Unveiling Experiential Skills' Impact on Life Sciences: Leveraging Bloom's Taxonomy for Proficiency

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Abstract: This article delves into the impact of experiential skills development on the proficiency of Life Sciences (Biology) learners, specifically focusing on integrating Bloom's Taxonomy in formulating assessment questions. Within the framework of South Africa's educational system guided by the Curriculum Assessment Policy Statement (CAPS), this mixed-method approach underscores the importance of aligning assessment questions with Bloom's Taxonomy to enhance experiential skills development and improve learner proficiency. The research, using a dual study methodology (PhD and MEd), emphasises the significance of question complexity and difficulty in driving experiential skills development despite varying perspectives among teachers on question sequencing. It argues that while standardised assessments may dictate question formats, teachers' inherent questioning styles are crucial in facilitating authentic learning experiences. Moreover, the article unveils a notable enhancement in learner proficiency resulting from effective planning and execution of experiential skills lessons, corroborating existing literature. In conclusion, valuable light is shed on the pivotal role of experiential skills development in enhancing learner proficiency in Life Sciences education, particularly within the South African context. By leveraging Bloom's Taxonomy in questioning and lesson planning, teachers can effectively cultivate critical thinking and problem-solving skills in learners. The findings advocate for tailored approaches to address proficiency gaps and stimulate learner achievement, thereby fostering engaged learning and real-life skill application in Life Sciences classrooms.

Keywords: Bloom's Taxonomy, Experiential skill development, Life sciences, Modes, Proficiency

1. Introduction

Under-developed skills due to the lack of knowledge of experiential learning hinder the creation of new experiences in the Life Sciences classroom. The initial goal was to recognise the essential experiential skills relevant to the Life Sciences field and comprehend their importance in teaching the subject. In this paper, a dual study methodology was adopted to compare findings of teachers' understanding of experiential learning in MEd (Mc Pherson-Geyser, De Villiers & Kavai, 2020). In contrast, the PhD study examined the current techniques used in learning and methods of teaching and evaluating experiential skills. This study focused on identifying areas for improvement and innovation. Experiential skills are acquired over a series of learning stages related to the subject or area of learning at hand, with each of these stages allowing a learner to reach a performance objective through practical experience (Kolb & Kolb, 2005; Kolb, 2006; McDonald, 2020). It suggests that a deliberate focus on the four modes of experiential skills development (concrete experiences, reflective observations, abstract conceptualisation, and active experimentation) within questioning strategies can address proficiency gaps and foster learner achievement. By prioritising experiential skills development and adopting learner-centric approaches, educators can nurture a culture of engaged learning in the classroom, driven by learners' expressed desire for the real-life application of acquired skills. Ultimately, the research underscores the importance of collaborative planning discussions and alignment between teachers and learners in assessments to optimise learning outcomes and empower learners in their experiential skills development journey.

The question of whether teaching and learning Life Sciences through experiential skills utilising Bloom's Taxonomy was prompted by conducting a master's research study (Mc Pherson-Geyser, De Villiers & Kavai, 2020). This study demonstrated teachers' limitations in implementing experiential learning and developing experiential skills.

Following the need for skill development, a PhD research study was conducted to investigate whether assessments planned by the teachers, with emphasis on experiential skill development on the learners' part, would lead to higher learner proficiency. The curriculum used in South Africa for Further Education and Training (FET) in the CAPS (2011) for Life Sciences consists of four sections. These sections are as follows: Section 1: Introduction to the Curriculum and Assessment Policy Statement; Section 2: Introduction to Life Sciences; and Section 3: Content covered in Grade 10, Grade 11, and Grade 12. Section 4 focuses on assessments and is divided across the Life Sciences practicals, identifying the assessment requirements for Life Sciences end-of-year examinations.

Experiential skills should create opportunities for the learner to take a personal role in the direction of their learning through first-hand experience (Bartle, 2015). University of California Davis (UC Davis) (2011) posits that learners are involved in practical problems. The University also states that learners want the freedom to be involved with challenging content while discovering solutions and observing their progress in the learning process (UC Davis, 2011). The findings will provide information to the Department of Education (DoE) and other relevant stakeholders on strategies that could be used to develop methods and strategies to aid experiential skills development in learners. This, in turn, may positively influence learners' proficiency, better enabling them to interpret questions on all the cognitive levels of Bloom's Taxonomy.

