EXPLORING THE EFFECTS OF PEER ASSISTED LEARNING STRATEGY ON GRADE 10 PUPILS' LEARNING OF TURNING EFFECT OF A FORCE IN SELECTED SECONDARY SCHOOLS OF KABWE DISTRICT

BY

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A Thesis submitted to the University of Zambia in fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Science Education.

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DECLARATION

I, **Fungamwango Hashel Mwansa**, now declare that the work contained in this thesis resulted from my effort. I sincerely say that this research has not been previously published for any academic award at any other higher education institution and that all the sources I have used or quoted have been indicated and acknowledged accordingly through complete references.

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APPROVAL

This Dissertation of **Fungamwango Hashel Mwansa** has been approved as fulfilling the requirements for the award of the Degree of Doctor of Philosophy in Science Education by the University of Zambia.

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ABSTRACT

This study examined the effectiveness of the Peer-Assisted Learning (PAL) strategy in enhancing learners' active engagement, motivation, self-concept, teamwork, retention, and academic performance in lessons focused on the Turning Effect Of a Force (TEOF). Employing mixed methods approach with a concurrent research design, the study utilized the Solomon Four Group Design and a quasi-experimental "Nonequivalent Control Group Design." The study involved 131 participants from four secondary schools, with a gender distribution of 68 girls and 63 boys. The study spanned 34 weeks, during which experimental groups (class 1 and class 3), comprising 65 participants, engaged in a 6-week PAL program, while control groups (class 2 and class 4) adhered to traditional instruction methods with 66 participants. The F-value obtained from the one-way ANOVA was found to be $F(3, 106) = 115.068$, indicating a statistically significant difference among the groups ($p < 0.05$). Post-hoc tests, employing the Tukey HSD, were subsequently conducted to explore pairwise comparisons. The results of these tests revealed that the post-test scores of Class 1 (84.0 ± 8.4) and Class 3 (82.1 ± 7.1) were significantly higher than those of Class 2 (53.8 ± 7.1) and Class 4 (52.7 ± 8.3) suggesting a positive impact of the PAL strategy on learning outcomes and the experimental classes showed a remarkable 30-32% increase in post-test scores as compared to control groups. Notably, there was no significant difference (p-value = 0.845) between experimental classes. To test the retention of concepts a second post-test was administered 7 months after the first post-test for all groups. The results revealed that the means of Class 1 (83.9 ± 7.4) and Class 2 (83.1 ± 5.9) were significantly higher than Class 2 (45.2 ± 4.49) and Class 4 (43.9 ± 4.3). The results demonstrated significant differences in post-test 2 scores among the groups ($F(3,127) = 523.263$), affirming the lasting impact of the PAL strategy on learners' retention of concepts. This study's findings underscore the positive influence of PAL on learners' active engagement. Learners showed improved motivation and self-concept. The PAL strategy emerged as a catalyst for fostering teamwork and collaboration among learners. This study provides valuable insights for educators and policymakers, suggesting the incorporation of the PAL strategy in teaching difficult topics in physics. Future research should explore the sustainability of PAL effects over more extended periods and consider variations in subject matter to generalize findings across diverse academic disciplines.

Keywords: PAL strategy, TEOF, Active engagement, motivation, self-concept and retention.

DEDICATION

This thesis is dedicated to my beloved late mother, Annie Mwape Mwansa, my lovely children, and my dear wife, Christine Mabenga. Thank you for your patience and encouragement, you have always been supportive in all ways, and I thank Jehovah for giving me such a humble and understanding woman.

I also dedicate this thesis to my siblings, who have inspired and motivated me. Your unwavering support and encouragement have pushed me to surpass my limits and strive for excellence.

To my friends, thank you for being there for me through the highs and lows of this journey. Your friendship, laughter, and understanding have provided the much-needed balance and made this experience more memorable.

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ABBREVIATIONS AND ACRONYMS

ECZ	Examination Council of Zambia
PAL	Peer-Assisted Learning
PI	Peer Instruction
TEOF	Turning Effect of a Force
FGD	Focus group discussions
L1A	Learner one school A
L2A	Learner two school A
L3A	Learner three school A
L4A	Learner four school A
L5A	Learner five school A
L6A	Learner six school A
L7A	Learner seven school A
L8A	Learner eight school A
L1C	Learner one school C
L2C	Learner two school C
L3C	Learner three school C
L4C	Learner four school C
L5C	Learner five school C
L6C	Learner six school C
L7C	Learner seven school C
L8C	Learner eight school C

PTSA	Peer Teacher School A
PTSC	Peer Teacher School C
DEBS	District Education Board Secretary
HOD	Head of Department
HSD	Honest Significant Difference
ANOVA	Analysis of variance

CHAPTER ONE
INTRODUCTION

1.1 Overview

This chapter presents an introduction to exploring the learning of the turning effect of a force (TEOF) through the lens of the Peer-Assisted Learning (PAL) strategy in selected secondary schools of Kabwe district. The chapter offers a historical perspective of peer-assisted learning strategy. It further defines peer-assisted learning, gives a statement of the problem, the purpose of the study, objectives and subsequent research questions to be addressed, the significance of the study, delimitation, limitations of the research and provides a chapter summary.

