



Enhancing Learner Engagement and Conceptual Understanding of Cell Structure and Function through Cooperative Learning: An Action Research Project at Mpongwe Secondary School

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Abstract: This action research study examined the impact of cooperative learning on Grade Ten pupils' academic performance in cell structure and organization at Mpongwe Secondary School in Zambia's Copperbelt Province. The research was prompted by observed learner disengagement during teaching practice, with minimal active participation and prevalent rote memorisation contributing to poor performance and negative attitudes toward biology. Using a mixed-methods action research design involving 41 Grade Ten pupils and three experienced biology teachers, data were collected through pre-tests, post-tests, questionnaires, interviews, observations, and document analysis. The five-week cooperative learning intervention incorporated Johnson and Johnson's five essential elements: positive interdependence, individual accountability, face-to-face interaction, social skills, and group processing. Findings demonstrated significant improvement in learner performance, with mean scores increasing from 70.1% in the pre-test to 75.7% in the post-test. The failure rate dropped from 7.4% to 2.4%, and the standard deviation decreased from 20.04 to 15.63, indicating more equitable learning outcomes. Questionnaire results revealed that 100% of learners reported improved communication skills, 97.6% developed teamwork spirit, and 95.1% developed positive attitudes toward biology. Qualitative data confirmed enhanced participation, effective peer support, and development of research, observation, and creative skills. The study concludes that cooperative learning effectively improves academic performance, engagement, and skill development in biology education. Recommendations include teacher training in cooperative learning strategies, addressing over-enrolment, and gradual implementation of learner-centred pedagogies.

Keywords: cooperative learning, biology education, cell structure, action research, learner engagement, academic performance, Zambia, secondary education

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1. Introduction

Biology is the natural science discipline concerned with the study of living things, encompassing three main branches: botany, which is the study of plants; microbiology, which deals with microorganisms such as bacteria and viruses; and zoology, the scientific study of animals including human beings and insects (Campbell,

2013). The subject plays a fundamental role in enabling scientists to understand ecosystems, preserve biodiversity, study disease causing microorganisms, and protect endangered species from extinction (Fayer, 2008). Despite its critical importance, biology is perceived by many learners as a difficult and bulky subject, often leading to negative attitudes and disengagement from the learning process.

The challenge of biology education in Zambia must be understood within a broader national context. According to the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ), Zambia has been ranked as the lowest performing country in natural sciences in the entire Southern and Eastern Africa region (SACMEQ, 2023). This concerning finding prompted the researchers to investigate what other countries were doing differently in achieving success in natural sciences education. One significant factor that emerged was the substantial difference in teaching strategies employed across countries (Karsenti, 2008). This regional underperformance underscores the urgent need for pedagogical innovation in Zambian science classrooms.

Biology education, which involves the transmission and construction of fundamental biological concepts between teachers and learners, requires the use of effective and innovative pedagogical approaches. For meaningful learning to occur, teachers must possess adequate pedagogical knowledge and skills that enable them to present scientific concepts in ways that promote understanding and inquiry. Research shows that teachers' instructional practices and professional knowledge significantly influence the quality of teaching and learning in the classroom (Hattie, 2009). As a result, the strategies employed by biology teachers play a crucial role in shaping students' engagement, conceptual understanding, and academic achievement.

During the researcher's teaching practice at Mpongwe Secondary School, an important observation was made: most biology teachers relied predominantly on traditional teaching methods, particularly the lecture method. This approach typically positions learners as passive recipients of knowledge rather than active participants in the learning process. Teacher-centred instruction has long been criticised in science education because it limits student participation, critical thinking, and conceptual development (Prince, 2004). In contrast, learner-centred and inquiry-based approaches encourage students to actively construct knowledge through discussion, experimentation, and problem-solving.

Studies in science education consistently show that active learning approaches significantly improve student performance compared to traditional lecture-based instruction. For instance, a large meta-analysis of undergraduate science, technology, engineering, and mathematics (STEM) courses found that students in active learning environments performed better and had lower failure rates than those taught through traditional lectures (Freeman et al., 2014). Despite such evidence, many classrooms around the world, including in developing contexts, continue to rely heavily on teacher-centred approaches.

Furthermore, the way difficult biological concepts are taught can strongly influence students' academic performance. When teachers rely mainly on textbooks and memorisation rather than conceptual explanations

and practical activities, students often struggle to develop deep understanding of biological processes. Effective science teaching therefore requires approaches that emphasise inquiry, experimentation, and conceptual engagement rather than rote learning (Bybee, 2013; Osborne & Dillon, 2008). Such pedagogical practices help learners develop scientific reasoning, problem-solving abilities, and a deeper appreciation of biological concepts.

Cooperative learning presents a viable alternative to traditional lecture based instruction. The term cooperative implies working in groups to achieve common goals, allowing members to share ideas, improve social skills, and enhance communication through interaction. Cooperative learning involves active engagement where students answer exercise questions, formulate their own questions, discuss concepts, explain ideas to peers, work collaboratively, and perform demonstrations in class. More formally, it can be defined as an instructional method in which pupils work in teams or groups on problems and projects under teacher guidance, ensuring both positive interdependence and individual accountability. Deutsch (1962) and Johnson and Johnson (1989) established that in cooperative learning situations, positive interdependence exists among students' goal attainment, meaning learners perceive that they can reach their learning goals only if other students in the group also reach theirs.

The theoretical foundation of cooperative learning draws from social theorists preceding World War II, including Allport, Watson, and Mead, who discovered that group work proved more effective and efficient in both quality and quantity compared to individual work. Vygotsky (1962) emphasised the social nature of learning, asserting that without the cooperation of its members, society cannot survive, and that individuals most likely to survive are those best enabled to do so by their group members. Montagu (1965) similarly observed that what children can do together today, they can do alone tomorrow, highlighting the developmental trajectory from collaborative to independent competence.

One specific cooperative learning strategy is the jigsaw method, where each learner researches one section of the material and then teaches it to other group members (Joliffe, 2007). This approach ensures that no single group member possesses all the resources, information, or skills necessary for the highest quality presentation, creating mutual interdependence. Recent research from Rwanda investigating the jigsaw teaching method with university students found that those taught using this approach scored significantly higher than those who received traditional lectures. Students reported multiple benefits including enhanced communication skills, teamwork, knowledge retention, a fun learning atmosphere, and increased self-esteem (Ndikumana et al., 2024). Similarly, a pilot study conducted in Kazakhstan demonstrated that implementing the jigsaw method led to substantial improvements in student performance, with the percentage of students receiving

high grades increasing by 43.75 percent while the percentage of low grades decreased by 50 percent (Myrzagaliev et al., 2024). These findings provide strong empirical support for the effectiveness of structured cooperative learning approaches in biology education.

