# Comparison of Active Learning and Traditional Lecture method in developing Biology practical skills on learners: A case study of Mukinge Girls Secondary School, Zambia

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**Abstract**

This study compares the impact of two active learning methods; Problem-Based Learning (PBL), and Project-Oriented Learning (POL) versus the Traditional Lecture (TL) method on learners' ability to differentiate between monocotyledons and dicotyledons based on their morphological and anatomical characteristics. The research used a quasi-experimental design involving 150 students, divided into three groups: two experimental groups subjected to active learning methods and a control group exposed to traditional lectures. The study used mixed research methods to assess the effectiveness of these teaching strategies. Pre and post-test scores were employed to evaluate learners' improvements and observational techniques were employed to analyse classroom engagement and the development of scientific skills. The results indicate that both active learning methods significantly enhanced learner engagement, understanding, and the application of scientific concepts. The PBL and POL groups demonstrated superior critical thinking, collaboration, and problem-solving skills, with the POL group showing the highest improvement in project management and creative thinking. By contrast, the TL group exhibited moderate improvements, primarily in memorization rather than conceptual understanding. These findings support the growing body of literature that advocates for active learning as an effective alternative to traditional teaching methods in science education.

**Keywords:** Active Learning, Problem-Based Learning, Project-Oriented Learning, Traditional Lecture, Monocots, Dicots.

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## 1.Introduction

Learning, in its essence, is a fundamental aspect of education. However, the most crucial step of the educational process is concerned with choosing an appropriate and efficient strategy that is instrumental to shaping the students' thinking abilities and, in turn, making the learning process very beneficial (Senthamarai, 2018; Tavoosy & Jelveh, 2019). Recent research has established two important factors that are central to developing critical thinking skills among learners: (i) the strategy followed by the educator and (ii) the interactive experiences of learners in the learning procedure (Kahu &Nelson, 2018).

The active learning method includes problem-based learning (PBL), collaborative and project-oriented learning (POL), encouraging learners to engage themselves in the learning process actively, rather than simply passively receiving information. A deeper understanding can be attained when learners are highly engaged (Smith et al.,2008). This has been shown to have a positive impact on student learning outcomes, including improved academic achievements (Freeman et al., 2014), increased student engagement and motivation (Hake,1998), enhanced analysis and decision-making skills, and more retention of subject matter (Hmelo-Silver, 2004).

With POL, students learn by researching a challenging problem, and coming up with a tangible product. It encourages participation, higher-level thinking, and student engagement (Savery, 2015). PBL is based on the resolution of difficult situations through which students significantly develop their cognitive structures, foster cooperative work, gain skills for independent learning, and encourage values such as responsibility, and cooperation. (Gonzalez-Argote, & Castillo-González, 2024). However, in the lecture method, the educator shares information with pupils without much interaction. This has brought more harm than good as it leads to learner dependency, promotes passiveness, and the falsehood of knowledge acquisition (Kalimaposo & Chivunda,2023). Zambian educators still use lecture methods, which have proven unsuccessful in developing a learner who acquires the abilities to know how to learn and ultimately become an independent learner rather than being recipients of transmitted knowledge (Kalimaposo & Chivunda, 2023). According to Abonyi (2004), most of Zambia's science-based fields are worried about the lack of a sound base in scientific concepts, which stems from the devised instructional designs that considerably to support pupils in developing scientific procedure skills. Most biology educators are predominantly dependent on the lecture method, contending that the subject is extensive and that adopting an alternative method prevents them from completing the syllabus (Reiss, 2018). Over a considerable period, Zambia has faced this challenging issue, however, minimal intervention actions have been implemented to ameliorate the situation for the national interest at large.

## 2.Problem Statement

Despite considerable research having been undertaken, particularly in the area of learner-centred methods that focus on shaping a good standing learner in the 21st century, there is insignificant enhancement seen in measurable results in Zambian students, coupled with the prevalence of declining performance in science-related subjects. For example, in the year 2022, the mean score was only 26.72(The Examinations Council of Zambia,2022). Even the Northwestern province has consistently demonstrated poor performance in Biology, with learners achieving low scores. This raises concerns about the effectiveness of the current teaching lecture methods, and hence, there is a growing concern to explore alternative approaches which can improve performance in the province. Hramiak & Hudson (2014) argue that despite a considerable number of studies undertaken in the area of education, not much attention has been given especially to the subject concerning how to educate. In addition, limited researches have reported on how best to educate pupils on the characteristics of dicots and monocots employing an effective, engaging classroom setting and practice.

