

The Effect of Practical Work on Grade 11 Learners' Misconceptions about Cellular Respiration



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ABSTRACT

This study examined the effects of practical work on the misconceptions of cellular respiration held by Grade 11 learners in the Mankweng circuit in the Capricorn South District of the Limpopo Province, South Africa. 114 Grade 11 learners from the researcher's school participated in the study, divided into experimental and control groups. The experimental group participated in practical work. Using a two-tier multiple-choice test, the impact of these activities on learner comprehension was evaluated. The test's first section concentrated on knowledge claims, while its second section examined learners' misconceptions in contrast to answers that were supported by science. The findings showed that learners were able to overcome misconceptions that might have originated from their upbringing or prior education with the help of practical work. However, the findings showed that some learners still lacked understanding of cellular respiration's basic principles and goals, and how it relates to photosynthesis in plants. According to the study, schools should schedule more time for practical work in their Life Sciences classes to improve learning depth and positive approaches towards the life sciences. Larger research with diverse learner demographics is also encouraged to validate and build upon these findings. By pointing out misconceptions and offering evidence-based methods for conceptual change, this study makes significant contributions to educational scholarship that will impact curriculum creation, teacher preparation, and classroom procedures. By demonstrating how practical work may bridge comprehension gaps and support inclusive, culturally relevant education, it enhances the discussion of science education.

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INTRODUCTION

Misconceptions play a crucial role in hindering learners from achieving a deep and meaningful understanding.¹ Misconceptions are incorrect assumptions that learners develop that deviate from concepts accepted by science. These contrasting perspectives have been described as children's science, misconceptions, divergent viewpoints, presumptions, alternate frameworks, and incorrect notions.² This

¹ Humphrey D. Assem et al., "A Review of Students' Academic Performance in Physics: Attitude, Instructional Methods, Misconceptions and Teachers Qualification," *European Journal of Education and Pedagogy* 4, no. 1 (2023): 84–92.

² Valarie L. Akerson, Ingrid Weiland, and Khadija E Fouad, "Children's Ideas about Life Science Concepts," in *Research in Early Childhood Science Education* (Springer, 2015), 99–123; M A Martawijaya et al., "The Effect of Applying the Ethno-STEM-Project-Based Learning Model on Students' Higher-Order Thinking Skill and Misconception of Physics Topics Related to Lake Tempe, Indonesia," *Jurnal Pendidikan IPA Indonesia* 12, no. 1 (2023): 1–13; Muhammed Akif Kurtuluş and Nilgün Tatar, "An Analysis of

study will use the term "misconception" to simplify understanding, referring to any learner-held beliefs that stem from flawed reasoning or understanding, or that conflict with the perspectives recognized by scientists.

When learners go to school or continue their education, they are not simply empty containers ready to be filled with information.³ Learners come to class with prior knowledge, which might be accurate or flawed. This information stems from their daily experiences, intuition, and past education—each possibly harboring inaccuracies.⁴ Teachers, textbooks, friends, and family have all been shown to play a role in the formation of learners' misconceptions.⁵

Identifying the misconceptions learners hold is vital when teaching a new topic. Some claim that learners form misconceptions both before and during their schooling. These misconceptions can arise from everyday experiences, the use of informal language in scientific discussions, compartmentalized thinking, teaching methods, and educational materials. The segmentation of concepts and memorization without understanding seem to be the primary reasons behind these issues, which hinder the Life Sciences curriculum's aim of fostering meaningful learning.⁶

Dewey believes that an individual has the potential to gain knowledge from dual origins.⁷ These two types of knowledge are practical knowledge and intuitive knowledge, often termed "gut" knowledge. Intuitive knowledge emerges through environmental engagement, whereas practical understanding is acquired through practice. Practical knowledge involves systematic evaluation of execution, like practical work, while gut knowledge primarily characterizes an individual's perception of reality.

Nijenhuis-Voogt noted that cellular respiration and photosynthesis were among the topics that posed significant challenges for learners.⁸ Understanding concepts related to cellular respiration or photosynthesis can be challenging for learners. Consequently, the study proposes pinpointing misconceptions about cellular respiration and devising strategies to remedy them.