1.2 Background of the study

Physics is a science that helps the world to understand the events in the cosmos. Physical rules and principles may be found in everything that happens to us (Kaya & Boyuk, 2011). Over the years, it has been noted that learning physics is always difficult for students at all levels, from lower to higher physics courses, even after they have been repeatedly "taught." (Reiner et al., 2000; Angell et al., 2004; Mualem & Eylon, 2007; Ekici, 2016). Even though physics permeates every aspect of our lives and makes them easier, studies conducted on a national and worldwide scale reveal that physics learners, perform lower academically than peers in other fields of learning (Rivard & Straw 2000; Mattern & Schau, 2002; Gok & Silay, 2008; Kaya & Boyuk, 2011; Examination Council of Zambia, 2013).

The performance of the learners in physics year after year has been going down, and the lack of interest among learners in physics in secondary schools is a serious problem in our society (Erinosho, 2013; Siabeycius & Poicin, 2012; Greene, 2018; Kapngero, 2018; Examinations Council of Zambia, 2015). Several researchers (Onah &Ugwu, 2010; Ojo, 2001; Zewdie, 2014; Elby, 2001; Rivkin et al., 2005; Nye et al., 2004) have documented factors that affect learning of physics, such as; lack of appropriate teaching materials and qualified teachers, use of traditional teaching methods, lack of mathematical skills, learner epistemologies and misconceptions, large class sizes, poverty and child abuse. The effectiveness of teaching strategies plays a pivotal role in shaping students' academic performance and sustaining their interest in learning physics. In instances where teaching strategies fall short of engaging students effectively, a notable consequence is the manifestation of low academic performance. This connection between teaching methodologies and student outcomes underscores the

significance of employing innovative and student-centred approaches in the physics classroom. When instructional techniques fail to capture students' attention or fail to make the subject matter relatable, there is a heightened risk of students becoming disenchanted with the learning process. Consequently, a lack of interest may set in, impeding the development of a genuine curiosity and enthusiasm for physics (Greene, 2018; Kapngero, 2018; Mukama, 2019) Physicists and physics educators have realized that effective teaching correlates highly with understanding physics concepts (Hake, 2007; Erinosho, 2013). Many learners learn very little physics from traditional teaching strategies (characterized by lectures requiring little or no active student involvement), which contributes to the problems of misconception and unsatisfactory conceptual understanding of Physics (Hake, 2007; Cahyadi, 2004; McDermott, 2001).

Young et al. (2009) and Bligh (2000) ascertained that traditional teaching strategies fail to maintain learners' attention and concentration. During lessons using traditional teaching strategies, learners' engagement declines after 10-15 minutes and learners perceive physics as unattractive, difficult, tedious, incomprehensible, boring, and irrelevant to understanding the world (Wieman & Perkins, 2005; Siabeycius & Poicin, 2012). As a result, learners have lost interest in studying physics at the tertiary level. This explains the low enrolment in physics-related programs in Zambia and worldwide (Maguswi, 2011). Traditional teaching strategies also affect learners' attitudes toward physics and retention of physics concepts (Kimba et al., 2018; Darmaji et al., 2019).

Many pedagogies have been developed to improve learner knowledge of physics and to improve teacher effectiveness, ranging from adaptations of existing teaching strategies to total redesign of the system, such as; Peer Instruction (PI), Interactive Engagement (IE), Active Learning (AL) and Peer Assisted Learning (PAL) (Topping & Ehly, 2001; Cahyadi, 2004; Henning et al., 2008; Mazur & Watkins, 2010).

Peer Assisted Learning (PAL) is an umbrella term encompassing a variety of cooperative and collaborative educational strategies, including peer teaching, peer learning, peer assessment, peer mentoring, and peer leadership (Henning et al., 2008). PAL is a teaching strategy where learners take responsibility for each other's learning in a setting constructed by the learner and teacher (Boud et al., 2001). The PAL strategy encourages learners to take more responsibility

for their learning by requiring them to provide their feedback and contribute to their assessment as well as the evaluation of their peer's lifelong learning skills, which are not as readily pursued by other means of learning strategies. Among those skills associated with the PAL strategy are:

- Creating learning outcomes connected to cooperation, teamwork, and joining a learning community.
- Critical inquiry and reflection; when the teacher's authority is not immediately present, pupils have more opportunities to participate in meditation and concept development.
- Communication skills; students acquire more practice communicating in the subject area than is normal in learning activities in which the teacher is the one educating. They can express their understanding and be criticised by peers while also learning from taking on the reciprocal role.
- Learning to learn; Learning to learn entails learners accepting responsibility for identifying their learning requirements and planning how to satisfy them. This is an important learning-how-to-learn skill and practice for the kind of interactions required in the workplace. Learning to collaborate with others to achieve mutual goals appears to be a vital prerequisite for functioning in a complex society.