Contemporary research across multiple contexts continues to validate the effectiveness of cooperative learning in biology. A 2024 study from Ethiopia assessed the relative effectiveness of cooperative learning strategies on learners' peer relatedness, academic support, and learning gains in secondary school biology. Using a quasi-experimental design involving 81 students, the research revealed that participation in cooperative learning strategies had a moderate to substantial effect on the measured variables. Furthermore, regression analysis indicated that peer relationships and academic support together accounted for 43.2 percent of the variance in overall learning gains (Kebede et al., 2024). The study also highlighted that shifting classroom instruction from a content centric approach to a learner centred approach can enhance not only the quality of teaching but also the quality of learning and key indicators of student success. These findings are particularly relevant to the Zambian context as they emerge from a neighbouring African country with similar educational challenges.

The advantages of cooperative learning are multiple. First, it increases retention in learners, because when students learn from peers, concepts are more easily understood and retained. Second, teammates can provide attention and mutual assistance. Third, learners can translate teacher language into student language for one another, making complex concepts more accessible. Additionally, cooperative learning has been found to have better effects on students' interest and achievement in learning difficult biology concepts compared to peer teaching alone. Research also indicates that cooperative learning significantly improves both achievement and knowledge retention compared to lecture based teaching.

A recent study from Nigeria examined the effect of jigsaw learning strategy on secondary school students' academic achievement in biology. The research, involving 97 students, compared the jigsaw method with conventional lecture methods and found that both approaches enhanced student achievement, though the difference was not statistically significant. The study recommended that teachers should blend these instructional strategies to foster a more dynamic and inclusive learning environment since both approaches benefited male and female students (Ezeugwu et al., 2024). This finding suggests that cooperative learning need not entirely replace traditional methods but can be effectively integrated with them.

Further evidence from the United States investigated how collaborative e-learning strategies affected student understanding of biology concepts. The study involved 24 diverse students including regular education students, English language learners, and students with

individualized education programs. Results showed substantial improvement in student performance, with mean scores increasing from 50 percent to 91 percent following collaborative interventions. Students reported high engagement and satisfaction with collaborative learning approaches (Urbina, 2025). Similarly, research from Indonesia integrating blended learning with the cooperative Teams Games Tournament approach demonstrated significant improvement in both teacher performance and student learning outcomes. Students' classical mastery rose from 53.57 percent to 79 percent, with statistical analysis confirming a significant difference between pre-test and post-test scores and a very large effect size (Jamhari et al., 2025).

The positive effects that cooperation has on numerous important outcomes, including improved communication skills, enhanced social life of learners, higher achievement and productivity, and greater psychological health and competence (Johnson & Johnson, 1989), make cooperative learning one of the most valuable tools available to educators. The findings provide preliminary evidence that shifting classroom instruction from a content centric approach to a learner centred approach can enhance not only the quality of teaching but also the quality of learning and key indicators of student success (Kebede et al., 2024). Moreover, collaborative teaching approaches have been shown to enhance subject integration of knowledge and lead to enhanced student learning and understanding by providing diverse instructional strategies and perspectives (Nashidengo et al., 2025). Research also indicates that collaborative learning activities can help foster success for underrepresented students, though careful attention must be paid to implementation challenges such as time management and appropriate spacing of learning activities (True & Abreu, 2024; Urbina, 2025).

This research study was conducted during student teaching practice with Grade Ten pupils at Mpongwe Secondary School over approximately five weeks in the second term of the Zambian public school calendar. Using both quantitative and qualitative action research methods, including teaching observations, interviews, questionnaires, focus group discussions, homework, class exercises, and tests, the study aimed to investigate learners' performance on the topic Cell Structure and Organization and explore how cooperative learning could enhance understanding and improve average class performance. While confined to this specific topic, the findings may be generalizable to other biological topics.

1.1 Statement of the Problem

For most learners, the mere mention of the word biology evokes statements that the subject is boring, difficult to study, and excessively bulky. This negative perception has direct implications for students' ability to understand biological concepts across various topics. During classroom observations conducted during teaching practice at Mpongwe Secondary School, a concerning pattern emerged: in classes of approximately sixty

pupils, only ten to twenty learners actively participated in answering questions and contributing to lessons. Following instruction, when exercises were assigned, only about half the class would attempt the questions independently, while the remainder merely copied from peers. This passive engagement, with students functioning as spectators rather than participants, inevitably leads to high failure rates in examinations, as the majority of learners fail to develop meaningful understanding. Observable indicators of disengagement include lack of interest in lessons and frequent dozing during class time.

Analysis of observed lessons revealed that most teachers rely predominantly on the lecture method as their main teaching approach. This teacher centred methodology has contributed substantially to poor pupil performance in biology. Compounding this issue, an interview with one observed teacher indicated that pupils typically memorised notes only when examinations approached, without genuinely applying learned concepts. This reliance on rote memorisation rather than meaningful learning represents a significant pedagogical challenge. Recent research confirms that poor student achievement in science subjects can be attributed to the reality that the majority of secondary school teachers use ineffective teaching strategies that do not encourage students' active learning through involvement. A recent study similarly concluded that the teaching approach used for difficult biology concepts is significantly responsible for poor student performance in secondary school biology.

Active and collaborative learner involvement in the classroom, combined with knowledge sharing within group members, has a direct positive effect on increased understanding of subject content and learner performance. The critical issue this research study seeks to address is how cooperative learning can be systematically implemented to improve learner performance in biology, specifically within the context of teaching Cell Structure and Organization at Mpongwe Secondary School. There is an urgent need to shift from teacher centred approaches to genuinely learner centred pedagogy. The most effective way for learners to understand biological concepts is through structured group work where they function as a team. This approach increases retention, because when students learn from one another, concepts become more accessible and memorable. Furthermore, teammates can provide mutual attention and assistance, and learners can effectively translate teacher language into student language for their peers (Jacob, 1999; Johnson & Johnson, 1989).

Contemporary evidence from various studies demonstrates that cooperative learning strategies significantly enhance peer relatedness, academic support, and learning gains in biology (Kebede et al., 2024). Similarly, recent research showed that collaborative learning strategies produce substantial improvements in student performance, with mean scores nearly doubling following intervention (Urbina, 2025). Studies have also documented significant improvements

in both theoretical understanding and practical skills among students learning in collaborative environments (Myrzagaliyeva et al., 2024). Therefore, systematic implementation of cooperative learning in schools holds significant potential to improve overall learner performance in biology.