## 3.Research Objectives

This study compares the effect of two active learning strategies in contrast to the traditional lecture method, focusing on student's ability to demonstrate in-depth knowledge in distinguishing monocots and dicots through their structural and anatomical features during the practical. The research objectives are to compare:

- The Impact of active learning in teaching and learning biology practical concepts and

Performance of students in Biology practical in differentiating between monocotyledons and dicotyledons based on their morphological and anatomical characteristics by exposing them to active learning strategies (POL and PBL) and traditional lecture methods.

## 4.Literature Review

The subject of active learning is one of the most significant current discussions in education. The influence of active learning on student outcomes provides insights into the design and implementation of effective learning strategies (Freeman et al.,2014) and contributes to the development of evidence-based teaching practices (Ambrose et al.,2010). Delisle (1997) stresses the role played by active learning in allowing educators to assist learners in developing essential scientific inquiry skills in biology that are essential to solving a problem. For example, the set of critical thinking skills required includes: how to clearly articulate problems, source relevant information, analyse and integrate information and propose viable solutions. Thus, the overarching objective in acquiring these skills is to equip students with a sound capacity to develop key competencies such as resource management, organization, interpersonal, personal, and communication skills (Thornhill-Miller et al., 2023).

Adaptations need to be made by the education system regarding the needs of society concerning the types of professionals and learners required in the international workplace. To resolve these issues, twenty-first-century professionals and learners have to be equipped with various competencies that can be acquired by carrying out learner-oriented strategies. Diversity of pupils should be considered by educators and they should therefore adapt their educational strategies appropriately. Hence, throughout the class, teachers need to give pupils opportunities to respond in different ways (Cardino & Cruz,2020).In the classroom, this can be achieved only by using active learning strategies. According to Mulenga& Bwalya (2022), this will assist the students and give them opportunities to master practical processing abilities in biology. Considering the differences of every learner, methods of educating should be freely prescribed (Munna & Kalam, 2021). PBL and POL are active learning methods, in which POL promotes collective processing and learning while PBL encourages interdependent productive learning, responsibility, growth of skills and contextualized education (Crespí et al., 2022).

The PBL method enhances pupils' chances for liberty and analytical thinking. It presents pupils with problems before the educator gives any instructions. Using this approach, pupils can acquire fundamentals and concepts related to biology to work through problems and solve them. According to Almulla (2020), PBL can be used by students to observe how to resolve issues in the real world. For the firm establishment of critical thinking, students should be made to comprehend and use the acquired knowledge they have gained from different classroom settings.

According to (Thomas,2000), POL is a project-based learning technique that involves; solving problems, making decisions, inquiring activities, allowing pupils to work autonomously over prolonged periods and building up reasonable outcomes and presentations. Initiatives in POL, such as research and development, are wide because of different criteria shortage of a regularly known framework or philosophy (Abonyi, 2014).

POL leads learners to be highly reflective of the knowledge they have attained and apply it to their activities. It is taking the lead as the most wanted methodology in science subjects. The study by Ekwueme et al., (2015) revealed that academic performance and participation in science activities improved by using hands-on approaches. To promote learning meaningfully, POL can help pupils in comprehending the correct way to execute biology practicals. According to Simuunza et al., (2020), POL is multidimensional, enabling the evolution of research skill development, critical thinking capacities, and group work, along with project-based emphasis.

Despite the traditional lecture method being frequently used in teaching, it has not produced the expected student results (Munna& Kalam,2021). The Zambian educational system heavily utilizes the lecture method (Kalimaposo & Chivunda,2023). Zambian educators have not yet advanced to the level where they are arguing for a purely transition to a learner-focused environment to bring about a complete change which implies that, the educational structure still needs to do a great deal of work.–According to Hafeez (2021), the most successful approach is by combining PBL, POL, and discussion teaching. The main challenge encountered by educators in implementing learner-oriented methods is the misunderstanding that these approaches are tedious and may hinder educators from completing the syllabus on time. However, Al-Balushi & Al-Aamri (2014) found that the lecture and POL methods require the same time for planning and can be used in the normal classroom setup and still achieve its objectives. According to Musonda & Chituta (2020), POL and PBL were commonly superior to normal educational designs in learner performance and attitude.