This study examines the turning effect of a force (TEOF) through the lens of Peer Assisted Learning (PAL). TEOF is one of the topics in the physics syllabus. This topic is taught in grade ten in the Zambian Secondary Schools, grade ten is the first grade at the senior secondary school level. Appropriate knowledge of TEOF is essential because it helps people in society to do the following at ease: Turning a door handle and opening the door, riding a seesaw, closing a pair of scissors, closing and opening bottle caps, turning a wrench while removing a nut or bolt from instruments, rotate an axle connected to the wheels of a vehicle, rotate steering wheels of cars, rotate a pencil inside a sharpener and a simple beam balance. When forces are applied to these objects, they turn around their fixed point, the pivot or fulcrum. TEOF has numerous applications in other fields (Craig, 2006; Goyal, 2014; Zhang et al., 2016; Swinnen, 2016; Heywood, 2018; Gillespie, 2021) such as the following;

i. Engineering and Mechanics:

- Designing and analyzing mechanical systems, such as gears, pulleys, and levers, to ensure proper functioning and efficiency.
- Understanding the stability and equilibrium of structures, including buildings, bridges, and vehicles. Torque plays a vital role in determining structural integrity.

ii. Robotics:

- Controlling the movement of robot arms and joints by applying torque to achieve precise positioning and manipulation of objects.
- Implementing torque sensors to measure and monitor the force exerted by robotic systems, enabling safe human-robot interactions.

iii. Automobiles and Transportation:

- Determining the power and performance of vehicles by analyzing engine torque output affects acceleration, towing capacity, and overall efficiency.
- Applying torque to wheels through differentials and transmissions to enable steering, braking, and propulsion in vehicles.

iv. Biomechanics and Human Anatomy:

- Studying human movement and analyzing the mechanics of joints to understand how torque affects various activities like walking, running, and lifting objects.
- Designing and fitting prosthetic limbs and orthopaedic devices, considering torque requirements to replicate natural movements and enhance functionality.

v. Sports and Fitness:

- Explaining the physics behind various sporting activities, such as throwing, swinging, and kicking, where torque is essential for generating power and control.

- Developing exercise equipment, such as resistance machines and free weights, that utilize torque principles to provide resistance and build muscle strength.

However, learners perceive TEOF as challenging in ordinary-level physics (Duman et al., 2015; Sarıoğlan & Küçüközer, 2014: Özcan, 2017; Ortiz, 2001; Muthuramalingam et al., 2020). Numerous academic investigations and research endeavours have extensively documented the prevalence of students' misconceptions when it comes to comprehending fundamental concepts and principles associated with force and its effects. These empirical studies have shed light on the various ways in which students often grapple with and misunderstand crucial aspects of this fundamental physics concept (Alonzo & Steedle, 2009; Coelho, 2010; Kelly & Sung, 2017; Stavrum et al., 2020). One prominent area of concern highlighted by these studies is the misinterpretation of the pivotal notion of torque or moment of force. Students frequently struggle to grasp the relationship between force, distance, and the rotational effect they produce. Their misconceptions may manifest as the inability to differentiate between the magnitudes of forces applied at different distances from an axis of rotation, or they might mistakenly assume that a larger force necessarily results in a greater turning effect without considering the pivotal role of distance.

Another factor contributing to the challenge learners face in grasping the concept of TEOF is a deficiency in comprehending the principles of equilibrium and stability (Sarıoğlan & Küçüközer, 2014: Özcan, 2017). Additionally, students often encounter obstacles due to a lack of the requisite mathematical aptitude required to apply disciplinary criteria effectively (Canu et al. 2016)

1.3 Statement of the problem

Learners worldwide face challenges in understanding the TEOF (Barniol et al., 2013; Duman et al., 2015; Sarıoğlan & Küçüközer, 2014: Özcan, 2017). Studies indicate that, due to the perpetual use of traditional teaching strategies, learners are not fully engaged in lessons on TEOF. As a result, they lack motivation and self-concept. Worse, their performance and knowledge retention are generally below societal expectations (Examination Council of Zambia, 2015; Chilufya & Ndhlovu, 2014; Haßler et al., 2015; Sarıoğlan & Küçüközer, 2014; Özcan, 2017). Recognizing this educational dilemma, there arises a critical need for the identification and implementation of a suitable teaching strategy capable of addressing

multifaceted challenges, including enhancing learner performance, motivation, self-concept, retention, and overall attitude toward the learning of TEOF. Drawing inspiration from successful strategies implemented in other subjects and regions, the Peer-Assisted Learning (PAL) strategy has emerged as a proven strategy for fostering effective teaching and learning (Rohrbeck et al., 2003; Tao, 2004; Henning et al., 2008; Adesoji, 2008; Parkinson, 2009; Adam et al., 2011; Gambari & Yusuf, 2017; Arthur et al., 2022). This study sought to investigate the effectiveness of the PAL strategy in the learning of TEOF in selected secondary schools in Zambia.