Misconceptions need to be recognized before being corrected.⁹ Upon identifying the misconception(s), appropriate strategies to address them must be sought. Accurately diagnosing misconceptions and subsequently devising lessons to tackle them are challenging endeavors. Simply glossing over misconceptions won't resolve them, as they tend to persist.¹⁰ If they are not found and addressed immediately, they will have a detrimental effect on the learners' future learning.¹¹ Various methods can uncover misconceptions, such as two-tier diagnostic assessments, concept mapping, prediction-observation-explanation activities, surveys or interviews about concepts and processes, illustrations, and word associations.¹²

Scientific Articles on Science Misconceptions: A Bibliometric Research.,” *Ilkogretim Online* 20, no. 1 (2021); Soeharto Soeharto and Benő Csapó, “Evaluating Item Difficulty Patterns for Assessing Student Misconceptions in Science across Physics, Chemistry, and Biology Concepts,” *Heliyon* 7, no. 11 (2021); Markéta Machová and Edvard Ehler, “Secondary School Students’ Misconceptions in Genetics: Origins and Solutions,” *Journal of Biological Education* 57, no. 3 (2023): 633–46; Thomas A C Reydon, “Misconceptions, Conceptual Pluralism, and Conceptual Toolkits: Bringing the Philosophy of Science to the Teaching of Evolution,” *European Journal for Philosophy of Science* 11, no. 2 (2021): 48.

³ Harold Modell, Joel Michael, and Mary Pat Wenderoth, “Helping the Learner to Learn: The Role of Uncovering Misconceptions,” *The American Biology Teacher* 67, no. 1 (2005): 20–26.

⁴ Frank Guerra-Reyes et al., “Misconceptions in the Learning of Natural Sciences: A Systematic Review,” *Education Sciences* 14, no. 5 (2024): 497.

⁵ Modell, Michael, and Wenderoth, “Helping the Learner to Learn: The Role of Uncovering Misconceptions,” 20-26.

⁶ John C Bean and Dan Melzer, *Engaging Ideas: The Professor’s Guide to Integrating Writing, Critical Thinking, and Active Learning in the Classroom* (John Wiley & Sons, 2021).

⁷ J. Dewey, *Democracy and Education* (New York: Macmillan, 1916).

⁸ Jacqueline Nijenhuis-Voogt et al., “Students as Creators of Contexts for Learning Algorithms: How Collaborative Context Design Contributes to a Wide Range of Learning Outcomes,” *International Journal of Computer Science Education in Schools* 7, no. 1 (2024).

⁹ Gaguk Resbiantoro and Rahyu Setiani, “A Review of Misconception in Physics: The Diagnosis, Causes, and Remediation,” *Journal of Turkish Science Education* 19, no. 2 (2022): 403–27.

¹⁰ Lauren Margulieux et al., “When Wrong Is Right: The Instructional Power of Multiple Conceptions,” in *Proceedings of the 17th ACM Conference on International Computing Education Research*, 2021, 184–97.

¹¹ Abimbola Eden Chima, Nneamaka Chisom Onyebuchi, and Sulaimon Adeniyi Idowu, “Integrating AI in Education: Opportunities, Challenges, and Ethical Considerations,” *Magna Scientia Advanced Research and Reviews* 10, no. 2 (March 30, 2024): 006–013, <https://doi.org/10.30574/msarr.2024.10.2.0039>.

¹² Morgan McAfee and Bobby Hoffman, “The Morass of Misconceptions: How Unjustified Beliefs Influence Pedagogy and Learning,” *International Journal for the Scholarship of Teaching and Learning* 15, no. 1 (2021): 4.