1.2 Purpose of the study

The main purpose of this study is to explore, implement, and analyse the impact of using cooperative learning on Grade Ten pupils' academic performance and engagement when teaching the topic Cell Structure and Organization at Mpongwe Secondary School. Understanding how to effectively utilise cooperative learning in classroom instruction promotes meaningful learning and active student participation. Therefore, this research seeks to investigate cooperative learning systematically so that its practical application in teaching biology can be enhanced, ultimately contributing to improved educational outcomes in natural sciences education in Zambia.

1.3 Objectives of the Study

The objectives of this study are:

1. To determine whether cooperative learning improves pupil performance in learning cell structure and organization at Mpongwe Secondary School.
2. To enhance pupil classroom participation and teamwork in biology learning through cooperative learning strategies.
3. To analyse the impact of cooperative learning on pupils' academic performance and classroom engagement when teaching cell structure and organization.

1.4 Research Questions

This study seeks to answer the following research questions:

1. How does cooperative learning improve the effectiveness and level of understanding among students when learning cell structure and organization?
2. How can existing cooperative teaching strategies be enhanced to make them more effective in the biology classroom?
3. How does cooperative learning contribute to improving learners' social life and communication skills?

2. Literature Review

This literature review examines the body of knowledge concerning cooperative learning as a teaching strategy. The review explores the theoretical foundations, key elements, empirical evidence of effectiveness, methods

of implementation, and limitations of cooperative learning, with particular attention to studies examining cooperative learning in science and biology education contexts. The review synthesizes foundational theories with contemporary research findings from 2024 and 2025.

2.1 The concept of cooperative learning

Cooperative learning is a learner-centred instructional strategy in which students work collaboratively in small groups to share knowledge, solve problems, and reflect on their experiences (Jolliffe, 2007). Unlike simple group work, cooperative learning deliberately structures positive interdependence among learners. Students must work together to complete tasks collectively toward achieving shared academic goals. The role of the teacher shifts from being the primary source of information to becoming a facilitator who guides the learning process.

Smyth and Rose (1995) described effective cooperative learning tasks as intellectually demanding, open-ended, creative, and requiring higher order thinking skills. In well-structured cooperative learning environments, small teams comprising learners of different ability levels use a variety of learning activities to improve their understanding of subject content. Every member is responsible not only for learning what is taught but also for helping teammates learn.

Kagan (1994) identified several mutual benefits of cooperative learning: each learner gains from other members' efforts; all group members share a common fate; every team member's contribution is vital; and team members celebrate together when one member achieves success. The teacher presents learning material, provides instructions, and assigns tasks to be worked on collaboratively, with each member responsible for ensuring team success (Johnson & Smith, 2000).

2.2 Theoretical foundations of cooperative learning

The theoretical foundations of cooperative learning were established by social theorists including Allport, Watson, Shaw, and Mead, who discovered that group work was more effective and efficient than working individually (Johnson, 2014). In the 1930s, philosophers and psychologists such as John Dewey, Kurt Lewin, and Morton Deutsch further influenced cooperative learning theory.

Dewey believed learners should develop knowledge and social skills that would serve them outside the classroom. Lewin focused on establishing relationships among team members to achieve learning objectives effectively. Deutsch (1962) contributed the concept of positive social interdependence, the idea that learners perceive they can reach their learning goals only if other students in the group also reach theirs.

Philosophers David and Roger Johnson made vital contributions, including publishing the five elements of cooperative learning in 1994 (Battistich, Solomon, & Delucchi, 1993). Vygotsky (1962) emphasised the social nature of learning, asserting that individuals most likely to survive are those best enabled to do so by their group members. Montagu (1965) observed that what children can do together today, they can do alone tomorrow.

2.3 Five essential elements of cooperative learning

Johnson and Johnson (1994) identified five essential elements that must be present for cooperative learning to be effective.

Positive Interdependence

Students must believe that each person's efforts benefit not only themselves but the whole group. Teachers achieve this through mutual goals, division of labour, shared materials, assigned roles, and group-based grading.

Face-to-Face Interaction

Direct interaction enables oral explanations, discussion of concepts, and connection of new learning with prior knowledge, improving social, communication, and interpersonal skills.

Individual Accountability

Each student must do their share of work. No learner should be a spectator. Individual accountability ensures all students are responsible for their own learning while being accountable to their teammates.

Social Skills

Cooperative learning requires students to develop leadership, decision-making, trust-building, communication, and conflict-management skills. These must be deliberately taught and practiced.

Group Processing

After completing tasks, learners evaluate how well their groups functioned and how social skills were utilized, allowing groups to improve their effectiveness over time (Pohl, 2000).

Bonwell and Eison (1991) emphasized that two features must be present: learners must work toward a common goal with each member contributing effort, and reward structures, individual responsibility, and tasks must be clearly identified. Cooperative learning combines guidance with active learning and is sometimes called "learning by teaching" (Martin, 1985; Martin & Oebel, 2007).

2.4 Contemporary research supporting cooperative learning (2024-2025)

Research on cooperative learning has produced overwhelmingly positive results across multiple educational contexts. Johnson and Johnson (1989) concluded that cooperative learning results in improved reasoning, generation of new ideas, and greater learning transfer.

Recent African Studies

A 2024 Ethiopian study on secondary school biology found that cooperative learning strategies had a moderate to substantial effect on peer relatedness, academic support, and learning gains. Peer relationships and academic support together accounted for 43.2 percent of the variance in overall learning gains (Kebede et al., 2024).

Research from Rwanda investigating the jigsaw method with university students found those taught using this approach scored significantly higher than those receiving traditional lectures. Students reported enhanced communication skills, teamwork, knowledge retention, and increased self-esteem (Ndikumana et al., 2024).

A Nigerian study comparing jigsaw and conventional lecture methods in secondary school biology found both approaches enhanced student achievement and recommended blending instructional strategies for a more dynamic learning environment (Ezeugwu et al., 2024).

Recent International Studies

A Kazakhstani pilot study demonstrated that implementing the jigsaw method led to a 43.75 percent increase in high grades and a 50 percent decrease in low grades (Myrzagaliyeva et al., 2024).

United States research on collaborative e-learning strategies in biology showed mean scores increasing from 50 percent to 91 percent following collaborative interventions, with students reporting high engagement and satisfaction (Urbina, 2025).

An Indonesian study integrating blended learning with cooperative Teams Games Tournament demonstrated students' classical mastery rising from 53.57 percent to 79 percent, with statistical analysis confirming a very large effect size (Jamhari et al., 2025).

Namibian research exploring co-teaching found that collaborative teaching enhanced subject integration and led to improved student learning (Nashidengo et al., 2025).

2.5 Cooperative learning methods

Most cooperative learning methods place learners in groups of five to six students and implement team rewards to motivate students.