2. Problem Statement

In 2019, the Minister of Education instructed a change to the Curriculum Assessment Policy Statement (CAPS) that would be implemented in 2020, where informal practicals were increased and more scientific skills were required to complete practical assessments (DoE, 2019). Taking into consideration the limited degree of knowledge among teachers on experiential skills development (Mc Pherson-Geyser et al, 2020), as well as the lack of training available for teachers to implement CAPS practicals, this expectation by the DoE presented a potential challenge. As a practitioner, I saw a gap between experiential skills development and the content taught. Brink (2015) argues that Life Sciences cannot continue unless skills development and content education work together and that South African society should understand the crucial role of this connection. Experiential skills are essential in our South African society, as they can be used to create and verify knowledge or to analyse truths and belief systems (Thuketana, 2020). Teachers are exposed to many modern teaching strategies over their careers, and most of these strategies utilise experiential learning as a scholastic platform (Kolb & Kolb, 2017). From this, it could be deduced that certain skills are needed to develop proficiency in a Life Sciences learner. Furthermore, teachers may have limited knowledge of developing experiential skills in their learners (Girvan, Conneely & Tangney, 2016). This, in turn, creates further challenges for learners who attempt to achieve the higher cognitive levels of Bloom's Taxonomy.

As a practitioner, and by observing learners in the classroom, I realised the need to develop experiential skills and recognise the lack of alignment with the practical aspect of the Section 4 assessments. Teachers had no training in developing their learners' skills to a degree sufficient for completing practical assessments successfully. Teachers also lacked the fundamental knowledge to align specific skills with their assessments when evaluating their learners' proficiency.

3. Literature Review

3.1 Overview of Bloom's Taxonomy

Bloom's Taxonomy, created by Benjamin Bloom in 1956, classifies educational learning objectives into six levels of complexity (Chandio et al, 2021). This model, depicted as a stairway, guides learners from basic knowledge to higher-order thinking as they ascend the levels. Teachers, including those in Life Sciences, use it to create assessments and develop various skills in learners. The lower levels focus on knowledge and comprehension, often stimulated by teacher lectures where learners absorb and reproduce information. The higher levels - analysis, synthesis, and creation (evaluation) - may be harder to attain due to contextual factors. Bloom's Taxonomy has proven enduring (Lasley, 2024), with teachers still trained to use it through CAPS. The six levels of Bloom's Taxonomy are divided into three domains (Armstrong, 2010) to promote higher-order thinking skills:

- cognitive: mental skills (knowledge)
- affective: growth in feelings and emotional areas (attitude or self)
- psychomotor: manual or physical skills (skills)

These three domains can provide the enhancement needed for learning and teaching Life Sciences through experiential learning. By implementing these three domains when teaching or learning Life Sciences and using them in collaboration with assessments, teachers may achieve maximum results and skills development in the Life Sciences classroom. Each framework's six categories requires the previous skill to be attained before progressing to the next, more complex skill. This approach allows teachers and learners to identify higher-order thinking skills and to modify their teaching and learning habits accordingly (Main, 2022). The graphic representation below, which indicates each level of Bloom's Revised Taxonomy, is more verb-oriented to ensure skills development through the use of the hierarchal model. Please see Figure 1 (Armstrong, 2010) in this regard.

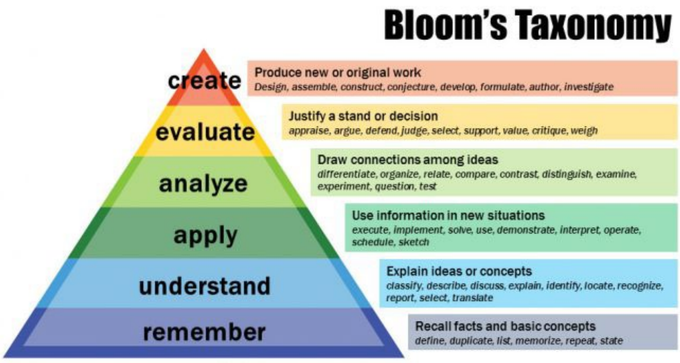

Figure 1: Bloom's Revised Taxonomy (Armstrong, 2010)

The development of this model employed common vocabulary, facilitating skill development that was aligned with learners' thinking processes to meet assessment goals (Kelly, 2017). This vocabulary should not only be used for assessments but also in the learning and questioning processes within Life Sciences classrooms. A clear interrelation emerges by connecting Bloom's Taxonomy's cognitive levels to the experiential skills needed for Life Sciences learners (Kolb & Kolb, 2017). Considering this, using cognitive levels teachers are trained to apply in assessments and learner development highlights the need for research in South African Life Sciences classrooms to optimise both teaching strategies and learning outcomes.