To effectively dispel and correct misconceptions, it is beneficial to first raise learners' awareness of these misconceptions by engaging them in an experience, such as a practical work or a reading passage that challenges the erroneous belief.¹³ Certain impact variables capable of countering misconceptions include the educator's conscience, understanding of learners, and practical life experiences. Engaging in practical work with concrete materials is an efficient method to correct misconceptions and enhance comprehension of the subject. The majority of research within the Life Sciences considers the understanding, analysis, and implementation of life sciences as crucial parts of its educational program.¹⁴

LITERATURE REVIEW

Identifying Learners' Misconceptions in Science Teaching

Cognitive psychology has led to a shift in understanding learners' misconceptions in science education, which are often influenced by their own experiences as pupils rather than their years of education.¹⁵ These misconceptions can hinder changes in pedagogical practices and may take precedence over views and beliefs specific to science teaching. To understand learners' misconceptions, it is essential to understand their beliefs that characterise their working environment.

Science lessons are still primarily presented using traditional techniques in South African schools, where educator-centered approaches predominate. Active learning, cooperative learning, and inductive teaching and learning are examples of learner-centered techniques. The roles that educators and learners play in learner-centered approaches should align with constructivist learning theory.

The Importance of Understanding Cellular Respiration

To survive, organisms need energy, which can be acquired through cellular respiration, animal nutrition, or direct radiant energy from the sun.¹⁶ The collection of metabolic processes and reactions that occur in living things, known as cellular respiration, transforms biochemical energy from nutrients into ATP and releases waste. Anaerobic (without oxygen) and aerobic (with oxygen present) cellular respiration are the two different forms of cellular respiration.

Breathing and cellular respiration are two different processes. The process of breathing, sometimes referred to as physiological respiration, includes ventilation, gas transport, gas exchange with cells, and gas exchange inside the lungs. Cellular respiration, on the other hand, refers specifically to the metabolic activities that take place inside cells to produce energy from nutrients.

Understanding learners' misconceptions about cellular respiration is crucial for improving science learning and overall learner performance.¹⁷ Educators should be aware of the process of conceptual change and be able to make the necessary changes to develop learners' understanding of scientific concepts.

Cellular Respiration Education in South Africa

Science education in countries like the United Kingdom is characterised by practical work activities, where learners manipulate and observe real objects and materials.¹⁸ This approach is said to be essential to the allure and efficacy of science education since it fosters learners' comprehension of science, their appreciation of the fact that science is supported by evidence, and their acquisition of practical skills. In countries like South Africa, Ghana, and Kenya, science education is frequently confused with inquiry-

¹³ Aloys Iyamuremye et al., "Effectiveness of Hands-on Practical Activities in Teaching and Learning Chemistry: An Exploration of Students' Engagement, Experience, and Academic Performance," *African Journal of Educational Studies in Mathematics and Sciences* 19, no. 1 (2023): 97–107.

¹⁴ K R Munasi and Sikhulile Msezane, "Addressing Challenges and Implementing Professional Development for Integrating Education for Sustainable Development into Life Science Education: Integrating Education for Sustainable Development into Life Science Education," *International Journal of Curriculum and Instruction* 16, no. 3 (2024): 590–610.

¹⁵ McAfee and Hoffman, "The Morass of Misconceptions: How Unjustified Beliefs Influence Pedagogy and Learning,"

¹⁶ Joseph Gillen et al., "LPS Tolerance Inhibits Cellular Respiration and Induces Global Changes in the Macrophage Secretome," *Biomolecules* 11, no. 2 (2021): 164.

¹⁷ Hassan O Kaya and Yonah N Seleti, "African Indigenous Knowledge Systems and Relevance of Higher Education in South Africa," *International Education Journal: Comparative Perspectives* 12, no. 1 (2013).

¹⁸ Niklas Gericke, Per Höglström, and Johan Wallin, "A Systematic Review of Research on Laboratory Work in Secondary School," *Studies in Science Education* 59, no. 2 (2023): 245–85.

based learning.¹⁹ But teaching science via inquiry calls for more; it calls on learners to investigate ideas, pose questions, and produce answers using logic and evidence. Since cellular respiration is a complicated and multidimensional process, it makes a perfect subject for inquiry-based education. Learners can gain a greater comprehension of the fundamental biological concepts and processes, as well as improve their critical thinking and problem-solving abilities, by investigating this idea.