Jigsaw Method: Each student researches on one piece of a larger project; all pieces are then assembled by the group. This creates mutual interdependence as no single member possesses all necessary information.

Student Teams Achievement Divisions (STAD): Students are placed in groups, presented with a lesson, and tested individually. Individuals are graded based on group performance, encouraging collaboration (Devries & Slavin, 1978).

Jigsaw II: Slavin's (1980) variation where home group members focus on separate parts of the same material, becoming experts who teach other members.

Reciprocal Teaching: Brown and Paliscar (1982) developed this strategy where learners in pairs take turns reading and asking questions, using metacognitive techniques including clarifying, questioning, predicting, and summarizing.

The Williams Method: Learners work together on differentiated tasks that increase in cognitive ability, allowing progression toward learning objectives (Johnson, Johnson, & Stanne, 2000).

2.6 Challenges and limitations of cooperative learning

Teachers implementing cooperative learning may face resistance from students who believe they are being held back by slower teammates or feel ignored (Lubienski, 1999). When group members do not understand information, the entire group may be slowed (Andrews, 2001).

Group dynamics problems include power imbalances resulting in dictatorship, dominating personalities that exclude others' ideas, dependent learners who do not contribute, and shy students who feel uncomfortable expressing themselves (Clarke, 1997).

Assessment concerns include peer evaluations that may not reflect true experiences due to perceived competition, and time constraints between learning activities and syllabus requirements (Prawat, 1997). Students who prefer independent work may withdraw from group activities, and groups may focus more on social activities than academic tasks (Dansereau, 1987).

2.7 Implementing cooperative learning successfully

Many techniques minimize implementation problems by addressing the five essential elements (Johnson, Johnson, & Stanne, 2000). Most experienced instructors recommend a gradual approach, choosing methods with which they feel comfortable and adopting additional strategies only after becoming accustomed to current ones (Mills, 2003).

3. Methodology

This section presents the research methodology employed in this action research study. It outlines the research design, study setting, target population and sample, data collection instruments, procedures for data collection, intervention implementation, and methods of

data analysis. The section also addresses ethical considerations observed throughout the research process. The methodology was designed to investigate the impact of cooperative learning on Grade Ten pupils' understanding of cell structure and organization at Mpongwe Secondary School in Zambia's Copperbelt Province.

3.1 Research design

This study employed an action research design, which is particularly appropriate for educational settings where practitioners seek to improve their own teaching practices. Action research is widely used in education because it enables teachers and researchers to systematically investigate problems within their own classrooms and implement practical solutions. According to Craig A. Mertler, action research is a structured and collaborative process in which practitioners identify a problem, implement an intervention, and reflect on the outcomes in order to improve practice within a specific context (Mertler, 2020). This approach allows educators to critically examine their teaching strategies, make informed adjustments, and enhance student learning through cycles of planning, action, observation, and reflection. According to Ferrance (2000), action research specifically refers to a disciplined inquiry conducted by a teacher with the intent that the research will inform and change his or her practices in the future.

The action research design was selected because it allows the researcher, who was also the classroom teacher, to identify a problem within the teaching and learning environment, implement an intervention, and systematically observe and reflect on the outcomes. This design is cyclical in nature, involving planning, action, observation, and reflection.

The study employed a mixed-methods approach, incorporating both quantitative and qualitative data collection and analysis. This approach was chosen because it allows for triangulation of findings, with data from one method complementing and validating data from the other. Quantitative data were collected through pre-tests and post-tests, while qualitative data were gathered through observations, interviews, and document analysis.

3.2 Research site

The research was conducted at Mpongwe Secondary School, a public co-educational institution under the Zambian Ministry of General Education. The school is located in the centre of Mpongwe town in the Copperbelt Province, at the Luanshya-Kapili junction. The school accommodates learners from Grade Eight to Grade Twelve.

Mpongwe Secondary School has three streams for each grade, designated as M, P, and O. Each class has an average of 40 pupils, which is considered conducive by Zambian standards. The total pupil population is

approximately 1,800, supported by about 36 teachers and 15 auxiliary workers.

As an older school, most of the laboratories are not up to standard, and the school lacks a library, making it difficult for learners to find adequate study space beyond their classrooms. By Zambian education standards, the school lacks a fully conducive learning environment.

During teaching practice, the researcher was assigned two Grade Ten biology classes, 10P and 10O, amounting to 12 periods per week. Both classes comprised 43 pupils each. The average age of learners was 16 years, with ages ranging from 15 to 19 years. Their general academic performance ranged from average to good.

3.3 Target population and research sample

Target Population

The target population for this study comprised all Grade Ten biology learners at Mpongwe Secondary School. The total population of Grade Ten biology learners was approximately 120 students across all streams.

Research Sample

The study employed purposive sampling, a non-probability sampling technique where participants are selected based on specific characteristics relevant to the research. The sample consisted of:

- **Learners:** Grade 10P class, comprising 41 learners, participated in the pre-test and post-test interventions. This class was selected because the researcher was assigned to teach it, allowing for direct implementation and observation of the cooperative learning intervention.
- **Teachers:** Three experienced biology teachers were purposively selected for interviews based on their extensive experience teaching biology at the school.

The sample included both male and female participants, reflecting the co-educational nature of the school.

3.4 Research instruments

Four main instruments were used to collect data for this study. These instruments were selected to ensure comprehensive data collection that would address the research questions from multiple perspectives.

Interview Guide

A semi-structured interview guide was developed to collect qualitative data from experienced biology teachers. The guide contained open-ended questions designed to explore teachers' perceptions of cooperative learning, the challenges they faced when teaching cell structure and organization, and the strategies they employed to enhance learner understanding. Semi-structured interviews allowed for flexibility, enabling the

researcher to probe further based on respondents' answers.

Questionnaire

A structured questionnaire was administered to learners to collect information about their attitudes toward biology, their perceptions of cooperative learning, and their experiences with group work. The questionnaire contained both closed-ended and open-ended questions. Closed-ended questions used a Likert scale format, while open-ended questions allowed learners to express their views freely. The questionnaire offered anonymity, which encouraged honest responses, particularly on sensitive topics (Kumar, 2005).

Observation Guide

An observation guide was used to record systematic observations during lessons. The guide focused on specific behaviours including:

- Level of learner participation in group activities
- Quality of interactions among group members
- Evidence of positive interdependence and individual accountability
- Learner engagement and attention during lessons
- Social skills demonstrated during group work

Observations were recorded as field notes immediately after each lesson to ensure accuracy (Kawulich, 2012).

Tests and Document Analysis

Two tests were administered:

- **Pre-test:** Administered before the intervention to establish baseline performance levels on cell structure and organization.
- **Post-test:** Administered after the intervention to measure learning gains.

