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# Enhancing Pedagogical Development of Natural Science Teachers Through a Key Concepts in Science Project: A Social Constructivist Perspective

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**ABSTRACT**

This study investigated whether the Key Concepts in Science Project influenced the pedagogical development of Natural Science teachers. Grounded in social constructivism, emphasising collaborative learning and hands-on interaction, the study employed qualitative methods to collect empirical data. Through photographic evidence, field notes, and focus group discussions with participating teachers, the study unveiled several themes, including the mastery of practical teaching approaches, horizontal and vertical knowledge articulation in syllabus delivery, sharing of best practices, and the significance of practical demonstrations in school settings. Field notes highlight rich information sharing and teacher commitment to professional development. The findings underscore the pivotal role of partnering with local community schools in fostering teacher optimism, resilience, and ongoing professional growth. This research offers valuable insights for educators seeking to enhance practical teaching skills and promote effective science education.

**KEYWORDS**

Teacher development; Natural Science education; practical teaching; social constructivism; inquiry-based learning

## INTRODUCTION, BACKGROUND AND RATIONALE

The Curriculum and Assessment Policy Statement (CAPS) for Natural Sciences Grades 7–9 in South Africa has three specific aims: firstly, to promote scientific inquiry; secondly, to impart subject knowledge and make connections; and thirdly, to emphasise the societal relevance of science (Department of Basic Education [DBE], 2011). These aims are designed to help learners: i) complete investigations, analyse problems, use practical processes and skills to evaluate solutions, ii) grasp scientific, technological, and environmental knowledge and apply it in new contexts, and iii) understand the uses of natural sciences and indigenous knowledge in society and the environment (DBE, 2011).

Regrettably, numerous schools in South Africa encounter substantial obstacles when attempting to implement the Natural Sciences curriculum (Mabena et al., 2021). These challenges are often contextual, including insufficient resources within Natural Science classrooms, such as teaching equipment and materials (Poultsakis et al., 2021). Additionally, they may be learner-related, manifesting in a foundational knowledge deficit concerning natural science concepts among learners. Furthermore, Amano et al. (2021) highlight that the language used for teaching and learning often presents a comprehension hurdle for learners in the natural science classroom. Moreover, teacher-related impediments to the effective implementation and delivery of the natural science curriculum revolve around insufficient subject knowledge and a lack of meaningful pedagogical skills necessary for inclusive and effective teaching (Chen & Xiao, 2021).

To address these concerns, the Key Concepts in Science Project was initiated within the Faculty of Education (FoE) at Sol Plaatje University (SPU). The project aims to provide developmental workshops for Grades 8 and 9 natural sciences teachers, targeting their ongoing professional growth in schools across the Northern Cape province, South Africa. Specifically, the project's primary objective is to enhance the pedagogical skills and capabilities of natural science teachers, with the ultimate goal of improving the quality of natural science education. Each workshop offers teachers authentic and practical experiences in utilising concrete teaching materials to cover topics within knowledge themes such as matter and materials, energy and change, and earth sciences, which are integral to the natural science school syllabus.

It is our aspiration that, through active participation in these workshops, teachers will be empowered to effectively engage learners in high-quality science instruction, thereby fostering a deeper understanding of scientific concepts. The purpose of this study was to investigate whether the Key Concepts in Science Project influenced the pedagogical development of natural science teachers. The findings from this study underscore the pivotal role of partnering with local community schools in fostering teacher optimism, resilience and ongoing professional growth. This research offers valuable insights for science educators seeking to enhance practical teaching skills and promote effective science education.