In the South African curriculum, cellular respiration is taught in Grade 11. The cytoplasm and mitochondria are the sites of aerobic cellular respiration, whereas the cytoplasm is the site of anaerobic cellular respiration. Anaerobic cellular respiration is widely used in the production of bread and beer.²⁰ To evaluate comprehension of the subject, learners are encouraged to examine the raw materials, products, and energy output in both aerobic and anaerobic cellular respiration, and to pinpoint variables and resources. Social and cultural contexts also influence what learners find interesting, and educators must consider learners' prior knowledge, expectations, and perceptions to effectively model scientific reasoning.²¹

METHODOLOGY

The research methodology used in the study was quantitative.²² The reason for using the quantitative method was to quantify opinions, attitudes, and experiences by asking a set of defined questions from which a score can be derived.²³

Participants

As all the research participants were studying life sciences, only two classes from the same school within the Mankweng Central circuit were specifically selected for this study. The two classes that comprised the study's sample consisted of 114 Grade 11 learners. The experimental group (Grade 11E) had 54 learners (26 Boys and 28 Girls), and the control group (Grade 11F) had 60 learners (30 Boys and 30 Girls). The researcher taught both classes.

Data Collection and Analysis

There was an experimental group where practical work was used, and a control group where practical work was not used in the Life Science classes. To gather data from the learners, a two-tier multiple-choice exam was used.²⁴ The researcher developed the test to suit the study. The test was then taken to experts for their expert opinion. The test was pilot tested with another school's Grade 11 learners; however, the results are not included in the sample. The test was subsequently administered to the experimental and control groups to assess their cellular respiration misconceptions both before and after the intervention to see if they had changed. The pre-test data were analysed using descriptive statistics, including the independent t-test and the Mann-Whitney U-test for assessing girls and boys.²⁵ IBM Statistical Package for Social Sciences Version 22 (SPSS) was used as a tool to analyse all of the data. The difference between the groups' arithmetic means before and after the intervention was also examined using an independent t-test.²⁶

¹⁹ Selina Thomas Mkimbili, "Implementation of Inquiry-Based Science Teaching in Sub-Saharan Africa: A Review," *Contemporary Issues in Education* 1 (2023): 279–99.

²⁰ Reetesh Kumar Ahirwar and Amit Kumar Meena, *Applied Physiology* (Academic Guru Publishing House, 2025).

²¹ D Royce Sadler, "Formative Assessment and the Design of Instructional Systems," *Instructional Science* 18, no. 2 (1989): 119–44.

²² Hossan, Dalowar, Zuraina Dato'Mansor, and Nor Siah Jaharuddin. "Research population and sampling in quantitative study." *International Journal of Business and Technopreneurship (IJBT)* 13, no. 3 (2023): 209-222.

²³ Daniel Muijs, Chris Chapman, and Paul Armstrong, "Can Early Careers Teachers Be Teacher Leaders? A Study of Second-Year Trainees in the Teach First Alternative Certification Programme," *Educational Management Administration & Leadership* 41, no. 6 (November 5, 2013): 767–81, <https://doi.org/10.1177/1741143213494188>.

²⁴ Indri Andriyatno, Zulfiani Zulfiani, and Yuke Mardiaty, "Higher Order Thinking Skills: Student Profile Using Two-Tier Multiple Choice Instrument," *International Journal of STEM Education for Sustainability* 3, no. 1 (2023): 111–24.

²⁵ Matthew Damian Riina et al., "Continuous Variable Analyses: T-Test, Mann–Whitney, Wilcoxin Rank," in *Translational Radiation Oncology* (Elsevier, 2023), 153–63.

²⁶ Robert Wall Emerson, "Mann-Whitney U Test and t-Test," *Journal of Visual Impairment & Blindness* (SAGE Publications Sage CA: Los Angeles, CA, 2023).

Ethical Considerations

Before initiating the study, the researcher collaborated with participants to review the initial learner group assignments and clarify all procedural elements of the study. Informed consent forms for the participation of minor children were disseminated to the relevant parties and translated into Sepedi to ensure both language accessibility and cultural sensitivity. To maintain the research's integrity and safeguard both the data and the researcher, careful steps were implemented to prevent any potentially misleading communication. The researcher arranged activities outside normal school hours to limit any disturbance to school operations. Additionally, participant anonymity was strictly preserved by avoiding the use of actual names and, when required, assigning pseudonyms.