*4.1 Development of important process skills*

Biology classes should try to put all effort into altering the aspects that pupils visualise as a result of getting scientific directives. For instance; pupils can acquire facts and concepts, develop investigative and lab abilities, and scientific understanding, develop scientific investigative methods, and become knowledgeable citizens through social association involving discussions in science (Shana & Abulibdeh, 2020).

At the secondary level, Zambian students graduate mostly with one necessary skill, factual knowledge, because educators are highly interested in pupils passing their exams rather than developing the required skills. They have challenges in employing their current knowledge to solve problems in various situations (Kalimaposo & Chivunda, 2023).

*4.2 Technological skills and collaboration*

Learners who learn through active learning are provided with hands-on learning experiences through different technological instruments, which enables strong collaborative attempts to solve problems (Kumar & Natarajan, 2007) by integrating technology side by side to collect the information to resolve the problem. According to Ghavifekr & Rosdy (2015), Project-oriented learning supports the computer knowledge of learners because, in this approach, technology can be efficiently used.

*4.3 Conceptual understanding*

Conceptual comprehension and skills in solving problems are enhanced when educators use active learning methods in pedagogy (Olimpo & Esparza, 2020). In an active learning environment, educators and students have to use detailed procedures to encourage a high level of conceptualization. Before class, learners should have a regular habit of reading and getting ready for the topic by utilizing pre-quizzes. In class, students can apply the concepts, generate predictions, present them to their classmates and receive feedback from the teacher. The last step includes the learners applying the knowledge gained through homework, specifically designed tutorials based on the concept. In Zambia, this is not emphasized because it is believed that learners should be given notes and educators should carry out the relevant research on behalf of the learners is one of the major causes of the worsening of the Zambian educational system in certain provinces (Examination Council of Zambia performance review,2022).

*4.4 Academic achievement*

Nurbavliyev et al's (2022) study suggest that students in the active learning class experienced a more effective learning process in terms of academic performance. According to Boedeker et al., (2025), Active Learning has been significantly more effective in science education compared to alternative methods such as traditional lecture-based and passive approaches. An active classroom outperforms traditional instruction in utilizing laboratory equipment and processes (Ali et al., 2019).

*4.5 Motivation*

Motivation is a crucial component in advancing students to a higher level of conceptual understanding and enhancing learners' academic success (Weiler & Murad, 2022). For example, motivated pupils sometimes make a collaborative effort to meaningfully learn and understand the material and think about how to apply it to their lifestyle (Azarkamand et al.,2015). Hence, educators must make sure that, using numerous teaching strategies, they should engage and motivate students in the classroom. The concept of motivation suggests that the willingness of students to learn is increased by active learning. According to Anyaehie et.al., (2007), Active Learning enhanced pupils attendance compared to the lecture method.

*4.6 Meaningful learning*

Compared to the passive lecture method, active learning utilizes prior knowledge to allow pupils to learn meaningfully (Hsbollah & Hassan,2022). Taraban et al., (2007) argued that there was subject knowledge, minimal skill growth and no scientific exploratory attitudes by the pupils in the teacher-centered instructional methods. On the contrary, active learning results in dynamic and exploratory-based scientific learning, integrating practical activities involving the mind.

*4.7 Improved Reflective practice for learners and teachers*

According to Jennifer (2005), reflective practice is a group of capabilities that allow someone to embrace a critical view when dealing with a problem or mental situation. Active learning requires educators to scheme and carefully consider how their selected strategies will affect the pupils in the classroom. A skilled educator must be able to obtain the capacity to frequently reflect to come up with better ways to collaborate with pupils. Reflective practices are important for educators to improve skills and capabilities that are appropriate to their professional choices. Well-organised active learning encourages higher-level thinking despite surrounding a broad range of techniques. In scientific practicals, it is imperative to make use of active methods so that learners relate to the concepts (Sheffield City Polytechnic, 1992). They further suggest that active learning methods increase long-lasting memory and need a high cognitive level to resolve problems.