1.4 Purpose of the study

The purpose of the study was to explore the effects of peer assisted learning strategy on grade 10 pupils' learning of TEOF in selected secondary schools of Kabwe District.

1.5 Research Objectives

The research objectives were as follows:

i. To assess the impact of the PAL strategy on learners' active engagement in lessons on TEOF.

ii. To establish the effect of the PAL strategy on learners' motivation on TEOF.

iii. To establish the effect of the PAL strategy on learners' self-concept on TEOF

iv. To examine the impact of the PAL strategy on learner academic performance on TEOF.

v. To ascertain the effect of the PAL strategy on learner retention of concepts on TEOF.

vi. To determine the impact of the PAL strategy on learners' teamwork.

vii. To determine the impact of the PAL strategy on learners' collaboration.

1.6 Research questions

The study was guided by the following research questions:

i. What is the effect of the Peer-Assisted Learning (PAL) strategy on learners' active engagement in TEOF lessons?
ii. How does the PAL strategy impact learners' motivation when learning the TEOF?
iii. What is the effect of the PAL strategy on learners' self-concept on TEOF?
iv. What is the impact of the PAL strategy on learners' performance on TEOF?

v. What is the effect of PAL on learners' retention of TEOF concepts?

vi. What is the impact of the PAL strategy on learners' teamwork on TEOF?

vii. How does the PAL strategy affect learners' collaboration when learning the TEOF?

1.7 Hypothesis testing

1.7.1 Null Hypothesis (H0)

There is no significant difference in learners' performance on TEOF between those taught using the PAL teaching strategy and those taught using traditional methods.

1.7.2 Alternative Hypothesis (Ha)

There is a significant difference in learners' performance on TEOF between those taught using the PAL teaching strategy and those taught using traditional methods.

1.8 Significance of the Study

The study's findings possess the potential to exert a far-reaching impact on a diverse spectrum of stakeholders within the realm of physics education. These stakeholders encompass students, teachers, educational researchers, administrators, curriculum developers, peer educators, and future researchers, each of whom stands to benefit and contribute in unique ways:

For learners, the study's findings hold the promise of more effective and engaging learning experiences. Understanding the challenges and misconceptions associated with the turning effect of a force (TEOF) can empower them to approach this topic with greater clarity and confidence. The implementation of the Peer-Assisted Learning (PAL) strategy, as demonstrated in the study, offers students a valuable opportunity to enhance their conceptual grasp, problem-solving skills, and overall academic performance.

Physics educators stand to gain essential insights from the study's findings. Knowledge of common misconceptions and challenges faced by students in TEOF lessons enables teachers to tailor their instructional approaches more effectively. They can adjust their teaching strategies, materials, and assessments to address these issues, leading to improved student outcomes. Additionally, the study highlights the potential benefits of peer-assisted learning, providing teachers with a valuable pedagogical tool to enhance engagement and comprehension in challenging physics topics.

Researchers can build upon the study's findings to delve deeper into the intricacies of peer-assisted learning strategies in physics education. They can investigate the transferability of

PAL to other physics concepts and explore variations of the strategy for diverse learner groups. Furthermore, the study contributes to the broader body of research on student misconceptions in physics, offering a foundation for further investigations in this area.

School administrators, science standard officers and policymakers can use the study's findings to inform decisions about instructional practices and resource allocation. Understanding the potential benefits of PAL in improving student engagement and learning outcomes may influence the adoption of such strategies at an institutional level. This could lead to more effective physics education programs and, in turn, better academic performance.

Curriculum developers can consider the study's findings when designing physics curricula. Incorporating strategies that address common misconceptions and foster engagement, such as PAL, can enhance the overall quality of physics education materials. This alignment with effective teaching practices ensures that curricula better meet the needs of both students and teachers.

Peer educators, such as student tutors or mentors, can draw inspiration from the study's success with PAL. They may be encouraged to embrace peer-assisted learning as a valuable avenue for helping their peers navigate challenging subjects like TEOF. The study provides evidence of how peer educators can positively impact their peers' comprehension and engagement.