Additional documents analyzed included:

- Class exercise books and homework submissions
- Schemes of work to identify teaching methods previously used
- School records including report cards and examination analysis reports
- Group work records and audio recordings of group discussions

3.5 Data collection procedures

Data collection proceeded in three phases: baseline data collection, intervention phase data collection, and post-intervention data collection.

Baseline Data Collection

Baseline information was collected before implementing the intervention to establish the existence and extent of the problem. This phase involved:

- Conducting unstructured interviews with the biology teacher who previously handled the research class to understand pupil attitudes toward biology
- Interviewing Grade 11 pupils who had already studied cell structure and organization
- Collecting previous biology results to serve as pre-test data
- Analyzing schemes of work to identify teaching methods previously used
- Reviewing school documents including report records and examination analysis reports

This baseline data provided insight into learner performance, attitudes, participation levels, study habits, and the difficulties teachers and learners faced in teaching and learning cell structure and organization.

Intervention Phase Data Collection

During the five-week intervention, data were collected through:

- Continuous direct observation of group interactions
- Recording of group discussions (audio recordings and photographs)
- Analysis of class exercises and homework
- Monitoring learner participation in groups
- Random selection of group members to present solutions, ensuring individual accountability

Post-Intervention Data Collection

After the intervention, a post-test was administered to all learners in the research class. The post-test was effectively supervised to ensure authentic results. Post-test scores were compared with pre-test scores to assess improvement. Learners' exercise books were also analysed to track progress throughout the intervention period.

3.6 Intervention procedure

The intervention was implemented over five weeks during the second term of the Zambian public school calendar. The procedure followed a structured approach designed to maximize the effectiveness of cooperative learning.

Group Formation

Based on baseline data, learners were divided into eight groups of approximately five members each. Groups were carefully constructed to ensure heterogeneity in terms of academic ability, ensuring that learners of

different understanding levels were distributed across groups. No permanent leaders were appointed; leadership emerged naturally based on who understood concepts and could contribute meaningfully to group tasks.

Teacher-Learner Communication

The intervention began with an introductory lesson explaining the cooperative learning approach and its purpose. The researcher delivered clear explanations of cell structure and organization concepts, followed by guided questions discussed collaboratively. Practical activities were assigned to groups, with each member responsible for contributing to task completion. Clear instructions were provided, and groups worked on assigned tasks while the researcher facilitated the learning process.

Learner-Learner Communication

Within groups, learners shared ideas, answered questions, performed practical activities, and compared solutions to arrive at the best answers. Groups were occasionally rearranged, and selected pupils presented findings to newly formed groups. Marks were assigned based on the quality of work produced.

Learner-Teacher Communication

Groups presented their findings, and the researcher provided feedback, made corrections on questions where groups struggled, and allowed learners to ask further questions for clarification. Learners were encouraged to argue, air their views, and engage in academic dialogue.

Ensuring the Five Elements of Cooperative Learning

Throughout the intervention, deliberate efforts were made to incorporate Johnson and Johnson's (1994) five essential elements:

- **Positive interdependence:** Groups worked toward common goals; success depended on all members contributing.
- **Individual accountability:** Random members were selected to present group findings.
- **Face-to-face interaction:** Groups sat together and discussed tasks.
- **Social skills:** Learners practiced communication, leadership, and conflict management.
- **Group processing:** Time was allocated for groups to reflect on their functioning.

3.7 Data analysis procedure

Data analysis was conducted using both quantitative and qualitative methods, consistent with the mixed-methods research design.

Quantitative Data Analysis

Quantitative data from pre-tests and post-tests were analyzed using descriptive statistics. Mean scores, percentages, and frequency distributions were calculated to compare performance before and after the intervention. Test scores were tabulated and presented using tables and figures to illustrate learning gains.

Qualitative Data Analysis

Qualitative data from interviews, observations, and open-ended questionnaire responses were analysed using thematic analysis. The process involved:

- Transcribing interview recordings and organizing field notes
- Reading through all data to gain overall understanding
- Coding the data by identifying meaningful units
- Grouping codes into categories and emerging themes
- Interpreting themes in relation to research questions

The qualitative data provided rich contextual information that complemented the quantitative findings.

3.8 Ethical considerations

Ethical considerations were observed throughout the research process to protect the rights and welfare of all participants. Permission to conduct the research was obtained from the school administration at Mpongwe Secondary School. The researcher also complied with university requirements for conducting research during teaching practice.

All participants were informed about the purpose of the research, the procedures involved, and their rights as participants. For learners, assent was obtained, and their regular classroom teacher also provided consent. Teachers who participated in interviews provided verbal informed consent. Participants were assured that their participation was entirely voluntary and that they could withdraw from the study at any time without negative consequences. No penalties or disadvantages resulted from non-participation.

All data were treated with strict confidentiality. Participants' names were not used in any reports or publications. Codes were used to identify participants in interview transcripts and observation notes. Questionnaire responses were anonymous to encourage honest answers. Interviews were conducted in private settings to ensure participant comfort and confidentiality. Group observations were conducted as part of normal classroom activities, minimizing any disruption to the learning environment.

The research was designed to benefit participants through improved teaching and learning. No harm, whether physical, psychological, or social, was caused to any participant. The intervention was integrated into

normal classroom instruction, ensuring that learners were not disadvantaged.

4. Results and Discussion

This section presents the findings of the action research study on the impact of cooperative learning on Grade Ten pupils' performance in cell structure and organization at Mpongwe Secondary School. The section is organized into two main sections. The first section presents the results derived from pre-tests, post-tests, teacher interviews, learner questionnaires, and document analysis. The second section provides a detailed discussion of these findings, interpreting them in relation

to the research questions and existing literature. The section concludes with a summary of key findings.

4.1 Results and findings

Pre-test results

Before implementing the cooperative learning intervention, a pre-test on cell structure and organization was administered to 41 learners in Grade 10P at Mpongwe Secondary School. The test aimed to establish baseline performance levels and identify learners' prior knowledge of the topic. Table 1 presents the distribution of grades obtained in the pre-test.

Table 1 :Pre-Test Results Distribution (N=41)

Grade	Score Range (%)	Frequency	Percentage (%)	Cumulative Percentage (%)
Unsatisfactory	0-34	3	7.4	7.4
Satisfactory	35-39	1	2.4	9.8
Pass 7	40-44	1	2.4	12.2
Credit 6	45-49	2	4.9	17.1
Credit 5	50-54	1	2.4	19.5
Merit 4	55-59	4	9.8	29.3
Merit 3	60-64	1	2.4	31.7
Distinction 2	65-73	7	17.0	48.7
Distinction 1	74-100	21	51.3	100.0
Total		41	100.0	

The pre-test results show that 21 learners (51.3%) scored in the Distinction 1 category (74-100%), while 3 learners (7.4%) fell into the Unsatisfactory category (0-34%). The

remaining 17 learners (41.3%) were distributed across the other grade categories. Table 2 presents descriptive statistics for the pre-test results.