3.2 Exploring Experiential Learning: Defining and Theorising the Concept

Efficient classroom practices by well-trained teachers are essential for developing learners' skills and ensuring an effective education system. Usman (2016) states that achieving educational objectives enhances service quality. The CAPS document (DoE, 2019) highlights scientific knowledge and the importance of 'process' skills and 'attitudes' (Maranan, 2017). Robinson (2001) criticises ritual knowledge in teaching. Kolb's model categorises learning styles into Concrete Experience, Abstract Conceptualization, Reflective Observation, and Active Experimentation, impacting classroom effectiveness (McLeod, 2017).

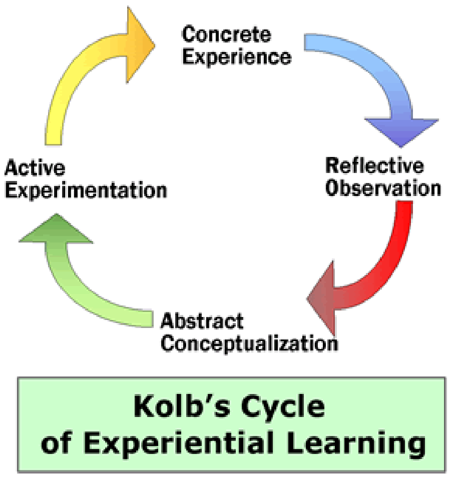

Figure 2: Kolb's cycle of experiential learning (McLeod, 2017)

John Dewey highlighted the tension between education and personal experience, emphasising 'reflective thought' for learning from observations (Kolb & Kolb, 2005; Dimova & Kamarska, 2015). He advocated moving from inductive to deductive reasoning. Dewey and Kolb, both experiential learning theorists, focus on enhancing classroom learning but overlook the specific skills teachers should impart and learners should develop through experiential methods. There are many characteristics related to experiential learning that are needed for the development of skills in the Life Sciences classroom. Dewey (2001) and Kolb (1984) both outline experiential learning by stating five main activities:

- Involvement: Learners must be active in the lesson, both physically and mentally.
- Reflective thought: If learners have been active during the lesson and have reached a conclusion, the current learning objective should be reflected upon.

- Meaning: The lesson's outcomes should not be forced onto the learner. Instead, learners should be allowed to assign meaningful interpretations to the learning process.
- Subjectivity: The experience should be formed by each learner's view of the world and not automatically take on the teacher's view.
- Human experience: Experiential learning opportunities must be provided as part of the learning process.

The foundation of each lesson centres on the skills critical for learner development. These skills are grouped in a logical order of increased sophistication (Dewey, 2001; Durham, 2017; Kolb, 1984), and they are as follows:

- observation (concrete experiences)
- communication
- classification (abstract conceptualisation)
- measurement (active experimentation)
- inferences (reflection)
- prediction

Every Life Sciences lesson should begin with observation as a way to stimulate the learner's senses, as sensory stimulation is essential to learning about the world (Maranan, 2017). Observations and communication work hand-in-hand as the active source of the experiential lesson, and this is provided through the effective sharing of observed information. Classification is indispensable; it forms an expected part of CAPS, as it clears the path to better understand objects or phenomena within given contexts. Through experiential skill development, there is a shift from the passive learning experience to an active learning experience in which a learner can acquire the necessary skills. In Life Sciences, as it is usually taught where learners merely listen and complete assessments (Mc Pherson-Geyser et al, 2020), active learning does not do this. Therefore, it is necessary to establish how experiential development lessons operationalise skills, linking them to learner proficiency in Life Sciences. Unlike observations, inferences and predictions are not gathered through direct evidence but through interpretation. Successfully integrating these skills in the Life Sciences classroom will ensure a richer learning experience that has a more meaningful impact on the learner.

Following the need for experiential skills development in the South African classroom, experiential learning raises awareness of the challenges teachers and learners might face if experiential learning activities were completed (Mc Pherson-Geyser et al, 2020). According to Mc Pherson-Geyser et al (2020), South African teachers face many ambiguities in conceptualising the term' experiential learning'. Uncertainty of experiential learning and the diversity of the modes could enhance the uncertainty of skills development when changes are made to the curriculum.