The study serves as a foundation for future research endeavours in the field of physics education. Researchers can build upon the study's methodology and findings to explore new avenues in instructional design, Peer-Assisted Learning strategies, and the correction of student misconceptions in physics and related disciplines.

1.9 Scope of the study

1.9.1 Delimitations of the Study

This study focused on secondary school learners in grade 10 from public schools within Kabwe district. The study primarily focused on TEOF, a topic in ordinary-level physics, and explored implementing the PAL strategy in the regular classroom setting. The PAL strategy included problem-solving tasks and peer tutoring sessions and was conducted in Kabwe district, the central province of Zambia, for seven months.

1.9.2 Limitations of the Study

Generalizability: The study's findings may not apply to all educational settings since it was conducted in only four secondary schools. Different schools may have variations in teaching methods, student populations, and resources, which could influence the effectiveness of the PAL strategy.

Sample size and composition: The imbalanced gender distribution, with 68 females and 63 males, may introduce gender-related biases and limit the generalizability of the findings to a broader population.

Duration of the intervention: While the seven-month intervention period may have been suitable for the study's specific context, longer-term effects and sustainability of the PAL strategy beyond this timeframe are unknown. It would be valuable to investigate the results of the intervention over an extended period to determine its long-term impact on learners' performance.

Measurement instruments: The study used subjective methods such as focus group discussions, questionnaires, and lesson observations to collect data. These methods are susceptible to biases, including social desirability or interpretation bias, which may affect the accuracy and reliability of the results. The reliability and validity of the specific measurement instruments should also be considered.

Lack of random assignment: The study employed a quasi-experimental design and assigned participants to experimental and control groups based on existing classroom arrangements rather than random assignment. This non-random assignment method may introduce selection biases and confounding variables that could impact the study's internal validity. The random assignment would have helped ensure that participants in both groups were similar in all aspects except for the intervention.

Researcher bias: The study utilized thematic analysis for the qualitative data, involving interpretation and coding by researchers. The potential for researcher bias exists, as subjective judgments may influence the analysis and interpretation of the data. To mitigate this bias, it is important to have multiple researchers involved in the analysis process and establish inter-rater reliability measures which was missing in the study.

Specific subject and outcome focus: The study focused on the PAL strategy's effectiveness concerning the turning effect of a force. Therefore, the findings may not directly apply to other subjects or educational outcomes. The efficacy of the PAL strategy in improving performance in other areas may vary, highlighting the need for further research in diverse subject domains.

1.10 Theoretical framework

This study was guided by Vygotsky's social constructivism theory (1978) because this theory emphasizes learners learning from each other through guided and unguided interactions. It also promotes learners constructing their knowledge and sharing it with others. It also encourages learning situations in which learners actively participate in their learning. As a result, the roles of the teacher and learner have altered, with teachers collaborating with their learners to help support learning. Therefore, learning becomes a mutual experience for the learners and the teacher.

Vygotsky's social constructivism theory (1978) emphasizes the relevance of culture and interaction in cognitive ability development. It holds that individuals are active participants in forming their knowledge (Kalina & Powell, 2009; Schreiber & Valle, 2013). In other words, the theory of social constructivism states that learning happens primarily through social interaction with others, such as a teacher or a learner's peers. All of Vygotsky's research and theories collectively involve social constructivism and language development, such as cognitive dialogue, the zone of proximal development, social interaction, culture and inner speech (Vygotsky, 1962). Understanding his theories or building a classroom where interaction is prominent helps develop effective classrooms.

The zone of proximal development, or ZPD, is one of Vygotsky's key hypotheses. This aspect of childhood development governs how a child learns. Vygotsky's theory concerns the various psychological functions that arise as a child grows. ZPD has been defined as a zone of learning in which a child is assisted in learning a concept in the classroom. Often, children learn best when others surround them. ZPD incorporates the social constructivist technique, in which students act first on what they can do on their own and then, with instructor support, acquire the new concept based on what they were doing separately (Vygotsky, 1962).

Vygotsky (1962) employed scaffolding in his theory, along the same lines as cooperative learning, to realize that children learn more successfully when they have people to support

them. Scaffolding is an assisted learning technique that promotes each learner's ZPD, or progress to the next level of understanding, with the help of teachers, peers, or other adults. Each learner will experience a distinct form of internalization or "getting it" due to scaffolding. This process occurs when a student is requested to undertake an important task to the learner and completes it with assistance. While this job may be difficult to achieve, the teacher can assist. This support system will ultimately allow the student to solve the problem.

