking_Science_to_School.pdf
National Research Council. (2012). *Discipline-based education research: Understanding and improving learning in undergraduate science and education*. Washington, DC: National Academies Press.

NGSS Lead States. (2013). Following Generation Science Standards: For states, by states. Washington, DC: The National Academies Press.
Pajares, M. F. (1992). Teachers’ Beliefs and Educational Research: Cleaning up a Messy Construct. *Review of Educational Research 62(3),* 307–332. https://doi.org/10.3102/00346543062003307
Poti, J. G., Dudu, W. T., & Sebatana, M. J. (2022). A South African Beginner Natural Sciences Teacher's Articulated PCK-in-Practice with Respect to Electric Circuits: *A Case Study. EURASIA Journal of Mathematics, Science and Technology Education, 18*(10). https://doi.org/10.29333/ejmste/12426
Ramnarain, U. & Hlatshwayo, M. (2018). Teacher beliefs and attitudes about inquiry-based learning in a rural school district in South Africa. *South African Journal of Education, 38(1),* 1-10 https://doi.org/10.15700/saje.v38n1a1431
Ramnarain, U. (2016), Understanding the influence of intrinsic and extrinsic factors on inquiry-based science education at township schools in South Africa. *Journal of Research in Science Teaching, 53*(4), 598-619. https://doi.org/10.1002/tea.21315
Ramnarain, U. D., & Hobden, P. (2015). Shifting South African learners towards greater autonomy in scientific investigations. *Curriculum Studies, 47*(1), 94-121. https://doi.org/10.1080/00220272.2014.966153
Ramnarain, U., Nampota, D., & Schuster, U. (2016). The spectrum of pedagogical orientations of Malawian and South African physical science teachers towards inquiry. *African Journal of Research in Mathematics, Science and Technology Education, 20(2),*119–130. https://hdl.handle.net/10520/EJC191940
Russell, S. G., Sirota, S. L., & Ahmed, A. K. (2019). Human rights education in South Africa: ideological shifts and curricular reforms. *Comparative Education Review*, *63*(1), 1-27. https://doi.org/10.1086/701100
Sikko, S. A., Lyngved, R., & Pepin, B. (2012). Working with Mathematics and Science teachers on inquiry-based learning (IBL) approaches Teacher beliefs.
Smart, J. B. & Marshall, J. C. (2013). Interactions between classroom discourse, teacher questioning, and student cognitive engagement in middle school science. *Journal of Science Teacher Education*, *24*(2), 249-267. https://doi.org/10.1007/s10972-012-9297-9
Tan, A. L., Ong, Y. S., Ng, Y. S., & Tan, J. H. J. (2022). STEM problem solving: inquiry, concepts, and reasoning. *Science & Education*, 1-17. https://doi.org/10.1007/s11191-021-00310-2

AUTHOR(S) INFORMATION

Full name: Nomzamo Xaba
Institutional affiliation: University of Zululand
Institutional address: Office No.: NE 208 Postal Address: Private Bag X1001, Kwa-Dlangezwa 3886
Biographical sketch: Nomzamo Xaba is a Life Science Education lecturer and researcher in the MSTE department. I teach both undergraduate and postgraduate courses. I am passionate about quality science education; thus, my teaching philosophy mainly draws from constructivism, PCK and inclusive educational practices.

Full name: Aviwe Sondlo
Institutional affiliation: University of Zululand
Institutional address: Office No.: NE 309 Postal Address: Private Bag X1001, Kwa-Dlangezwa 3886
Biographical sketch: Aviwe Sondlo, an expert in Physical Sciences education, holds the position of lecturer in the MSTE department. He strongly advocates for socio-constructivism, as he believes that students play an active role in constructing meaning and understanding. His primary research interests revolve around the pedagogical content knowledge (PCK) of both in-service and pre-service teachers, inquiry-based learning (IBL), and the incorporation of technology in science education.