3.3 Bloom's Taxonomy in Education

These skills include understanding, observing, reflecting, analysing, judging, and creating (Kolb & Kolb, 2017). Kelly (2017) affirmed that developing these skills would, in due course, lead to the development of higher cognitive levels of Bloom's Taxonomy, which would then influence the proficiency of Life Sciences learners. Chan (2023) confirms that teachers struggle to change long-standing practices and accommodate quality experiential learning. Besides the findings from my previous study, school district meeting results for all grades in the Further Education and Training (FET) Phase are discussed. It was observed that the learner performance analysis for 2019 indicated that most learners were challenged in their attempts to answer more complex questions. They demonstrated that they had not yet achieved some of the higher cognitive levels necessary for a fuller, more holistic degree of understanding.

A demand for skill development among learners exists. Although an increase in practicals in the amended Section 4 suggests learners be continuously assessed, learners struggle to achieve most or all cognitive levels needed to apply their knowledge effectively in these assessments (Roadshow Statistics, 2020). This indicates that, in terms of content, the subject questions in themselves may be difficult despite being phrased within reach of a lower cognitive level. The opposite may also be true when asking for a higher-order thinking skill when using standard language, as shown in the end-of-the-year examination statistics for Grade 11 in 2019 (Roadshow Statistics, 2020). (Please see Figure 3 in this regard.) Jansen (2011) argues that there is a collapse in the South African education system. A breakdown of alignment between experiential skills development and content with continuous assessment at a higher cognitive level signifies the severity of this problem and makes a loud call for intervention. Hence, it is necessary to develop experiential skills in learners.

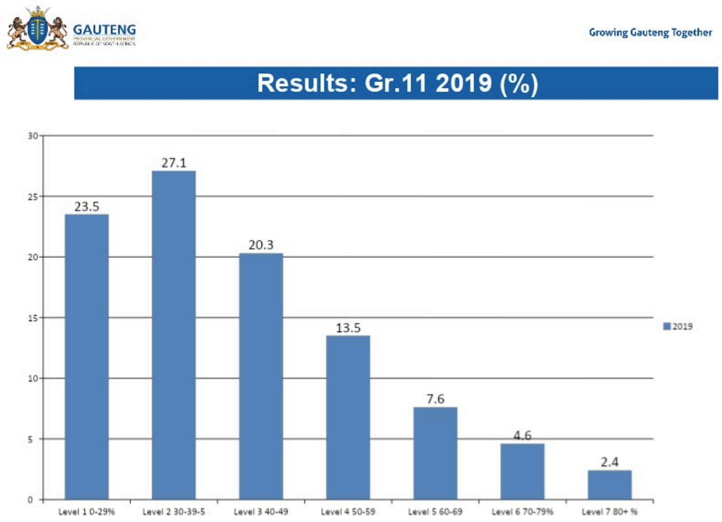

Figure 3: Roadshow statistics for end-of-year exams in skills development in Grade 11 Life Sciences (DoE, 2019)

The graph in Figure 3 clearly indicates limitations on the higher cognitive levels developed in learners. A proficient learner in Life Sciences should be able to align the levels of cognitive demand with the difficulty level in an assessment. The levels, as detailed by the graph, indicate that the majority of learners fall under the category of levels 1 to 4, confirming that learners in the 2019 examination only mastered the lower cognitive levels. Category questions for levels 1 to 4 are seen as low-order questions where information is simply recalled. The minority of learners achieved levels 6 or 7 - the levels indicating that the learner is proficient in most or all of the cognitive levels. Category questions for levels 6 and 7 are grouped on the higher cognitive platform, allowing learners to interpret information, analyse its importance in the context of the knowledge learned, and judge its significance in real-life situations.

Underdeveloped skills due to the lack of knowledge of experiential learning hinder learners from creating new experiences in the Life Sciences classroom (McDonald, 2020). Teachers may not know about experiential skills development or struggle to incorporate all the skills learners require in real life.

4. Method

This dual methodology study applied qualitative and quantitative approaches within an interpretive and positivist paradigm. Qualitative descriptive case studies, utilising checklists for classroom observations, were used to analyse experiential skills development lessons based on the conceptual framework. Concurrently, quantitative pre-, during-, and post-testing explored the impact of these skills on learner proficiency. Purposive sampling targeted Grade 10 Life Sciences teachers (N=8) and Grade 11 Life Sciences learners (N=66) in Gauteng (a province in South Africa), aiming to represent specific groups and ensure transferability. Ethical considerations were upheld, including expert-reviewed instruments and participant anonymity. Triangulating findings from both approaches provided an in-depth understanding of this study's objectives.