According to Vygotsky, cooperative learning is essential to developing a deeper understanding. Collaborative learning is an important component of establishing a social constructivist classroom. Learners should collaborate with teachers one-on-one and with other learners; they have much to give each other. When learners master the completion of group projects or activities, internalization of knowledge occurs at a different rate for each individual based on their particular experience. According to Vygotsky, internalisation occurs more successfully when there is social interaction. Teachers might design work situations in which learners collaborate to build cognitive or individual internalization of knowledge. Vygotsky firmly believes in the importance of social contact and cultural effects on a learner and how learning occurs. Before they can begin learning the curriculum, learners must first comprehend themselves and those around them. A teacher who values multiple cultures might help learners share their diverse backgrounds. Learners should discuss the material being taught the same way they discuss their various cultures. Teachers should encourage material discourse so learners may think critically about their learning. If they think critically, they will come away with the personal meaning that they created for themselves. The concept of dialogue is found throughout social constructivism and is enhanced by diversity. These features of social constructivism have a clear connection (Kalina & Powell, 2009).

There is a correlation between the teacher, peer, or other adult and the learner in ZPD and scaffolding. Learners must interact socially to appreciate variety. The key to good communication is that all participants must share common ground. In a social constructivist framework, language usage in the classroom is the most crucial process. According to Vygotsky, language improves learning and comes before knowledge or thinking. "It is erroneous to see language as a correlative of cognition; language is a correlative of consciousness," Vygotsky said. Social engagement is essential for appropriate language usage

and effective classroom communication skills. Learners should utilize language as frequently as they do oxygen. (Kalina & Powell, 2009).

Topping and Ehly (2001) claim that a linear model of cognitive development is not accurate. Instead, a continual iterative process and virtuous cycle are formed due to the affective and cognitive outputs feeding back into the original sub-processes. The procedure should be applied as the peer connection grows and the learning progresses from the surface to the strategic and deeper levels and from declarative to procedural and conditional (Thurston et al., 2007).

The time spent on a task and time invested in it determines organization and engagement. Both helpers and assistants are required to develop objectives and plans. Conflict and challenge are necessary for cognitive PAL to remove obstructions caused by outdated misconceptions and incorrect ideas. Building knowledge from a more competent party requires managing activities within each party's zone of proximal growth, known as scaffolding and error management.

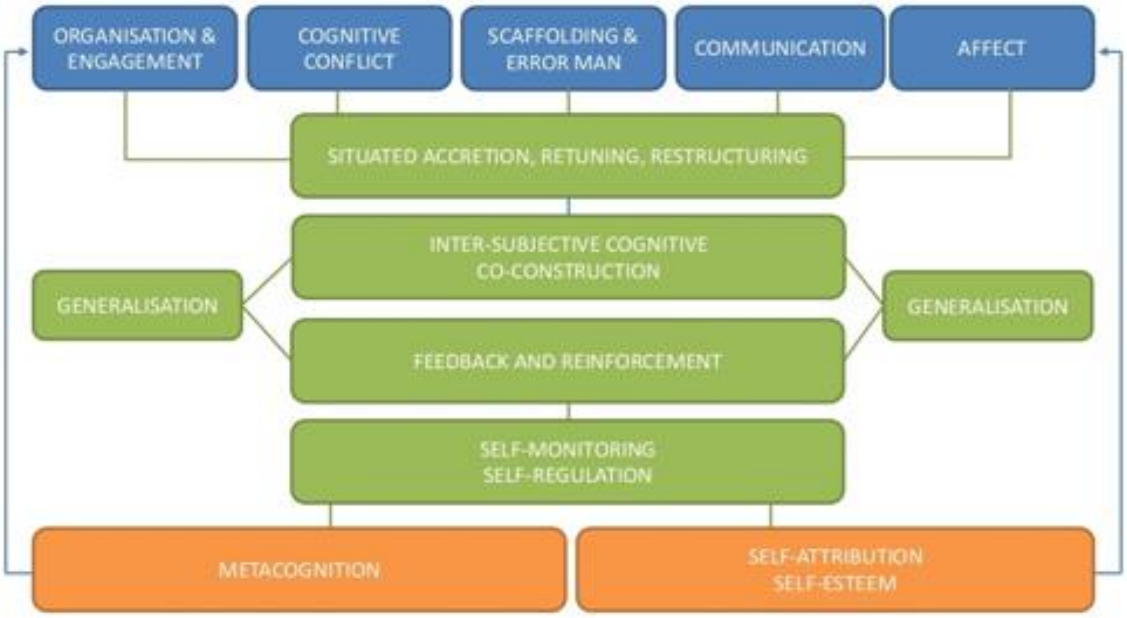

Figure 1.1 PAL framework by Topping and Ehly (2001)

Another need of PAL is the development of both the helper's and the helped's communication abilities, it places high demands on both the helper and the helped's communication abilities, and sometimes a person cannot fully understand an idea until they have to describe it to

someone else, translating and formalizing cognition into words. Transferable abilities should include listening, explaining, posing questions, summarizing, speculating, and hypothesizing.