PRESENTATION OF RESULTS /FINDINGS

Pre-test and Comparison of Groups

Two groups participated in the study: the Control Group (CG) and the Experimental Group (EG). The EG received a practical work intervention, while the CG did not receive any practical work intervention. Each group received a total of sixty marks for completing the examinations. The total number of participants was 114. The pre-test results helped determine the learners' prior knowledge and level of success, and the results are based on the performance of the two groups.

To assess whether there is a difference among the variables of the groups before intervention, a Mann-Whitney test was done.

Table 1: Mann-Whitney test for both control and experimental groups before intervention

	VAR 00002
Mann-Whitney U.	1445.500
Wilcoxon W.	2876.500
Z	-.834
Aymp.Sig. (2-tailed)	.404

The Mann-Whitney analysis revealed no significant difference between the pre-test scores of males and females in the control and experimental groups, with a significance value of 0.404. This implies that both male and female Grade 11 learners understood cellular respiration at a comparable level before the intervention.

Stated differently, the pre-test results show that before the intervention, learners' concepts of cellular respiration were similar for all genders. This result is a helpful starting point for evaluating how the intervention affected learners' comprehension of the topic.

Does there exist a substantial difference between the post-test outcomes of the experimental and control groups?

To ascertain whether the variables of the groups differed in any way following the intervention, a Mann-Whitney test was used. Table 2, which presents the test findings, displays the statistical analysis and significance values for the group comparison after the intervention.

Table 2: Mann-Whitney test for both control and experimental groups after intervention

	VAR 00002
Mann-Whitney U	49.500
Wilcoxon W	1879.500
Z	-8.880
Aymp.Sig. (2-tailed)	.000

Table 2 indicates a significant difference between the EG and CG post-test grade ratings (Sign 0.000; $p < 0.05$). These findings imply that the learners' performance was improved by the practical work they did on the EG. The findings indicate that practical work reduces the misconceptions of Grade 11

learners regarding cellular respiration. These assessments suggest that learners' conceptual grasp of cellular respiration as a subject was enhanced by practical work.

Covariance analysis was also used to evaluate how each therapy affected the learners' comprehension of cellular respiration. The intervention served as the independent variable, while the post-test results indicated the learners' level of comprehension. Post-test scores were used as covariates in this study since they are shown to be strongly correlated with learners' comprehension of scientific topics.²⁷

Do boys and girls differ in any statistically meaningful ways?

²⁷ Kola Soyibo and Ann Hudson, "Effects of Computer-Assisted Instruction (CAI) on 11th Graders' Attitudes to Biology and CAI and Understanding of Reproduction in Plants and Animals," *Research in Science & Technological Education* 18, no. 2 (2000): 191–99.

Table 3: T-test done to check if there was any statistical difference from the results of the pre-test (experimental)

		Levene's Test for Variance Equality		t-test for mean equality						
		F	Sig.	t	df	Sig (2-tailed)	Average Difference	Standard deviation of error	95% level of confidence in the difference	
									Lower	Upper
VAR0000	Assumed to be equal variances	1.56	.215	.666	102	.507	1.35	2.04	-2.68	5.39
	Equal variances not assumed			.673	101.59	.503	1.35	2.01	-2.64	5.35

Independent Sample Test

The independent t-test analysis's findings indicate that there was no discernible difference between the EG and CG mean scores on the pre-test, as indicated in Table 3. This suggests that before the intervention, the knowledge and comprehension levels of both groups were similar, based on the pre-test findings. The fact that there was no appreciable difference between the two groups at the pre-test stage offers a solid foundation for comparing how the intervention affected the post-test scores.