## LITERATURE

In the South African schooling context, the content covered in the subject Natural Sciences during Grades 8 and 9 forms a crucial foundation of knowledge for Physical Sciences as a subject in Grades 10 to 12. Specifically, concepts related to chemistry, matter and materials, energy and change and earth sciences are vertically aligned within the Physical Science school curriculum. Unfortunately, many learners struggle to grasp the content of Grade 12 Physical Science due to insufficient foundational knowledge established during Grades 8 and 9 (Malinga & Jita, 2020). To address this challenge, the National Curriculum Statement in South Africa advocates for the adoption of an inquiry-based learning approach in Grades 8 and 9. However, the effective implementation of such pedagogical practices encounters significant obstacles in various schools, primarily stemming from deficiencies in teacher competence and resources, as highlighted by Ramnarain and Rudzirai (2020). The success of inquiry-based teaching and learning depends heavily on science teachers' mastery of scientific processes and concepts and the ability to convey scientific theory in a meaningful manner to learners in class.

Through the utilisation of inquiry-based methods, science educators can facilitate students' development of investigative questions, formulation of investigation plans, and comprehension of subject matter. Throughout this approach, teachers must seamlessly integrate their content knowledge, pedagogical content knowledge, and theoretical understanding to ensure optimal learning outcomes (Jacob et al., 2020). The South African science curriculum emphasises an inquiry-based approach to practical work, encouraging exploration, data collection and drawing of conclusions. Scientific inquiry, according to Ramnarain and Rudzirai (2020), is highly recommended in classroom instruction to help learners understand scientific concepts and the nature of science better. Inquiry-based learning (IBL) is a teaching method that promotes learners' interest in science topics, leading to a better understanding and mastery of natural science (James et al., 2017). Du Plessis and Letshwene (2020) add that one's teaching approach to natural science can either encourage or discourage learners' interest in the subject. Poor instructional methodology on the part of a science teacher often leads to learners developing a negative attitude towards pursuing a career in science. This can occur in both secondary school and higher education, as reported by Wiebe et al. (2018).

Scholars believe that science teachers need to improve their pedagogical skills to engage learners in scientific inquiry (Naudé & Pretorius, 2024; Ramnarain & Rudzirai, 2020). Expository teaching and rote learning are common in classrooms where science teachers lack proper training, making it difficult to convey complex scientific principles and ignite learners' passion for the subject. Therefore, the quality of pedagogical training received by teachers is crucial for implementing inquiry-based science instruction. In South Africa, under-resourced science classrooms are a significant challenge that hinders learners' ability to engage meaningfully with IBL (Bayaga, 2022; Siphukhanyo & Olawale, 2024). Some schools lack the necessary resources to allow learners to "do the science" themselves practically, as is required in the CAPS document for Natural Sciences. This leads to a teaching and learning approach driven mainly by the

transmission of scientific knowledge, resulting in rote learning. Improving classroom resources and pedagogical approaches through targeted interventions is necessary to achieve the objectives outlined in the Natural Sciences curriculum in South Africa.

## THEORETICAL FRAMEWORK

The Key Concepts in Science project is grounded on the foundational theory of social constructivism, which emphasises collaborative practices, peer-to-peer learning and information sharing, especially during hands-on and practical experiments. According to this theory, learning occurs when individuals interpret and assimilate learning concepts through their experiences and cultural context (Saleem et al., 2021). The theory emphasises the role of the indivdual's interaction with their social environment by means of language (Bächtold, 2013). Knowledge is considered to be socially produced and co-constructed within communities that share a language and culture. Social constructivism also views knowledge as a collaborative effort among children, teachers, and peers (Moloi et al., 2023; Omodan & Tsotetsi, 2020; Segooa & Molise, 2024). According to Adebola and Tsotetsi (2022), collaborative practice among peers promotes inclusion while working hand-in-hand to tackle problems, develop new ideas and critical skills, promoting higher-order thinking skills and self-discovery. Groenewald and Mpisi (2022) assert that human collaboration helps to share best practices amongst each other, which will, in turn, lead to development and learning. Apart from the above advantages, collaborative learning practices among peers help to retain more information rather than independent learning (Loes, 2022).