Potentially highly potent is the affective aspect of the PAL strategy. Affect suggests drive, a positive self-image, responsibility, and ownership. It may be easier to admit ignorance and misinformation to a colleague who is not in a position of authority, allowing for later diagnosis and correction. The self-confidence of the helper can be influenced by the helper's modelling of excitement, competence, and the likelihood of success, and a sense of loyalty and accountability to one another may keep the duo motivated and on track. This results in the collaborative development of a shared understanding between the helper and the helped, which may not represent absolute truth but lays the groundwork for further development. This understanding is firmly rooted in the application's current authentic context and tailored to their perceptions' peculiarities (Vygotsky, 1962; Topping & Ehly, 2001).

Organization and engagement, Cognitive Conflict, Scaffolding and Error Management, Communication Skills, and Affective Component of PAL are the five categories or sub-processes that feed into a larger onward process of the helper and help to extend each other's declarative knowledge, procedural skill, and conditional and selective application of knowledge and skills by adding to and extending current capabilities (accretion), modifying current capabilities (re-tuning), and (in some cases) improving current capabilities.

Additionally, it entails assistance and scaffolding from a more experienced third party, mandating that activities are managed within each party's zone of proximal development (Vygotsky, 1978). To closely monitor the pace of development, the aid attempts to control and adjust the learner's information processing demands. The helper offers a further cognitive model of competent performance. The helper has even greater cognitive needs while monitoring learner performance and identifying, diagnosing, correcting, and controlling mistakes and misunderstandings. By doing that, the helper gets the most of their cognitive workout and benefits (Vygotsky, 1978; Topping & Ehly, 2001)

As a result, PAL promotes and supports more effective and engaged practice, which results in the consolidation, fluency, and automaticity of fundamental abilities. The ability to apply a concept and its developmental variants to an ever-widening range of alternative and varied contexts in multiple communities of practice can result from generalization from the specific

situated example through which a concept is learned. Much of this may occur implicitly, without the helper or help to be fully aware of what is happening (Vygotsky, 1978; Topping & Ehly, 2001).

During this process, the helper and the helped provide each other with implicit or explicit feedback. Implicit feedback may have happened on its own in the initial stages. PAL greatly increases the amount and speed of feedback to the learner. Precise reinforcement can come from inside the partnership or from outside of it in the form of verbal or nonverbal compliments, social approval and status, professional recognition, or even a more material reward.

Both the helper and the helped should become more mindful of what is going on in their learning interaction as the learning relationship grows, and they should both be able to monitor and manage the efficacy of their learning tactics in various settings. In addition to facilitating more efficient subsequent learning, this evolution toward fully aware explicit and strategic metacognition, however, should also give both the helper and the helped more self-assurance that they can do even more and that their achievement is a direct outcome of their hard work. These cognitive and affective outputs act as a positive feedback loop that continually iterates through the initial five subprocesses (Vygotsky, 1978; Topping & Ehly, 2001).

The model should continue to be applicable as the PAL connection grows as learning progresses from the surface to the strategic, then to the deep level, and from the declarative into the procedural and conditional.

1.11 Conceptual framework

The conceptual framework was adopted from Kirkham and Ringelstein (2008).