Table 4: T-test done to check if there was any statistically significant difference from the results of the post-test (experimental)**Independent Sample Test**

		Levene's Test for Variance Equality		t-test for mean equality						
		F	Sig.	t	df	Sig (2-tailed)	Average Difference	Standard deviation of error	95% level of confidence in the difference	
									Lower	Upper
VAR0000	Assumed to be equal variances	3.07	.083	-2.248	102	.027	-2.82486	1.26	-5.32	-.332
	Equal variances not assumed			-2.262	101.997	.026	-2.82486	1.25	-5.302	-.348

The independent t-test analysis's findings show that there was no discernible difference between the EG and CG's mean pre-test scores (Table 4). This finding suggests that, based on their pre-test scores, both groups had similar levels of knowledge or comprehension before the intervention. A strong basis for attributing any post-intervention differences to the intervention itself rather than pre-existing group differences is provided by the lack of a statistically significant difference between the two groups in the pre-test stage.

Table 5: Descriptive Statistical Insights

Metric	CG before the test	EG Pre-Test	After-Test CG	After the Test EG
Mean	31.5	31.2	32.1	48.5
Range	25-38	25-38	26-38	34-57
Improvement	Minimal	Significant	N/A	+17.3 avg

According to the pre-test findings, the EG and CG performed equally, with the EG averaging around 31.2 and the CG averaging about 31.5. Both groups received scores ranging from 25 to 38, with P44 receiving the lowest score of 25 and P14 and P35 receiving the highest score of 38. The two groups' comparable performance offers a useful starting point for comparison.

However, the post-test results for the EG showed significant improvement, with several participants receiving scores higher than 50. For example, P20 went from 26 to 54, and P10 went from 30 to 56. This suggests that Grade 11 learners' misconceptions about cellular respiration are effectively addressed by the practical work intervention.

The CG's scores showed no change when compared to the EG, with many people achieving similar results on the pre-test and post-test. For example, P1's score in both tests stayed at 30, suggesting that their performance has been consistent over time.

The general patterns in the data were broken by a few noteworthy anomalies. For instance, P13 in the EG demonstrated only marginal improvement, with their score increasing from 34 to 35. This implies that this specific person may not have been significantly impacted by the intervention.

P42 in the CG, on the other hand, continuously did well, earning good pre- and post-test scores. Given their consistent and excellent performance throughout time, it is possible that this person had a solid background in the material or was less impacted by outside influences. These anomalies emphasise how crucial it is to take individual variances into account when analysing the data.

DISCUSSION

This study set out to find out how practical work affected the misconceptions that Grade 11 learners had about cellular respiration. A pre-test was taken by both groups (EG and CG), and the findings show that there was no significant difference between their performance (T-test, $p > 0.05$), suggesting that the conceptual understandings of the two groups before teaching were similar. However, the EG learners did better than the CG learners on the post-test (their scores varied from 34/60 to 57/60), and the findings were significant (T-test, $p < 0.005$).

According to the findings, EG learners who received teaching through practical work had more academic achievement in their post-test scores than CG learners who received teaching using the traditional method. The findings of this study align with those of other studies, such as that conducted by Kibirige and Hodi.²⁸ All of the aforementioned researchers discovered that learners who used practical work in the lab outperformed learners who received teaching using conventional approaches on the post-test.

Furthermore, there was no obvious gender bias in the performance, meaning that the boys' and girls' performances were identical. As a result, both boys' and girls' performance in the life sciences was enhanced by practical work. This suggests that there was no gender discrimination in this study's practical

²⁸ Israel Kibirige and Tsamago Hodi, "Learners' Performance in Physical Sciences Using Laboratory Investigations," *International Journal of Educational Sciences* 5, no. 4 (2013): 425–32.

work. Likewise, results from previous research indicate that practical work enhances the performance of learners regardless of gender.²⁹ Considering that a learner-centred strategy implemented through practical work interventions effectively closes the achievement gap between females and boys, these results are not shocking.³⁰ The results concur with Dahar's study in Pakistan, emphasizing that practical work significantly enhances learners' success in the field of life sciences.³¹ Furthermore, Fleming contends that learners' performance is improved because they are more likely to comprehend and remember what they do than what they hear.³² The CG and the EG performed significantly differently after three weeks of teaching. Additionally, learners gain from conceptual engagement, especially when engaging in hands-on activities, scientific application, and "interaction" in practical work.³³

The CG's traditional teaching methods hindered learners' comprehension of the life sciences, and their performance following such teaching was unfavourable to the subject. This may have resulted from the science classes' teaching approach to abstract material. It is understandable why learners invest so much time in comprehending scientific material. On the other hand, practical work enhances their comprehension of scientific ideas, which raises the standard of science teaching. Learners reported spending less time comprehending scientific material; they found science classes enjoyable and became more interested in pursuing life sciences in the future. As a result, their attitudes played a crucial role in their development of good attitudes, drive, and a sincere interest in science.