The project comprised four workshops held quarterly that were aimed at creating a social constructivist environment that fostered collaborative learning among natural science teachers as participants in the project. This approach emphasises peer teaching and learning (PTL) where natural science teachers share their knowledge, test and build their ideas and skills through relevant activities. Towards the end of each workshop, teachers had to demonstrate the skills that they had learnt. While the facilitators were present, the participants themselves were both engaged in teaching and learning processes. This approach allows teachers to interact with each other, share ideas and receive feedback, which leads to deeper and more significant learning (Rannikmäe et al., 2020). Hayden et al. (2021) add that this approach to active learning contributes to retaining knowledge with a deeper understanding.

During each of the scheduled workshops, natural science teachers were engaged in active learning by conducting practical experiments related to topics within the Natural Science school syllabus. Throughout this process, the teachers were also able to construct new ideas and concepts, clarify existing misconceptions related to topics, and improve their knowledge of the subject content. The workshops also allowed the teachers to apply their existing knowledge and real-world experience. They learnt to hypothesise, test their theories, try things that may not work, ask questions, and share and reflect on their learning experiences. This approach helped them to construct their understanding, accommodating and assimilating new

information with their current understanding. In this way, the teachers played a central role in mediating and controlling their goals and learning process (Rannikmäe et al., 2020).

The social constructivist approach in the context of the Key Concepts in Science project consisted of four important aspects:

***The role of the facilitator:***

The workshop involved several facilitators from the Natural Sciences Department of the Faculty of Education at the university, who had diverse ethnic and cultural backgrounds, as well as varied fields of experience. This approach helped to create an inclusive learning environment that incorporated a range of teaching disciplines and training within the natural sciences subject, giving the workshops a unique strength (Harrison-Bernard et al., 2020). During the workshop, the facilitators encouraged attendees to sit around a table to facilitate communication and sharing of teaching ideas and practical experiments. The facilitators guided the collaborative learning process by fostering an environment that encouraged active participation, knowledge sharing, and discussions among participants. Over the course of two years, the workshops covered various concepts from each strand in the Grades 8 and 9 Natural Sciences curricula. The teachers, both novice and experienced, were encouraged to share their knowledge of the subject content and challenges encountered while teaching these concepts. Active engagement and open discussions among the participants and facilitators were crucial components in challenging implicit prejudice and stereotypes.

***Benefits of peer-to-peer teaching and learning:***

Peer learning among teachers refers to the exchange of ideas, discussion of experiences related to alternative teaching methods, and collaborative resolution of instructional challenges. In a workshop, discussions were held while conducting practical experiments from various concepts of the natural science curriculum. These discussions helped the teachers engage in peer teaching and learning, promoting critical thinking, problem-solving skills, and communication development. According to Miquel and Duran (2017), such peer teaching and learning benefit the teachers involved. Characteristic of each workshop is the emphasis on constructivism. The upcoming section briefly describes the principles of constructivism within the workshop setup.

***Application of constructivist principles:***

Practical experiments based on constructivist learning principles were conducted amongst the natural science teachers for each knowledge strand in the Natural Sciences curriculum for Grades 8 and 9. During these experiments, teachers engaged in hands-on activities, hypothesis testing, and inquiry-based learning to construct their understanding of scientific concepts. To aid reflection and metacognition of their own conceptual knowledge and teaching methods, they discussed the worksheet they had to complete. In a social constructivist approach, reflection and reasoning are essential in learning design (Omodan, 2022). Identifying what they already know, what they need to learn, and how and where to get new information may help them solve their challenge any challenges they might have (Saleem et al., 2021).

***Self-regulated learning:***

During the workshops, specific goals related to scientific concepts were established and reflections were made on achieving those goals. To achieve this, teams and team members engaged in self-regulated, co-regulated, and socially shared regulation of learning (Cleary et al., 2022; Doğan, 2022). Throughout the workshop, teachers tracked their progress with regular check-ins with facilitators and peers. They discussed challenges they experienced when teaching the concepts in their schools, the conceptual change that took place and how the knowledge gained during the workshop could be incorporated into their classroom teachings. During these discussions, teachers were guided to adapt their teaching strategies for effective teaching and learning in their classrooms.