**5. Methodology**

From a population of 700 students from Mukinge girls' secondary school, a sample of 150 comprising 50 learners in each class was selected by simple random sampling. Mixed-method research was employed and qualitative data was collected from the participant's schematic observation sheets and quantitative data through a systematic observation sheet from learners engaging with the practical characteristics of monocots and dicots, and from the Biology Achievement Test. The learners were experimented to find out the characteristics of monocots and dicots. A quasi-experimental research design was used in this research in which the participants were allocated to the control and experimental (POL and PBL) groups. All groups were given a pre-test to confirm that their understanding of the distinctions between monocots and dicots was the same and that the students were at a suitable learning stage to acquire these concepts through these methods at the start of the research. Any differences that persisted between these two groups were measured using a post-test given after the treatments (Creswell& Creswell, 2017).

In the experimental groups (two classes), morphological and anatomical characteristics of monocots and dicots were covered by active learning techniques (POL and PBL), while the control group was covered by the lecture method. In the PBL group, learners were to find the problems under the topic and present their findings in their groups. In the POL group, learners needed to come up with a project of preserving the plant matter and present it as laboratory reports.

A teacher was taught how to handle problem-based learning in biology practical class. To prepare the teachers for active learning processes, subjects in the control and active learning groups were discussed. The project-oriented learners group gathered monocots and dicots plant parts, preserved them using herbarium processes and presented their findings as a project. The research objectives involved testing the arrangement of vascular bundles, seeds, leaves and roots. Most of the study concentrated on morphological and anatomical characteristics. Individual assignments were given to the pupils in the experimental group to prepare and store plants for identification. On the other hand, these processes were explained to the control group through the lecture method.

*5.1 Data collection techniques*

Quantitative data was collected through a systematic observation sheet from pupils performing the practical traits of dicots and monocots, and the Biology Achievement Test (BAT). A pretest was given to confirm the level of knowledge about the monocots and dicots before exposing them to these methods. The BAT was given as a post-test after the treatment. Qualitative data was gathered from the participants' schematic observation sheet by developing codes and from the research field notes. According to Denscombe (2017), quantitative data was collected through systematic observation sheets, whereas qualitative data was collected using participant observation sheets which revealed the procedures, growth, and actions of the groups being investigated in their normal settings. The researcher recorded some notes during the research process and drew up some codes. The researcher wrote notes to assist in not forgetting the codes interpretations, incidents, or happenings of the research process (Denscombe, 2017). The field notes taken were used to interpret the observations, create codes and permanent records during data interpretation.

*5.2 Instrument Reliability*

The BAT instrument's dependability was measured using the Test-retest method. A second test was done two weeks after the first test and the Pearson product-moment correlation was calculated, resulting in 0.88, indicating a high level of reliability. According to Kennedy (2022), the reliability test of the BAT showed that the instrument's internal consistency was measured by test-retest reproducibility and inter-observer consistency by the instrument's reliability tester.

*5.3 Instrument validity: Schematic Observation Sheet*

According to Rozali et al. (2022), validity involves the extent to which an instrument evaluates the constructs, concurrent, and content validity it is supposed to determine. For face validation, pilot testing was done before administering the tool to the target group, and the errors made in the pilot testing were taken into account and fixed. With the assistance of two senior biology teachers, it was ensured that the instrument would compute the intended results of the study.

*5.4 Data collection procedures*

At the beginning of the research, a pre-test was administered to find out the three groups' knowledge in terms of the anatomical and morphological dissimilarities between monocots and dicots. The experimental group was divided into two and given two different active learning methods: POL and PBL. In both approaches, 10 lessons of 80-minute duration covering morphological and anatomical disparities between dicotyledons and monocotyledons were discussed using both approaches. Both groups were given the task of finding solutions through group work and research, but the problem was that dicotyledons and monocotyledons were different in structure and anatomy. The project-oriented group was given the additional task of transporting the preserved plant parts they had identified earlier. Presentations of the research study and conclusions were given after the pupils were split into groups of five.