Table 2: Descriptive Statistics for Pre-Test Results (N=41)

Statistic	Value
Minimum Score	20.00
Maximum Score	95.00
Mean	70.12
Standard Deviation	20.04
Variance	401.70

The pre-test results reveal a mean score of 70.12% with a standard deviation of 20.04, indicating considerable variation in learner performance. The minimum score was 20%, while the maximum score was 95%. The high standard deviation suggests that learners entered the topic with widely varying levels of understanding.

Following the five-week intervention using cooperative learning strategies, a post-test on cell structure and organization was administered to the same 41 learners. The test was comparable in difficulty and content coverage to the pre-test. Table 3 presents the distribution of grades obtained in the post-test.

4.2 Post-Test Results

Table 3: Post-Test Results Distribution (N=41)

Grade	Score Range (%)	Frequency	Percentage (%)	Cumulative Percentage (%)
Unsatisfactory	0-34	0	0.0	0.0
Satisfactory	35-39	1	2.4	2.4
Pass 7	40-44	0	0.0	2.4
Credit 6	45-49	1	2.4	4.8
Credit 5	50-54	4	9.8	14.6
Merit 4	55-59	1	2.4	17.0
Merit 3	60-64	2	4.9	21.9
Distinction 2	65-73	4	9.8	31.7

Grade	Score Range (%)	Frequency	Percentage (%)	Cumulative Percentage (%)
Distinction 1	74-100	28	68.3	100.0
Total		41	100.0	

The post-test results show a marked improvement in learner performance. Twenty-eight learners (68.3%) scored in the Distinction 1 category (74-100%), compared to 21 learners (51.3%) in the pre-test. Notably,

no learners scored in the Unsatisfactory category in the post-test, whereas three learners had done so in the pre-test. Table 4.4 presents descriptive statistics for the post-test results.

Table 4: Descriptive Statistics for Post-Test Results (N=41)

Statistic	Value
Minimum Score	37.00
Maximum Score	98.00
Mean	75.74
Standard Deviation	15.63
Variance	244.40

The post-test results reveal a mean score of 75.74%, representing an increase of 5.62 percentage points from the pre-test mean of 70.12%. The standard deviation decreased from 20.04 in the pre-test to 15.63 in the post-test, indicating reduced variation in learner performance and suggesting that cooperative learning benefited learners across different ability levels.

4.3 Comparison of pre-test and post-test results

Table 5 presents a direct comparison of pre-test and post-test descriptive statistics, highlighting the changes observed following the cooperative learning intervention.

Table 5: Comparison of Pre-Test and Post-Test Results (N=41)

Statistic	Pre-Test	Post-Test	Change
Minimum Score	20.00	37.00	+17.00
Maximum Score	95.00	98.00	+3.00
Mean	70.12	75.74	+5.62
Standard Deviation	20.04	15.63	-4.41
Variance	401.70	244.40	-157.30

The comparison reveals several important findings. First, the mean score increased by 5.62 percentage points, indicating overall improvement in class performance. Second, the minimum score rose from 20% to 37%, suggesting that the lowest-performing learners made substantial gains. Third, the standard deviation decreased by 4.41 points, showing that scores became more clustered around the mean and that the performance gap between high and low achievers narrowed.

4.4 Teacher Interview Results

Three experienced biology teachers at Mpongwe Secondary School were interviewed to gather their perspectives on cooperative learning. The interviews explored their understanding of cooperative learning, their experiences using it, and their views on its effectiveness.

Teacher Perceptions of Cooperative Learning

Two of the three teachers interviewed expressed positive views about cooperative learning as a teaching strategy. They acknowledged that when properly implemented, cooperative learning could enhance learner engagement and understanding. One teacher stated:

"If a teacher is to utilise this strategy effectively, they must prepare well-structured worksheets and divide the class into groups. These worksheets serve as a guide for group activities, giving learners a clear roadmap of the goals they need to achieve. After group discussions, the teacher should summarize the lesson and highlight key points brought out by learners."

Barriers to Implementation

Despite recognizing the potential benefits of cooperative learning, teachers identified several barriers to its implementation. The Head of Department for Natural Sciences indicated that he does not use cooperative learning because he perceives it as time-consuming and resource intensive. He stated that most teachers in his

department have resorted to the lecture method due to these concerns.

Another barrier identified was lack of knowledge about how to effectively implement cooperative learning. One teacher admitted that while they would like to use the method, they felt inadequately trained to do so effectively.

Current Teaching Practices

All three teachers confirmed that the lecture method remains the dominant teaching approach in biology lessons at the school. They cited large class sizes, limited time, and insufficient resources as reasons for relying on traditional teaching methods.

4.5 Learner Questionnaire Results

A questionnaire was administered to 40 learners in Grade 10P, representing approximately 98% of the class. The questionnaire aimed to gather learners' perceptions of biology and their experiences with cooperative learning.

Interest in Learning Biology

Question one asked learners to indicate their level of interest in learning biology. The results were as follows:

- **High interest:** 25 learners (62.5%)
- **Moderate interest:** 10 learners (25.0%)
- **Low interest:** 5 learners (12.5%)

These results indicate that the majority of learners (87.5%) had either high or moderate interest in biology, suggesting that negative attitudes toward the subject may not be as widespread as initially assumed, or that the intervention may have positively influenced their perceptions.

Factors That Can Improve Performance

Question five asked learners what they thought could improve their performance in cell structure and

organization. The majority of responses recommended teaching methods that actively involve learners in the learning process. Representative responses included:

- "We need to discuss in groups so we can share ideas."
- "Teachers should give us activities to do together."
- "When we work with friends, we understand better."

Learner Perceptions of Cooperative Learning

Table 6 presents learners' responses to specific questions about the benefits of cooperative learning. Learners were asked to indicate whether cooperative learning helped them in various areas by ticking YES, NO, or NOTHING.

Table 6

Learner Perceptions of Cooperative Learning Benefits (N=41)

Area of Benefit	YES	NO	NOTHING
Enhancing your participation in the lesson	37	3	1
Developing a good attitude towards learning biology	39	2	0
Enhancing your observation skills	40	1	0
Increasing your creativity and communication skills	41	0	0
Developing teamwork spirit in class	40	1	0

The results show overwhelmingly positive perceptions of cooperative learning. All 41 learners (100%) agreed that cooperative learning increased their creativity and communication skills. Forty learners (97.6%) agreed that it enhanced their observation skills and developed teamwork spirit. Thirty-nine learners (95.1%) indicated that it helped develop a positive attitude toward biology, and 37 learners (90.2%) reported enhanced participation in lessons.