## METHODOLOGY

The study utilised a qualitative research approach and employed an intrinsic case study research design. The case involved a purposive sample of 12 teachers specialising in natural science education, examining their reflective accounts regarding the impact of the Key Concepts in Science Project on their pedagogical development at science educators. To accomplish this, data collection techniques included focus group discussions and participant observations, supplemented by photographic evidence. The implementation of these data collection techniques is described next.

### Data Collection and Procedures

The first data collection technique that was used to investigate whether the Science Concepts Project influenced natural science teachers' pedagogical development, was a focus group discussion. The focus group discussion took place after the fourth and final workshop that was held. A characteristic of a focus group discussion is the free flow of information sharing that takes place through open dialogue between the researchers and participants (Bruggeman et al., 2021). In following this approach, the natural science teachers had the freedom to share their personalised accounts of their perceptions of the Key Concepts in Science Project and whether the project had any influence on their pedagogical development as science educators.

Central to this study was the use of predetermined semi-structured questions to anchor the focus group discussion (Bruggeman et al., 2021). Given the study's focus, a specific set of questions was posed to the participants, including inquiries such as, "What was your experience participating in the Science Concepts Workshops?", "What were your observations of your fellow natural science teachers during each workshop?", "What were notable aspects of the Science Concepts Workshops?", and "How do you perceive others' views of the Science Concepts Workshops?" By posing these questions during the focus group discussion with natural science teachers, the researchers aimed to elicit qualitative data regarding participants' individual perspectives, insights, and cognitive processes regarding the impact of the Key Concepts in Science Project on the practical demonstration skills of natural science teachers.

In conjunction with the focus group discussion, the study incorporated a photo-voice methodology to document and highlight significant moments occurring throughout each of the Science Concepts workshops. The use of a photo-voice methodology enabled researchers to supplement verbal responses obtained from the focus group discussion with photographic evidence, facilitating a comprehensive examination of participants' feedback and promoting triangulation within the study. Particularly noteworthy was the role of this methodology in facilitating a nuanced interpretation of teachers' responses and the perceived value of the Science Concepts workshops.

To ensure methodological rigour in our study, we relied on measures such as "confirmability," "credibility," and "neutrality" as outlined by Hirose and Creswell (2023). Confirmability was maintained through our open dialogue between natural science teachers and us as researchers during a focus group discussion. Credibility and neutrality were ensured by engaging with the teachers over a series of workshops on the SPU campus. Finally, we shared our empirical findings with the team of natural science teachers to verify whether the empirical data accurately reflected their reflective accounts.

**Ethics**

The study adhered to Sol Plaatje University's institutional principles concerning informed consent, confidentiality, integrity, honesty, and plagiarism regulations. These principles hold significant importance for various reasons, including the promotion of democracy, respect for truth, respect for persons, and protection of participants' rights. To ensure adherence to ethical standards, the following procedures were implemented.

Permission was obtained from the Senate Research Ethics Committee (SREC) of Sol Plaatje University. Prior to the commencement of the study, all 12 natural science teachers were approached to seek their consent for participation. Furthermore, the confidentiality of the teachers was safeguarded throughout the duration of the study. In the event that photographs were taken, the facial features of each teacher were blurred to maintain anonymity. Additionally, teachers retained the right to withdraw from the study at any point in time.

**Data Analysis**

Data analysis is the act of selecting, comparing, categorising, and interpreting information in order to develop a logical explanation for a phenomenon of interest (Kalu, 2019). According to Parameswaran et al. (2020), the researcher summarises the material based on what has been heard in terms of frequent words, phrases, themes, or patterns that emerge from the participants' responses.