*5.5 Distinguishing activities in the three groups*

In the POL class, the teacher, developed, coordinated, and guided projects on dicots and monocots while training the learners, as opposed to giving them direct instructions. Together with creating a project for the preservation of plant parts, the students had to come up with botanical as well as indigenous names for the sections they studied. To determine the characteristics of monocots and dicots, along with herbarium practices in groups, the PBL group was initially given numerous issues to go through. Furthermore, there were no clear directions given; rather, the students were guided and learning took place collaboratively. In a traditional lecture group, the instructor provided students with clear instructions for topics like courses being taught, notes being provided, and teacher demonstrations. Later, when the class was stacked, the teacher answered questions from the pupils.

*5.6 Data analysis*

SPSS version 25 was used to measure the quantitative data from the biology achievement test as well as the pupils' dicot and monocot systematic observation sheet. A participant's study observation sheet for monocot and dicot characteristics was used to gather qualitative data. The researcher augmented the data with field notes to pinpoint specific codes observed during the data collection process. Each student's researcher notes and systems observation sheet, containing qualitative data was analyzed using MAXQDA to find the meaning of what was observed and taken down in the research notes. Analysis of Variance was used to examine the post-test data at the level of significance, $\alpha = 0.05$. A paired samples t-test was carried out to differentiate the mean scores of the pre-test and post-test to observe the effect of the treatment.

*5.7 Study Ethical Approval*

Permission was obtained from the Mukinge Girls Secondary School Headteacher to conduct the study and the respondents were told of the aim and significance of the research as well as their right to withdraw at any time. To protect their confidentiality, they were told not to reveal their names on the instruments.

## 6. Research Findings

This study compared the impact of two active learning methods in contrast to the traditional lecture method on student's capacity to differentiate between monocot and dicot plants by examining their morphological and anatomical characteristics. This was done by measuring how active learning influences learning and teaching in biology practical concepts and the student's performance in biology practical in differentiating between monocotyledons and dicotyledons based on their morphological and anatomical characteristics.

*6.1. Influence of active learning on learning and teaching in biology practical concepts*

Active learning method's influence in learning and teaching biology practical concepts was assessed in terms of: learners' performance in procedural abilities, research and concept accuracy, and understanding of practical requirements such as critical thinking, collaboration, communication and creativity. Other fields assessed included practical competencies such as pre-preparedness for the lesson, collaborative efforts, self-belief to do the tasks on their own, and the ability to reduce error and time spent on doing correct scientific steps in practicals. Each learner's systems observation sheet and researcher note which contained qualitative data, was analyzed by MAXQDA.

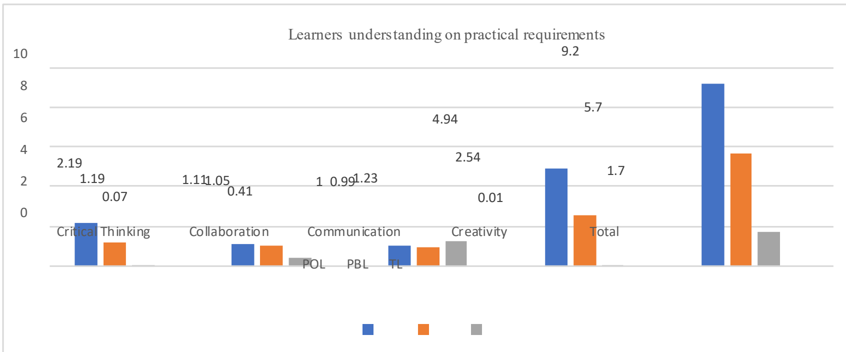
From Table 1 below, it is evident that the POL and PBL groups had a high (100% and 92%) positive influence on their procedural abilities, while the TL group had only 51%. On the other hand, for learners' improvement regarding research and concept accuracy, both PBL and POL groups improved by 100% while the traditional methods improvement was very low. It also demonstrates the progress made by each group in cutting the error margin and time spent on doing the correct scientific steps during the practical exercises. The PBL and POL took around 10 minutes, while the TL group took around 24 minutes to do the practical with correct scientific steps. Both PBL and POL showed excellent practical skills in reducing the error in the practical.