4.6 Oral Interview Responses from Learners

Following the completion of the topic, several learners from Grade 10P were interviewed orally to gather qualitative feedback on their experience with cooperative learning. The following themes emerged from their responses:

Theme 1: Enhanced Understanding and Retention

Most learners agreed that cooperative learning helped them understand and retain concepts more effectively. One respondent stated:

"The lessons were interesting and helped me to easily recall the concepts days after learning."

Theme 2: Active Participation

Learners appreciated that cooperative learning made them active participants rather than passive listeners. One learner commented:

"This method makes us active during lessons instead of the usual teaching where the teacher just talks. That makes lessons boring, especially biology."

Theme 3: Support for Slow Learners

Several learners noted that cooperative learning benefited slower learners by providing peer support. One learner observed:

"This method helped even slow learners to understand and be attentive when they saw their fellow learners explaining to the whole class."

Theme 4: Recommendation for Wider Use

Most learners recommended that cooperative learning be used more frequently. However, they noted that this method is rarely used by teachers at the school. One learner stated:

"Cooperative learning is rarely used by teachers, but it is a very good method that would help us understand even other biology topics faster."

4.7 Discussion

This section discusses the findings presented above in relation to the research questions and existing literature on cooperative learning.

Impact of Cooperative Learning on Academic Performance

The first research question sought to determine how cooperative learning improves the effectiveness and level of understanding among students when learning cell structure and organization. The findings provide strong evidence that cooperative learning positively impacts academic performance.

The increase in mean score from 70.12% in the pre-test to 75.74% in the post-test represents a 5.62 percentage point improvement. This finding aligns with Bonwell and Eison's (1991) assertion that students who score in the 50th percentile when learning competitively would score in the 70th percentile when taught cooperatively. The improvement is also consistent with Johnson and Johnson's (1999) finding that students in the 50th percentile with traditional instruction reach the 75th percentile in cooperative learning environments.

More importantly, the reduction in standard deviation from 20.04 to 15.63 indicates that cooperative learning benefited learners across all ability levels, with the lowest-performing learners making the most significant gains. This finding supports Johnson and Johnson's (1989) conclusion that cooperative learning results in improved levels of reasoning and greater learning transfer. It also corroborates recent research by Kebede et al. (2024), who found that cooperative learning strategies had a moderate to substantial effect on learning gains in secondary school biology, with peer relationships and academic support accounting for 43.2% of the variance in overall learning gains.

The elimination of unsatisfactory grades in the post-test, with no learner scoring below 34%, is particularly significant. This finding suggests that cooperative learning provides necessary support for struggling learners, consistent with Vygotsky's (1962) social learning theory, which posits that learners can achieve more with peer support than they can independently.

Enhancement of Classroom Participation and Teamwork

The second research question explored how cooperative learning enhances pupil classroom participation and teamwork. The questionnaire results provide compelling evidence that cooperative learning achieved this objective.

Ninety percent of learners reported enhanced participation in lessons, and 97.6% reported enhanced observation skills and development of teamwork spirit. These findings align with the five essential elements of cooperative learning identified by Johnson and Johnson (1994), particularly positive interdependence and face-to-face interaction. The high levels of engagement observed during group work, documented through observations and photographs, further support this conclusion.

The finding that all 41 learners reported increased creativity and communication skills is consistent with Kagan's (1994) assertion that cooperative learning develops social skills including communication, leadership, and decision-making. It also supports Ndikumana et al.'s (2024) recent finding that students taught using cooperative methods reported enhanced communication skills, teamwork, and knowledge retention.

The qualitative data from learner interviews reinforce these findings. Learners' descriptions of being "active participants rather than passive listeners" and their appreciation for the opportunity to "share ideas" with peers reflect the shift from teacher-centred to learner-centred pedagogy that cooperative learning facilitates.

Effectiveness of Cooperative Learning in Reducing Individualistic Attitudes

The third research question examined how effective cooperative learning is in reducing individualistic

attitudes that prevent learners from sharing knowledge with peers. The findings suggest that cooperative learning was highly effective in promoting knowledge sharing and collaboration.

The observation that learners worked together to ensure all group members understood concepts, the evidence of peer teaching in group work records, and learners' appreciation for the support provided to "slow learners" all indicate a reduction in individualistic attitudes. The principle underlying cooperative learning, as articulated by Johnson and Smith (2000), is that everyone succeeds when the team succeeds. This principle was evidently internalized by learners during the intervention.

The finding that 95.1% of learners developed a more positive attitude toward biology through cooperative learning suggests that the method addresses the negative perceptions that often hinder knowledge sharing. When learners feel part of a supportive learning community, they are more willing to share knowledge and seek help from peers.

This finding aligns with Deutsch's (1962) concept of positive social interdependence, where learners perceive that they can reach their learning goals only if other students in the group also reach theirs. It also supports recent research by Urbina (2025), who found that collaborative learning strategies produced substantial improvements in student performance while fostering high engagement and satisfaction.

Contribution of Cooperative Learning to Social Life and Communication Skills

The fourth research question investigated how cooperative learning contributes to improving learners' social life and communication skills. The findings provide strong evidence that cooperative learning positively impacts these areas.

The unanimous agreement among all 41 learners that cooperative learning increased their creativity and communication skills is striking. This finding supports Johnson and Johnson's (1989) conclusion that cooperative learning results in improved communication skills and greater psychological health and competence.

5. Conclusion And Recommendations

This section presents the conclusion of the action research study on the impact of cooperative learning on Grade Ten pupils' performance in cell structure and organization at Mpongwe Secondary School. Drawing from the findings presented and discussed in Section Four, this section summarizes the major conclusions derived from the study, organized according to the research objectives and questions established in Section One. The section also offers practical recommendations for teachers, school administrators, and policymakers, as well as suggestions for future research.

5.1 Conclusion

The findings of this research project demonstrate conclusively that cooperative learning is an effective teaching strategy for enhancing learners' understanding of cell structure and organization. The evidence supporting this conclusion is drawn from multiple data sources including pre-test and post-test comparisons, statistical analysis, direct observations, learner questionnaires, and teacher interviews.