5. Findings and Discussions

These findings underscore the pivotal role of Bloom's Taxonomy in enhancing experiential skills development in the Life Sciences classroom. Teachers can significantly improve learners' proficiency by integrating experiential learning modes into assessments. Daft and Marcic (2014) demonstrate that when teachers perceive Bloom's Taxonomy as a tool for incorporating experiential learning, it can lead to better learner outcomes. Table 1 shows that over 50% of learners reported improved understanding, explanation, analysis, judgment, and discovery skills.

Table 1: Experiential skills developed in learners

Experiential skill	Cumulative percentage of the sample
Understanding or identification	66.7%
Explanations	66.1%

Experiential skill	Cumulative percentage of the sample
Demonstrating knowledge	66.7%
Analysing data	92.5%
Judging	56%
Creating new knowledge and applying it to known theories	53.6%
I think I now possess ALL of the skills needed to complete a Life Sciences task, which could be content-based.	50%

These findings suggest the existence of a standard for effective experiential skills development in assessments, supported by a robust conceptual framework from which this study originates. Each assessment focused on a specific mode of experiential learning to develop an experiential skill. After a lesson was concluded, a test was written. The pre-test and during-test each focused on the same question types, progressively moving from a lower-order cognitive skill to a higher-order cognitive skill. The pre-test and the during-test can be directly compared. An intervention lesson occurred between the two tests to develop more experiential skills. The feedback on the pre-test allowed learners to improve on the skills they had not yet mastered. By directly comparing the pre-test and the post-test results, the difference in skills development from the beginning of the lessons to the end of the lessons is readily apparent.

Each test was based on Bloom's Taxonomy and included learning questions that predominantly focused on experiential learning modes. The first mode, concrete experiences, focused on lower-order questions, which only required a demonstration of basic understanding. The second mode, reflective observation, focused on discussions with insight, telematics, and data analysis. The third mode, abstract conceptualisation, focused on discovering new knowledge while referring to known theories. The final mode, active experimentation, focused on linking science to society while answering higher-order questions, allowing the learner to receive maximum marks in an assessment.

Descriptive and inferential analyses were conducted to reduce data and validate the instruments. This analysis was done using various scales that measure different experiential skills in the pre-, during-, and post-tests. Audio recordings were used to draw inferences from the experiential skills developed by the participants (Zikmund & Babin, 2013). The raw scores were used using a t-test. Then, it was summarised into a table, which made it more manageable to analyse the entire set of final scores for each learner (Gravetter & Wallnau, 2009). The paired, one-tailed t-test, which focused on results from an alternative test that would decrease or increase significance, was used to compare the Life Sciences learners' (N=66) experiential skill development and their proficiency. All the 15-mark tests were assessed using a rubric with a Linkert scale to ensure consistency.

Researchers such as Stronge, Ward and Grant (2011) and Armstrong (2010) specify the need for formatting questions, declaring that when they are formulated, they should be considered carefully and prepared well before a lesson. This careful consideration and thorough preparation ensure that the questioning leads to experiential skills development. Furthermore, it ensures that the questions included allocate different marks in an assessment per the level of Bloom's Taxonomy. Utilising Bloom's Taxonomy ensures that lessons support the development of experiential skills, emphasise the key points in a theme, and maintain an appropriate level of complexity and difficulty. However, the reality is that teachers have definitively different points of view regarding questioning and the specific ways of planning for the sequence of questions asked (Mc Pherson-Geyser et al, 2020). The focus was on how questions were developed in the tests and how the questions might best be aligned with Bloom's Taxonomy. The questioning sequence did not matter, as the modes of experiential skills development take place cyclically.

In this model, provided that all four modes are completed with the correct difficulty level, the learner would show improved proficiency in the developed experiential skills. Therefore, this focus on how questioning sequences are ranked becomes the least important aspect of experiential assessment lesson planning. The sequence of questioning was significantly less critical in regard to learner achievement. The focus was more on the difficulty level, as the questions were asked to develop experiential skills. The classroom becomes less prescribed by not focusing on the questioning sequence but rather on how questions are raised. This approach allows learners to develop new experiential skills through their classroom experiences. The movement of the DoE and its amendment to Section 4 ushered teachers into an era where they are told what to teach, and learners are assessed using standardised, government-prescribed assessments. Sometimes, the curriculum materials from the government or the district include questions a teacher should ask, thereby directing the learners. This might feel like another way teachers are told how to teach; the teacher only has the classroom activity or the assessment to showcase their art of teaching. When showcasing the assessment results, the teacher's authenticity is a highly sought-after aspect in the classroom—this way of questioning is a natural skill.