In contrast to individuals from the CG, the EG developed a clear conceptual comprehension of scientific techniques based on their reasoning during the post-test.³⁴ The CG learners did not develop a clear conceptual comprehension of scientific techniques, whereas the EG learners did, considering their reasoning during the post-test. The EG's conceptual comprehension is in line with Lazarowitz and Tamir's.³⁵ While learners from the CG showed negative views toward life science, those from the EG showed positive sentiments.

These results are expected because, in contrast to the usual teaching approach, practical work entails tasks that evoke strong feelings and bring up contextual concerns. Even while practical work classes took up a lot of time, they improved learners' understanding of the material. Because of this, some learners claimed that they were able to study and comprehend Life Sciences subjects faster than the CG, which did not include practical work. These results support earlier research showing that constructivist teaching methods are superior to traditional methods for improving learners' performance and accomplishment while teaching cellular respiration.

This study shows that misconceptions toward life sciences are significantly impacted by practical work. Learners will be even more driven to study and love the subject if they are presented with a real, difficult, and true problem. The learners' comprehension of the principles of cellular respiration was inadequate at the start of the study. Nonetheless, considering the study's findings, it is reasonable to propose that the practical work was a helpful way to encourage learners to adopt a positive outlook on their education. Because of their increased conceptual understanding, learners' performance improved, and they may have gained confidence in their ability to study for worthwhile learning experiences.³⁶

²⁹ Irene Chemutai Sang, Dinah Samikwo, and Borness Korir, "Student's Gender and Attitude towards Biology Practical Work Affects Academic Performance: A Case Study of Turbo Sub-County, Kenya," 2023.

³⁰ Carmo Cabral-Gouveia, Isabel Menezes, and Tiago Neves, "Educational Strategies to Reduce the Achievement Gap: A Systematic Review," in *Frontiers in Education*, vol. 8 (Frontiers Media SA, 2023), 1155741.

³¹ Muhammad Arshad Dahar and Fayyaz Ahmad Faize, "Effect of the Availability and the Use of Science Laboratories on Academic Achievement of Students in Punjab (Pakistan)," *European Journal of Scientific Research* 51, no. 2 (2011): 193–202.

³² Malcolm L Fleming, "From Seeing and Hearing to Remembering: A Conception of the Instructional Process," *Instructional Science* 9, no. 4 (1980): 311–26.

³³ Esther Kibga, John Sentongo, and Emanuel Gakuba, "Effectiveness of Hands-on Activities to Develop Chemistry Learners' Curiosity in Community Secondary Schools in Tanzania," *Journal of Turkish Science Education* 18, no. 4 (2021): 605.

³⁴ Avi Hofstein and Rachel Mamlok-Naaman, "The Laboratory in Chemistry Learning and Teaching," *Long-Term Research and Development in Science Education*, 2021, 1.

³⁵ Johan Svenningsson et al., "Students' Attitudes toward Technology: Exploring the Relationship among Affective, Cognitive and Behavioral Components of the Attitude Construct," *International Journal of Technology and Design Education* 32, no. 3 (2022): 1531–51.

³⁶ Ewan Wright, Anne L L Tang, and Syeda Kanwal Hassan, "Student Voice in Educational Research: Reflections on an International Mixed-Method Study," *International Journal of Research & Method in Education* 47, no. 5 (2024): 421–37.