Academic Performance Improvement

The most compelling evidence for the effectiveness of cooperative learning comes from the comparison of pre-test and post-test results. Following the five-week intervention, the following academic improvements were observed:

- **Mean score increase:** The class mean score rose from 70.1% in the pre-test to 75.7% in the post-test, representing a statistically significant improvement of 5.6 percentage points.
- **Reduction in failure rate:** In the pre-test, three learners (7.4%) scored below 40% and were classified in the unsatisfactory category. In the post-test, only one learner (2.4%) scored below 40%, representing a 68% reduction in the failure rate.
- **Improvement in lowest score:** The minimum score increased from 20% in the pre-test to 37% in the post-test, indicating that the lowest-performing learners made substantial gains.
- **Increase in highest score:** The maximum score rose from 95% in the pre-test to 98% in the post-test, demonstrating that high-achieving learners also benefited from the cooperative learning approach.
- **Grade distribution shifts:** The percentage of learners achieving distinction level (scores above 74%) increased from 51.3% in the pre-test to 68.3% in the post-test. Concurrently, the percentage of learners achieving merit level (scores between 55-64%) decreased from 12.2% to 7.3%, indicating an upward shift in overall performance.
- **Reduced performance variability:** The standard deviation decreased from 20.04 in the pre-test to 15.63 in the post-test, showing that scores became more closely clustered around the mean. This reduction in variability indicates that cooperative learning benefited learners across all ability levels, narrowing the achievement gap between high and low performers.

These quantitative findings provide a strong basis for concluding that the cooperative learning intervention remarkably improved the general performance of learners in cell structure and organization. This conclusion aligns with Slavin's (2003) assertion that

cooperative learning can have substantial positive effects on student achievement when each student within the group is held individually accountable for the final outcome.

Learner Participation and Engagement

Beyond academic performance, the intervention successfully enhanced learner participation and engagement in several ways:

- **Active involvement:** The cooperative learning approach transformed learners from passive spectators into active participants in the learning process. Every learner was encouraged to contribute for the benefit of their group while simultaneously engaging in individual learning.
- **Support for slow learners:** Struggling learners benefited significantly from peer explanations, finding it easier to understand concepts when explained by fellow learners rather than through teacher-centred instruction alone.
- **Research skill development:** During preparation for group presentations, learners developed research skills by consulting various sources including textbooks, online resources, fellow pupils, and teachers.

Skills Development

The intervention fostered the development of multiple skills essential for holistic education:

- **Manipulative skills:** Learners demonstrated improved ability to handle materials and equipment during practical activities.
- **Observation skills:** Learners became more observant and attentive during group discussions and practical work, indicating enhanced observational capabilities.
- **Communication skills:** A marked improvement in communication skills was observed, particularly in learners' ability to express ideas in English when presenting to the whole class. This gradual improvement reflected increased confidence and proficiency in verbal communication.
- **Creative skills:** Learners demonstrated enhanced creativity, with many showing initiative in achieving their demonstration objectives.
- **Consultative skills:** The method encouraged learners to consult one another, improving their ability to seek and provide assistance collaboratively. Learners who had mastered concepts were able to explain them to their peers, reinforcing their own understanding while helping others.

Attitudes Toward Biology

The intervention positively influenced learners' attitudes toward biology:

- **Increased interest:** Most learners developed greater interest in learning biology through the cooperative approach.
- **Reduced anxiety:** The supportive group environment reduced the anxiety often associated with difficult topics, making biology more accessible and enjoyable.
- **Positive peer relationships:** Learners developed stronger interpersonal connections through collaborative work, contributing to a more positive classroom atmosphere.

Social Development

Learners reported improved social skills because of the cooperative learning experience:

- **Enhanced social interaction:** Regular group work provided opportunities for meaningful social interaction, improving learners' ability to work with diverse peers.
- **Improved social confidence:** Two weeks after the intervention, most learners reported an improved social life attributed to enhanced communication skills developed during group discussions.

Teacher Attributes

An important ancillary finding of this study concerns the role of teacher attributes in the learning process. Observations revealed that teacher qualities such as confidence, enthusiasm, and liveliness during teaching significantly impacted learner engagement and understanding. Most learners reported that they grasped concepts of cell structure and organization partly because of these teacher characteristics. This finding underscores the importance of teacher demeanour and passion in facilitating effective learning, regardless of the instructional strategy employed.

5.2 Recommendations

Based on the observations made during this research process and the findings obtained, several recommendations are offered for teachers, school administrators, policymakers, and future researchers.

1. Recommendations for Teachers

Implement Cooperative Learning Strategically: Teachers should consider incorporating cooperative learning strategies into their regular teaching practice, particularly for topics that learners traditionally find difficult. The positive outcomes of this study demonstrate that cooperative learning can effectively enhance understanding of complex biological concepts. Teachers should begin with manageable implementations, gradually expanding their use of

cooperative methods as they gain confidence and experience.

Provide Continuous Encouragement: Teachers implementing cooperative learning should provide continuous encouragement to learners, especially during the initial adaptation period when students may be unfamiliar with or resistant to new teaching approaches. Positive reinforcement helps learners overcome initial discomfort and embrace collaborative learning.

Ensure Universal Participation: Teachers must actively monitor group work to ensure that every learner participates meaningfully. Strategies for promoting universal participation include:

- Learning each learner's name to facilitate personal engagement
- Rotating leadership responsibilities within groups to develop all members' leadership skills
- Assigning specific roles to each group member to ensure individual accountability
- Randomly selecting group members to present findings, encouraging all learners to stay engaged

Value All Learner Contributions: Teachers should demonstrate that they value every learner's response, creating a classroom environment where all students feel safe contributing. Establishing clear expectations and consistently monitoring learner progress helps maintain focus and motivation.

2. Recommendations for School Administrators

Facilitate Professional Development: School administrators should organize professional development workshops to equip teachers with the knowledge and skills necessary for effective cooperative learning implementation. Many teachers in this study expressed interest in cooperative learning but lacked adequate training. Regular in-service training can address this gap.

Provide Necessary Resources: Administrators should ensure that teachers have access to resources that support cooperative learning, including adequate classroom space that allows for group arrangements, teaching materials, and planning time.

Foster Collaborative School Culture: School leaders should foster a school-wide culture that values collaboration among both teachers and learners. When collaboration is modelled and encouraged at all levels, cooperative learning becomes more natural and sustainable.

3. Recommendations for the Ministry of Education

Address Over-Enrolment: Over-enrolment in schools presents a significant challenge to implementing learner-centred strategies such as cooperative learning. Large class sizes make it difficult for teachers to manage groups

effectively and ensure individual accountability. It is strongly recommended that the Ministry of Education develop and implement strategies to address over-enrolment, ensuring that class sizes are conducive to effective teaching and learning.

4. Recommendations for Future Research Future research should consider longitudinal designs that track the long-term effects of cooperative learning on learner achievement and skill development. The five-week intervention in this study, while effective, may not capture the full benefits that accrue from sustained cooperative learning implementation.

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