The empirical data that were generated were transcribed into a written format for this study. Transcripts were labelled with letters to guarantee participant confidentiality. We read the transcripts several times to obtain a sense of the data. Thematic coding, evaluation and categorising of data into themes subsequently took place (Parameswaran, 2020). This information was categorised based on similar responses under relevant themes. Responses,

phrases, or words that corresponded to or aligned with a specific theme were coded with a specific colour. The themes were described, interpreted, and presented in accordance with the aim of the study.

## FINDINGS AND DISCUSSION

This study explored the impact of the Key Concepts in Science Project on the pedagogical practices of natural science teachers, particularly in their utilisation of practical demonstrations within teaching. Through focus-group discussions and meticulous documentation of project events, comprehensive empirical data were gathered to address the aim of the study. Analysis of the qualitative data revealed that teachers' participation in the Key Concepts in Science project significantly influenced their pedagogical skills across four key domains. Specifically, teachers' involvement in the project facilitated:

- Utilisation of concrete recycled materials for practical experiments.
- Enhancement of subject-specific knowledge aligned with the Natural Science school syllabus.
- Adoption of alternative teaching methodologies through the exchange of effective teaching strategies.
- Implementation of practical teaching methods within authentic school contexts.

In the subsequent section, each of these skill developments will be thoroughly examined and described.

### *Theme 1: Utilisation of concrete recycled materials for practical experiments*

In science education, the utilisation of concrete recycled materials for practical experiments, involving both demonstration and hands-on activities by learners and science teachers, holds significant importance. Scholarly discourse suggests that the comprehension of scientific concepts can be greatly enhanced through the construction of experimental models, wherein teachers conduct experiments in classrooms within the constructivist framework (Harrison-Bernard et al., 2020). Teaching via practical experimentation contributes to the enhanced acquisition of scientific knowledge, fosters a deeper grasp of the empirical nature inherent in natural sciences and cultivates various procedural skills. The experimental model assumes a pivotal role in cognitive monitoring, guiding students in interpreting their observations. Consequently, students' attitudes toward and motivation for studying science tend to become more positive.

Our study, the Key Concepts in Science Project, facilitated through a series of workshops, played a pivotal role in enhancing teachers' proficiency in utilising concrete recycled materials for conducting practical teaching experiments. This assertion is corroborated by the verbal feedback shared during our focus group discussions.

Participant 3 expressed appreciation for the sessions, highlighting their contribution to improvisation and the enhancement of practical teaching methods with learners:

*"To be honest, I feel that the sessions really assisted us to improvise and to make our teaching more practical with our learners."*

*(Participant 3)*

Participant 7 underscored the utility of the workshops, particularly in resource-constrained environments, emphasising the transformative potential of basic household items for scientific experimentation:

*Due to my situation at school, where we don't really have practical equipment to perform practical tasks, these sessions assisted me to use basic goods to perform scientific experiments. I never knew that the daily household materials could be recycled and used in this way in our classrooms. (Participant 7)*

Participant 2 offered specific praise for the practical approach of the workshops, citing an example involving the visualisation of atomic structure using simple materials:

*What was quite special about the sessions was the practical nature of the workshop. I feel it was really helpful to be shown how one can teach atoms and subatomic particles by allowing my learners to build a two-dimensional atom on a paper plate. My kids will really enjoy it and they will be able to visualise the structure of an atom. I mean there is no other way to make them really understand how small the particles in an atom is. (Participant 2)*

**Figure 1.**

*Natural Science Teachers Engaging with Concrete Materials*

Collectively, these responses underscore the transformative impact of workshop engagement, illuminating the potential for practical experimentation even in resource-limited school environments, utilising readily available materials such as paper plates, coloured beads, and Prestik. In support of the verbal response provided by the participants above, photographic evidence of the teachers' engagement with concrete materials to perform practical experiments are illustrated above.

A closer look at this photograph reveals how several teachers were able to perform a practical in a small group setting. Figure 1 provides evidence of a group of teachers building two-dimensional models of an atom on a paper plate.