However, questioning as a natural teaching approach does not require planning. These questions are leading questions that focus on a review of previously read materials or materials presented and are usually questions of a lower cognitive level. Nevertheless, it became clear in the pre-, during-, and post-tests that various questions are needed to ensure that the cognitive level of an assessment is met by the end of a theme in the CAPS. Therefore, it was clear that planning questions according to Bloom's Taxonomy was a key aspect of the assessment outcome when developing experiential skills. In this regard, the findings indicated the following:

By not focusing on the sequence of questions but instead considering each question's complexity and difficulty, the learner's proficiency was improved, and most learners experienced a sense of achievement. This is affirmed by Armstrong's research and literature (2010).

Questioning is a crucial skill that a teacher must have. This skill is put to use when a teacher teaches a learner. High-quality questions ensure an experiential skill of the same quality. High-quality questions unlock various experiential skills by equipping learners with clarity, purpose, usefulness, and thinking orientation. Bloom's Taxonomy not only secures in-depth knowledge of a theme but also ensures that teachers prepare their learners for end-of-year examinations and the possible questions they may face. Skill development can be simple, but it takes time. From my own experience and observation, the main factor for teachers not spending time developing different skills is the limited time available in the curriculum. This issue can be bridged when planning an approach to questioning using Bloom's Taxonomy. Another reason for planning the types of questions in advance is not only to ensure quality but also variety. According to Armstrong (2010), six levels or categories of questions should be developed:

- Remembering
- Understanding
- Applying
- Analysing
- Evaluating
- Creating

These questions run parallel to experiential skills development, moving from a lower cognitive skill to a higher one. The findings showed that the learners were exposed to a range of questions, which required different cognitive skills and enabled them to apply their own mental initiative. Employing different questioning allows the learners to think creatively, critically, and analytically while developing the appropriate experiential skill. It also allows learners to utilise an array of knowledge when answering the questions employing the acquired skill, and this, in turn, improves their proficiency.

Finally, experiential skills are developed after formulating quality questions and ensuring variety. Consequently, learners are able to question others inside or outside the classroom critically. This ability to judge and question is in itself a lifelong skill. Effectively questioning (or judging) should fill gaps in knowledge and allow learners to solve the problems in their assessments. Therefore, utilising Bloom's Taxonomy in developing experiential skills will enable learners to discover a valuable learning tool and organise their thinking to achieve the desired proficiency. They will also start developing new experiential skills.

6. Conclusion

The benefits of experiential skills development through Bloom's Taxonomy and its influence on the learners' proficiency in Life Sciences were explored. This was done by highlighting the implementation of experiential learning modes in assessment-question formulation by the teacher, the experiential skills the learner needs, and these skills' influence on learner competencies in assessments in Life Sciences. Furthermore, this dual methodology study, where there's an interconnection between the interpretive and positivist paradigm (using both qualitative and quantitative research, in other words), explored the extent to which the experiential skills developed through Bloom's Taxonomy in assessments influenced the learners' proficiency. An important recommendation in this article is that teachers should be educated on the need to establish experiential skills as a modern teaching strategy. This strategy shows traits of flexibility, sustainability, accessibility, efficiency, and innovation, all of which work together to accomplish outcomes and produce proficient learners. The aim is to inform the DoE of the need to train teachers to be confident in applying experiential skills development to the various assessments that must be completed throughout the year. These findings could assist teachers in providing better support for learners when using experiential skills and gauging the effectiveness of the experiential skills in the classrooms and assessments, showcasing attributes and shortcomings that would influence learners' proficiency. The findings have confirmed that merely building on concrete experiences is not enough to develop a proficient learner who also requires knowledge through reflective observation, abstract conceptualisation, and active experimentation. A learner learns by doing, and this form of active, involved engagement develops experiential skills. Integrating Bloom's Taxonomy in Life Sciences assessments significantly enhances experiential skills development and learner proficiency, advocating tailored approaches for fostering critical thinking and real-life applications in South Africa's educational context.

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