Table 1: Learner's performance in PBL, POL and TL methods in learning and teaching practical concepts

| Qualitative methods | Learners' performance assessment | PBL | POL | TL |
|---|---|---|---|---|
| Systematic observation sheet and research notes | Procedure abilities | 92% | 100% | 51% |
| | Improvement in research and concept accuracy | 100% | 100 | 41.4 |
| | Ability to reduce errors in practical | 94% | 97% | 51% |
| | Time spent by learners on doing the practical with correct scientific steps (minutes) | 9.1 | 10.23 | 23.98 |

Figure 1 below shows the learner's understanding of practical requirements like critical reasoning, communication, collaboration and creativity. The results showed that the POL group scored the highest (9.2), followed by the PBL group (5.7), while the TL group's understanding was very low (1.7).

Figure 1: Learner's understanding of practical requirements (Source, author 2025)




Practical competencies such as pre-preparedness for the lesson, collaborative efforts and self-belief to do the tasks on their own were very high in both PBL and POL groups compared to the TL group (Figure 2).

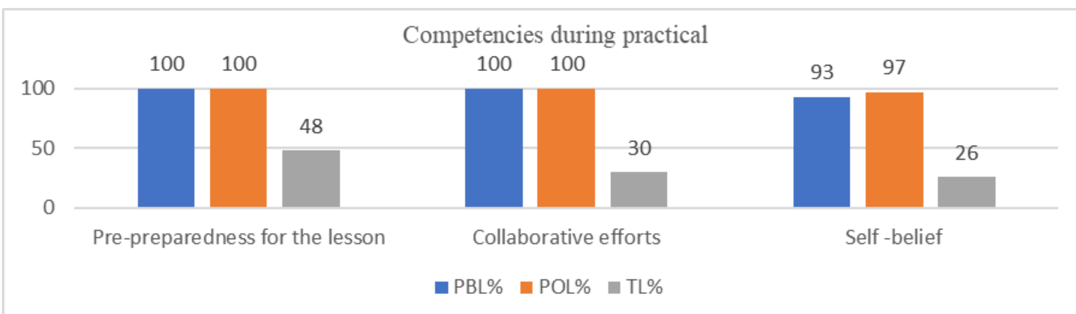



Figure 2: Competencies (pre-preparedness for the lesson, collaborative efforts and self-belief) during the practical (Source, author 2025)

Results in Figure 3 below, using MAXQDA, the systematic observation sheet and research notes showed that the pretest performance was similar for all three groups, while there was a great improvement in applying scientific process abilities in the PBL and POL groups in comparison with the TL method after the intervention.

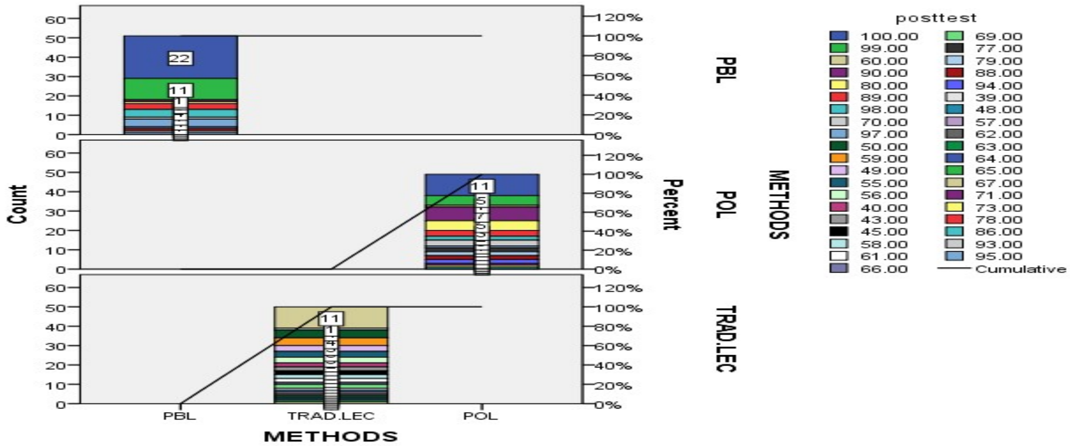



Figure 3: Scientific concepts in the biology practical for the pre- and post-tests (Source, authors,2025)

*6.2 The Effect of TL, POL, and PBL on the Performance Scores of Students*

The students were exposed to POL, PBL and TL methods, and their performance in the biology practical test in differentiating between monocotyledons and dicotyledons based on their morphological and anatomical characteristics. These were measured and analyzed using paired t-tests and ANOVA**.** Before exposing them to these methods, a pretest was given to confirm that their level of knowledge was the same for the topic under study and the results are as shown in Table 2.