It is evident from the above findings that making use of concrete recycled materials for practical experiments in science classrooms offers a multitude of benefits and is supported by scholarly discourse. Practical experimentation, facilitated through hands-on activities and demonstrations, significantly enhances students' understanding of scientific concepts within a constructivist framework (Harrison-Bernard et al., 2020). This approach not only enhances the acquisition of scientific knowledge but also fosters a deeper appreciation for the empirical nature of science and develops essential procedural skills.

***Theme 2: Enhancement of subject-specific knowledge aligned with the Natural Science school syllabus***

The curriculum for Natural Science is designed to advance scientific literacy through the cultivation of science process skills, critical thinking, and problem-solving across various contexts. Emphasising the development and application of scientific knowledge, the curriculum also underscores the understanding of the interrelationships and societal responsibilities inherent in science, society, and the environment (DBE, 2011). A critical determinant of effective natural sciences instruction is the depth of subject content mastery among educators. Teachers' content knowledge and pedagogical content knowledge necessitate specialised expertise in the disciplines they teach. To effectively impart knowledge to learners, educators must possess a comprehensive understanding of the subject matter and adapt their instruction to suit learners' levels. Professional development workshops can be instrumental in addressing deficiencies in teachers' subject content knowledge (Poti, 2020).

The Key Concepts in Science workshops played a pivotal role in enhancing teachers' proficiency in natural science subject matter. These workshops facilitated discussions on horizontal and vertical knowledge articulation aligned with the curriculum content. The subsequent excerpts from teachers' contributions during focus group discussion provide supporting evidence for the aforementioned assertion:

> *I must admit that the session cleared up my misconceptions of topics related to the [natural science] syllabus. I mean some of us teach the subject without proper foundational knowledge of science. For example, I never did physics on varsity, and I'm expected to teach topics such as reflection of light and the laws of reflection. (Participant 9)*

Participant 1 shared a similar sentiment by suggesting that:

> *Apart from the practical stuff, this engagement made me better understand topics that I need to teach. Especially at a Grade 9 level where the topics around physics and chemistry is becoming complex. I can now see how the Grade 9 topics connects with the Grade 8 topics under the same strand and why my colleague always complained about not having*

*foundational knowledge in Grade 8 for better performance of learners in Grade 9. (Participant 1)*

Finally, Participant 8 revealed that:

*I majored in Zoology, so I was not confident enough to teach natural sciences all these times due to the physics and chemistry part that I studied long years back. I can now recall those aspects. (Participant 8)*

According to Poti (2020), a significant aspect of successful natural sciences instruction is teachers' content knowledge and pedagogical content knowledge, which necessitate specialised expertise. Professional development workshops are essential for addressing gaps in teachers' knowledge. The participants' feedback indicated that their involvement in the Science Concepts workshops contributed to a deeper comprehension of topics aligned with the Grades 8 and 9 Natural Science syllabus. Specifically, participation in the project bolstered their subject knowledge concerning earth sciences, matter and materials, and energy and change. Additionally, their responses underscored the workshop's efficacy in rectifying pre-existing misconceptions associated with certain concepts within the Natural Science syllabus.

***Theme 3: Adoption of alternative teaching methodologies through the exchange of effective teaching strategies***

While professional development workshops are advocated for enhancing in-service teachers' subject content knowledge and pedagogical content knowledge, several critical elements must be prioritised to ensure their effectiveness. These elements encompass a focus on subject content, fostering opportunities for active learning, exchanging best practices, and integrating feedback and reflective practices (Poti, 2020).

The Key Concepts in Science workshops provided a platform for natural science educators to collectively share their insights and teaching experiences. The workshops also provided evidence supporting the argument for the need for collaboration between teachers from basic education and higher education institutions (Mpisi & Zoutendijk, 2022). Incorporating both novice and seasoned teachers, these workshops facilitated an environment where every participant could contribute their experiences in teaching science concepts within the Grade 8 and 9 curricula.