RECOMMENDATIONS

Several focused initiatives are suggested at various educational levels to enhance learners' conceptual knowledge and attitudes towards life sciences, especially in abstract topics like cellular respiration. First, the Department of Basic Education's curriculum planners and education policy makers should update the national curriculum to ensure that Life Sciences receives at least 4.5 hours each week. In addition, at least one two-hour double period should be set aside for practical work. By reorganising, learners would have more time to interact with scientific ideas meaningfully and be less dependent on rote memorisation.

Second, school management teams, which include principals, deputy principals, and departmental heads, must implement these changes at the school level. Extended Life Sciences periods should be accommodated in school timetables, and laboratories should be easily accessible, well-resourced, and incorporated into weekly lesson plans. Curriculum modifications will not result in better teaching methods without school backing.

Thirdly, life science educators must adopt a more interventionist and diagnostic teaching style. To spot and correct misconceptions early on, they should include concept mapping, prediction-observation-explanation assignments, and two-tier diagnostic exams in their lesson plans. Teachers should be encouraged to take part in continuing professional development programs that emphasise conceptual change rather than demonstration through the design and facilitation of practical activity.

Fourth, teacher development units and district subject advisers ought to take the initiative to plan support sessions and training workshops. These should give teachers the pedagogical abilities they need to identify and address misconceptions and to strategically employ practical work as a means of fostering deep learning. To guarantee uniformity and efficacy, advisors must also keep an eye on and assess how practical work is being implemented in various schools.

Lastly, further research should be done on the function of practical work in science education by academic institutions and educational researchers. To support teacher education programs and evaluate the effect of practical work on learners' comprehension, longitudinal studies in a variety of school environments are required. Additionally, these organisations ought to work with schools to provide assessment instruments and teaching materials pertinent to South African classrooms.

Together, these suggestions seek to establish a more responsive and cohesive learning environment where science teaching actively dispels myths and promotes meaningful learning, with practical work as a crucial element rather than an elective.

The amount of time allotted in secondary schools for life sciences periods, including practical work, must be raised beyond one hour if learners are to develop better attitudes toward the life sciences. A double period set (2 hours) for life sciences is recommended, and more than 4.5 hours should be dedicated to teaching life science each week, with time set aside for practical work.

CONCLUSION

This study aimed to examine how practical work affected Grade 11 learners' misconceptions regarding cellular respiration in the Mankweng Circuit. Fundamentally, the study sought to identify the type and tenacity of these misconceptions and assess whether experiential, hands-on learning may be used as a remedial strategy. The results demonstrate that practical work can greatly improve learners' conceptual knowledge and cultivate favourable attitudes towards the subject when carefully included in Life Sciences education. Learners who participated in practical work better understood abstract concepts and were more inclined to change their intuitive but false scientific ideas.

Although the study's sample size, gender imbalance, and localised context were its main limitations, its ramifications go beyond these specifics. To guarantee that practical work is not viewed as a secondary activity but rather as a key pedagogical tactic, it emphasises the urgent need for curriculum reform, more teaching time, and focused teacher development. If misconceptions are not addressed, they might harden and prevent future education. As a result, educators need to be prepared to recognize and dispel these beliefs via intentional, research-based interventions.

In summary, by showing that practical work is a potent tool for conceptual transformation rather than just participation, our study adds to the larger conversation on science education. The study provides a way forward for more inclusive, efficient, and significant life sciences education by emphasising the

significance of experiential learning in dispelling misconceptions. It urges all parties involved—policymakers, school administrators, teachers, and researchers—to rethink science education in ways that put comprehension above memorisation and inquiry above instruction.

The marked improvement in the EG's scores strongly suggests that the intervention was effective in achieving its intended goals. This improvement is attributed to the practical work treatment or methodology used in the intervention, which appears to have had a positive impact on the participants' performance or understanding. The stability of the CG's scores serves as a crucial baseline, indicating that there were no significant external factors or confounding variables that influenced the results. This stability helps to isolate the effect of the intervention, providing stronger evidence for its efficacy.

Study Limitations

The fact that the study was limited to one school in a specific circuit may have limited how broadly the results may be applied. Future studies should consider a more thorough examination that covers both rural and urban areas throughout several South African provinces to obtain a more thorough understanding. A more representative sample and a more in-depth investigation of the research subject would result from this.

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