Pre-Test Achievement Scores

Table 2: Summary statistics of the Pre-test

| Groups (Pre-test) | N | Mean | SD |
|---|---|---|---|
| POL | 50 | 48.54 | 9.34 |
| PBL | 50 | 48.65 | 9.1 |
| TL | 50 | 48.55 | 7.174 |

Since the means for all three groups were almost the same (Table 2), it was not necessary to conduct the ANOVA for significant differences. This indicates that there was no significant difference between the experimental and control groups in their understanding of the distinctions between dicots and monocots. This means that initially, all three groups were at a suitable learning stage to acquire these concepts through lecture methods, problem-based learning, and project-oriented learning.

Post-Test Achievement Scores

Normality Test

SPSS version 25 was used to conduct the Shapiro-Wilk test and Levene's test of equality of variance. The Shapiro-Wilk test revealed that the data is normally distributed, as all the p-values were greater than 0.05. Levene's test of equality of variance revealed that the variances were not significantly different, as all p-values were greater than 0.05 (see Table 3).

Table 3: Shapiro-Wilk normality test and Levene's test of equality of variance

| Post-Test (df = 49) | Treatment | Statistic | Sig |
|---|---|---|---|
| Shapiro-Wilk normality test | PBL | 0.998 | 0.97 |
| | POL | 0.999 | 0.95 |
| | TL | 0.964 | 0.98 |
| Levene's test of equality of variance | Groups | F | Sig |
| | TL | 0.935 | 0.337 |
| | POL | 1.080 | 0.303 |
| | PBL | 1.042 | 0.311 |

Paired Sample t-test

Paired samples t-tests conducted to assess the-performance between the pre-and post-test results revealed that both active learning methods significantly improved biology practical scores compared to the lecture method (Table 4).

| Groups | Test | N | Mean | SD | t | df | Sig (0.05) | Comments |
|---|---|---|---|---|---|---|---|---|
| 1. POL | Pre-test | 50 | 48.54 | 9.3 | 15.6 | 49 | 0.612 | The mean scores varied from 48.54 to 95.58. This suggests that this increase may have been caused by the treatment. Since p is 0. 612 > 0.05 indicating that the improvement in practical scores by the POL method is significant. |
| | Post-test | 50 | 95.58 | 7.5 | | | | |
| 2. TL | Pre-test | 50 | 48.55 | 7.17 | -11.2 | 49 | 0.000 | The TL's pre-test and post-test average scores were 48.55 and 40.4 respectively, indicating a drop in performance. The p-value 0.000 < 0.05 shows that there is no significant improvement by using the TL method. |
| | Post-test | 50 | 40.4 | 5.1 | | | | |
| 3. PBL | Pre-test | 50 | 48.65 | 9.1 | 14.37 | 49 | 0.702 | The average performance score went from 48.65 to 87.5 and the p-value was 0.702 >0.05 showing a significant improvement by using the PBL method. |
| | Post-test | 50 | 87.5 | 7.13 | | | | |

Table 4: Pre and post-test mean score comparison – Paired sample t-test

ANOVA Test to Compare the Effectiveness of the Three Methods

To assess the performance of the students, an ANOVA test was conducted at $\alpha = 0.05$ for significant statistical differences between the two experimental groups and the control group. Since all P values are 0.000 < 0.05 (Table 5), indicating that the experimental and control groups differed significantly in achieving mean scores.