Participant 4 highlighted the value of peer collaboration, stating:

*The practical aspect of the workshop was indeed beneficial, but I must acknowledge the wealth of knowledge I gained from my colleagues. We exchanged teaching ideas and techniques. Mr. X, in particular, shared his wealth of experience and innovative teaching approaches with us younger colleagues. (Participant 4)*

Participant 9 emphasised the benefit of interacting with experienced educators, stating:

*I had the privilege of sitting with Ms. X, the department head, and discussing her classroom management strategies. It was a valuable learning experience. (Participant 9)*

Participant 2 reflected on the workshop's impact on instructional innovation:

*I discovered new ways to introduce concepts creatively, rather than resorting to straightforward definitions. It has transformed my approach to teaching. (Participant 2)*

In line with these testimonies, photographic evidence presented in Figure 2 illustrates the conducive layout of the workshops, promoting group interaction.

**Figure 2.**

*Workshop layout for group interaction*

**Figure 3.**

*Group demonstration of experiment for interaction and sharing of experiences*

This setup encouraged peer collaboration, facilitating the sharing of insights and effective teaching strategies. Notably, the arrangement of tables allowed four teachers to engage in practical experiments simultaneously, fostering a dynamic and participatory learning environment.

It is evident from the above that the workshop promoted group interaction, exchange of ideas and collaborative learning. Overall, the workshops demonstrated that professional

development focusing on collaboration and the sharing of effective strategies can significantly enhance teaching practices and instructional innovation in natural science education.

***Theme 4: Implementation of practical teaching methods within authentic school contexts***

It is widely acknowledged that traditional classrooms relying solely on theoretical instruction are insufficient in adequately preparing students for subsequent stages of science education, encompassing both secondary and tertiary levels. Practical experimentation serves as a pivotal tool for elucidating, problematising, and fostering discussion around scientific concepts. Crucially, practical experiments are indispensable in science education at the school level, as they facilitate the enhancement and construction of scientific knowledge (Oliveira et al., 2016). Furthermore, practical investigations and experiments cultivate positive attitudes towards science, heighten intrinsic motivation to engage with scientific concepts, and are integral components of daily scientific practice. They nurture the development of prediction, observation, and interpretation skills that are transferable to novel contexts, while also stimulating active and comprehensive approaches to learning (Oliveira & Bonito, 2023).

**Figure 4.**

*Teacher presenting an experiment with the resources received*

The participation of teachers in the Key Concepts in Science workshops empowered them to adopt a practical teaching methodology within their school environments. Teachers unequivocally expressed that the knowledge and skills acquired during these workshops enabled them to conduct practical experiments in their classrooms. This sentiment is exemplified by the verbal testimonies of Participant 11 and Participant 17:

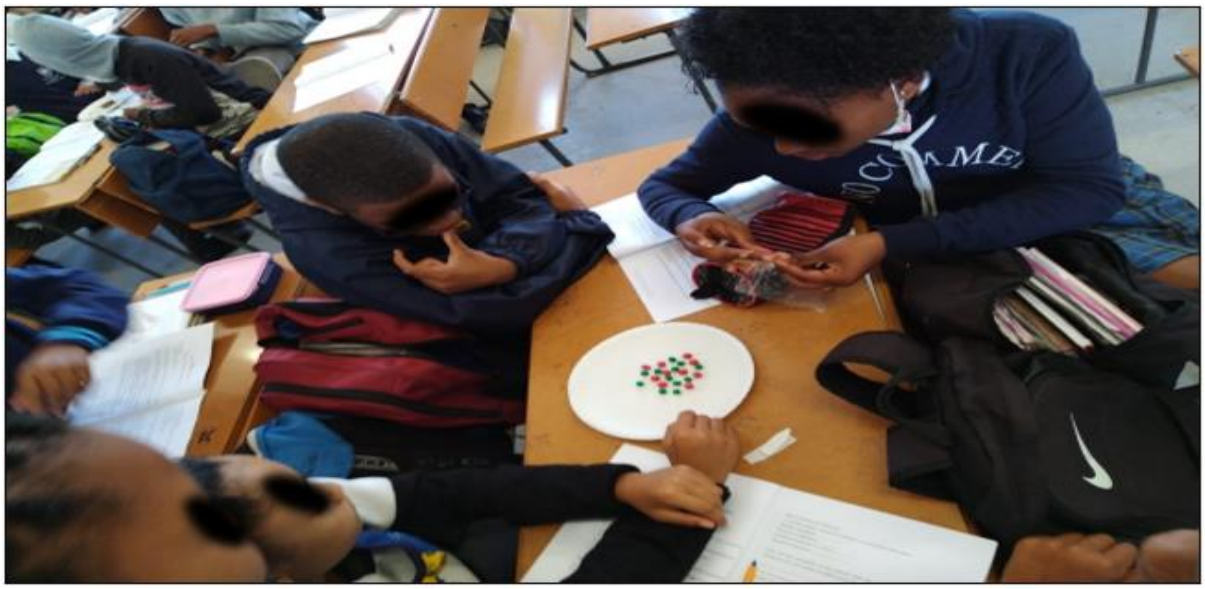
> *I feel more confident in utilising the materials provided in the workshops to conduct practical experiments in my classroom. (Participant 11)*
>
> *My students exhibit heightened interest in attending my classes, as I actively engage them in practical activities. (Participant 17)*

Furthermore, participants demonstrated a willingness to share photographic evidence of their classroom practices, as witnessed in Figure 4.

Finally, another participant shared footage showcasing students constructing a two-dimensional model of an atom, while another exhibited their presentation of a practical experiment using the resources obtained from the workshops.

**Figure 5.**

*Learners in the process of building the atomic model*



The participants' response and photographs show that the workshop significantly improved teachers' ability to conduct practical experiments, making science education more engaging and effective for students.

## CONCLUSION

South Africa grapples with significant hurdles in implementing effective science classroom practices and experiences, as outlined in the CAPS document for Natural Sciences Grades 7–9. While the curriculum underscores the development of practical skills and engagement with scientific concepts, the realisation of these objectives is impeded by insufficient resources and substandard teaching methodologies. In response to these challenges and in pursuit of improving education quality, the Key Concepts in Science project was launched.

Through a collaborative partnership between Sol Plaatje University and the Science-for-the-Future programme, the Key Concepts in Science workshops have emerged as pivotal platforms for providing essential professional development opportunities to Grades 8 and 9 Natural Sciences teachers. These workshops prioritise enhancing teaching methodologies, fostering practical, hands-on learning experiences, and promoting a deeper understanding of key scientific concepts.

The study findings unveil several noteworthy outcomes stemming from these workshops. Firstly, teachers have honed their ability to leverage recycled materials for practical teaching experiments, thus circumventing resource constraints in classrooms. Secondly, there has been a marked improvement in teachers' grasp of the Natural Science syllabus, facilitating

enhanced horizontal and vertical articulation of concepts. Thirdly, the workshops have cultivated a fertile ground for teachers to exchange insights, experiences, and best practices, fostering a collaborative learning environment. Lastly, teachers have been empowered to integrate practical demonstrations into their teaching practices at the school level, augmenting learner engagement and conceptualisation of taught concepts.

In sum, the Key Concepts in Science workshops have assumed a critical role in addressing the challenges besetting science education, particularly in Grades 8–9 within South Africa's Northern Cape province. By equipping teachers with the requisite skills, knowledge, and resources, these workshops contribute significantly to advancing science literacy and promoting inquiry-based learning. Continued investment in such initiatives is imperative to ensure the provision of quality science education for all learners across South Africa. Through sustained and collaborative endeavours, the objectives delineated in CAPS for Natural Sciences can be actualised, fostering a cohort of scientifically literate and engaged citizens.

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