Table 5: ANOVA: PBL, POL and TL on Achievement Scores

Dependent Variable: Y

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 87558.165[a] | 2 | 43779.083 | 843.942 | .000 |
| Intercept | 816626.555 | 1 | 816626.555 | 15742.354 | .000 |
| GROUP | 87558.165 | 2 | 43779.083 | 843.942 | .000 |
| Error | 7625.550 | 147 | 51.874 | | |
| Total | 911810.270 | 150 | | | |
| Corrected Total | 95183.715 | 149 | | | |

a. R Squared = .920 (Adjusted R Squared = .919 (Source: Author 2025)

## 7.Discussion

The research was led by two objectives that tried to compare the effect of two active learning methods with the lecture method in distinguishing the dissimilarities between monocots and dicots. The study discussions were steered by two objectives: the influence of active learning in educating and learning in daily classroom association and the effect of the two active learning methods and the traditional lecture method on post-test mean acquisition scores.

Results gathered from the schematic observation sheet and research notes showed that the utilization of active learning had a significant positive influence on the learners. Table 1 demonstrates the effectiveness of active learning groups in bringing forth practical skills in contrast to the conventional lecture method. It revealed that the active learning method had a beneficial influence on their procedural abilities, research, and concept accuracy compared to the TL group. The percentage of students who applied scientific concepts correctly, had high advancement in applying scientific process skills in the POL and PBL (active learning) groups in comparison to the TL method after the intervention (Figure 3). In contrast to TL, the results demonstrated that the use of POL and PBL greatly influenced the increase in learners' performance due to the correct presentation of scientific concepts.

The experimental group's positive trend in the results was attributed to the application of problem-based and project-oriented learning. The results demonstrated that encouraging students to participate in active learning in the classroom increased their motivation to pursue academic goals. The results also unequivocally showed that using active learning strategies improved students' comprehension and reduced the possibility that they would have misconceptions about the material studied.

Active learning and teaching improve strategies which the learner applies in class as well as outside because they are the owners of the information, which makes it easier to remember. For the scientific sphere of the country to improve, a great deal has to be done when it comes to observing the use of active learning methods in the classroom also rather than covering the curriculum.

At the beginning of the study, the three groups were statistically equivalent in terms of distinguishing between dicot and monocot and plants depended on anatomical and morphological features (Table 2). The findings in Table 5 proved that learners' post-test mean performance scores for the experimental groups trained by PBL and POL showed statistically significant improvements. The results tally with Musonda & Chituta's (2020) finding where they contrast the outcomes of passive learning with PBL and the POL techniques, and found a significant statistical difference in student performance and attitude. According to the research, problem-based learning and project-oriented learning were, in general, having a higher standard of instructional design. Nurbavliyev et al., (2022) & Ali et al., (2019) also concluded that, an active class exceeds the traditional lecture method regarding performance in the test utilizing laboratory apparatus and processes.

## 8.Conclusion

The qualitative findings of the study suggested that active learning approaches (POL and PBL), fostered positive competencies, including critical thinking, problem-solving, and collaborative efforts during the practical sessions.

Students further demonstrated engagement, motivation, and improved understanding of the subject matter.

The quantitative results from the ANOVA test revealed statistically significant differences in the students' learning outcomes between active learning groups and traditional lecture method groups. The paired t-test which assessed the–performances between the pre-and post-test results, revealed that both active learning methods significantly improved biology practical scores compared to the lecture method.

The study's results suggest that active learning methods can be a valuable teaching method compared to traditional lecture approaches. The study result indicates that to enhance learner input in handling educationally connected problems in the surroundings, activities such as active learning methods that permit someone's subject area to advance should be highly encouraged.

### *8.1 Implications of Findings*

The research has unlocked many unclear areas that subsequent researchers could go into, such as:

- Efficient laboratory practice that can enhance conceptual comprehension.
- The existing laboratory experience of students must be fully researched in the Zambian context.

- The readiness and effectiveness of locally available school laboratory practical experience has to be examined.

*8.2 Recommendations*

It is thus prudent that the Zambian education system needs to come up with intentional, well-studied reforms fostering more active learning methods, which are flexible and applicable to pupils in our setup. Active learning requires all the essential stakeholders to be ready to see the difference in every aspect of an individual's career and private life, that can subsequently impact the country in terms of the end product taken out of the education system. The government should fund to help develop a syllabus that ensures that every learner can be innovative in their own right and should develop a specific project. Future research should explore the nuances of active learning implementation, students' characteristics, and contextual factors to better understand its influence on pupils' learning.

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