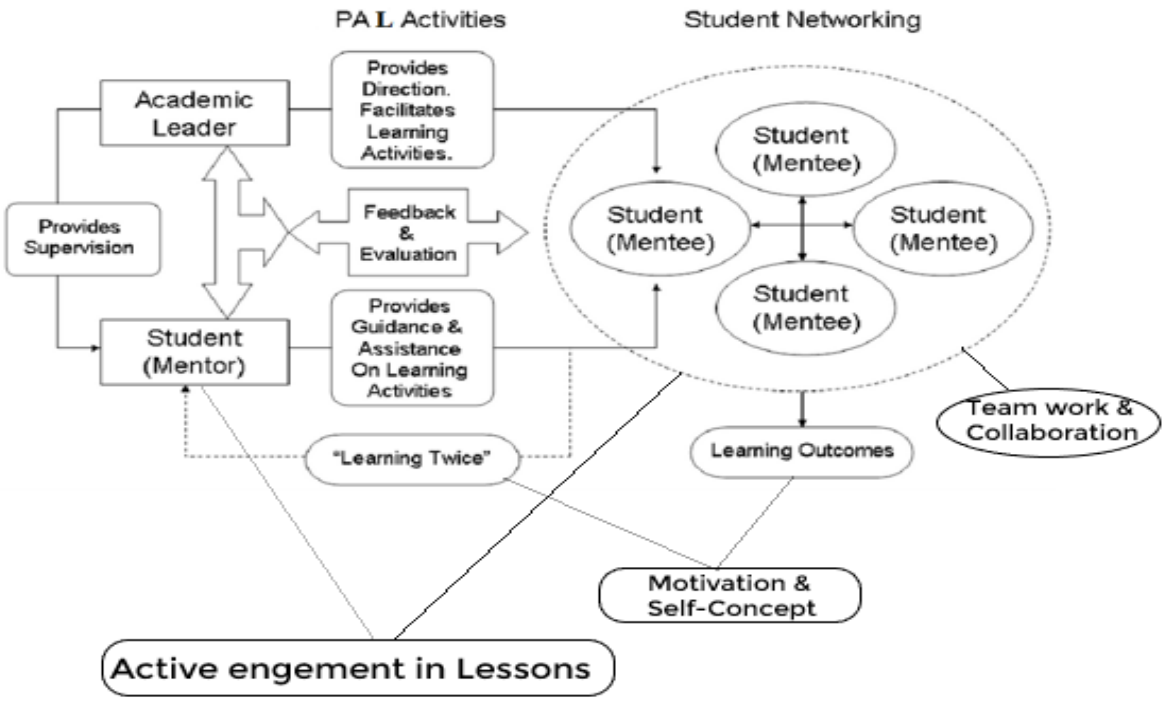

Figure 1.2 Conceptual framework of PAL adopted from Kirkham & Ringelstein (2008).

During the first, more formal session, the academic leader discusses and explains the particular problems and problem-solving approaches pertinent to a topic. These sessions could employ handouts or templates that learners can use as a guide. These materials are helpful for reflection and give learning direction. This review of the material provided to help learners realize their homework might give them a better understanding of the evaluation. The mentors serve as facilitators throughout these meetings, aiding the procedure. The workshops offer a chance to assess if the mentors are suitable for or require any more training in addition to serving as a method of teaching them. These seminars are held weekly throughout the term (Kirkham & Ringelstein, 2008).

The second category of PAL sessions is less structured in that learners and mentors may work on resolving individual issues instead of focusing on a single subject. Whether an academic leader is present or not, how these sessions are constructed encourages mentors to participate more actively. These classes are provided each week at a predetermined time (Kirkham & Ringelstein, 2008) to mentor the relationship between an experienced student mentor and a mentee. The mentor acts as a guide, role model, and source of support for the mentee, offering

academic, social, and personal guidance. Mentors are usually fellow students who have successfully navigated the same educational or unique challenges as the mentees. This peer support fosters a sense of connection, empathy, and relatability between mentors and mentees. Mentors assist mentees in setting goals, identifying strengths and weaknesses, and developing strategies for personal growth and academic success. The focus may include study skills, time management, goal-setting, self-reflection, and decision-making.

Mentors guide mentees by sharing their experiences, knowledge, and resources. They may assist with academic planning, course selection, navigating campus resources, and connecting mentees to relevant support services.

The PAL strategy expanded into the field of self-help in the third category. All students are encouraged to organize study groups and work outside the traditional classroom environment. This approach is founded on the idea that networking and peer cooperation may enhance learning, provide a feeling of community, and increase student retention.

Lessons involving the PAL strategy empower mentees by building their self-confidence, self-efficacy, and resilience. Mentors encourage mentees to take ownership of their learning and personal development, fostering a sense of autonomy and independence. The lessons involving the PAL strategy often provide ongoing support and engagement over an extended period, allowing for a sustained mentoring relationship. This longitudinal approach facilitates deeper connections, continuous guidance, and the opportunity for mentees to develop a sense of belonging within the academic community.

1.12 Operational definitions of key terms

In this thesis, the terms given are used to mean the following:

- **Active engagement:** Learners' active participation in learning through specific behaviours, actions, and cognitive processes on TEOF.
- **Motivation:** Learner's willingness to attend, participate, and show an inherent fascination with the TEOF lesson.
- **Self-Concept:** Learners' ability to express themselves and show a sense of belief in their capabilities about what they know about TEOF.

- **Performance:** Learners demonstrate understanding and application of TEOF concepts during assessments.
- **Teamwork:** Collaborative and coordinated effort displayed by learners while working together to understand TEOF concepts.
- **Retention:** The degree to which learners retain and demonstrate an understanding of TEOF concepts after a specified period

1.13 Summary of the Chapter

The chapter began by providing a background overview of the study, highlighting the context, previous research, and theoretical foundations. It then presented a statement of the problem, identified the research issue and set the stage for the research objectives and questions. The scope of the study was discussed, defining the boundaries and aspects considered. The significance of the study was highlighted, highlighting potential contributions and implications for the field, practitioners, policymakers, and the academic community. Limitations and delimitations were addressed, providing a clear understanding of the study's findings.

Operational definitions of key terms were provided, and the theoretical framework was introduced, providing a theoretical lens for understanding and analyzing the research problem. The conceptual framework outlined key concepts and relationships, guiding the research methodology and analysis.

1.14 Organisation of the Thesis

The first chapter has provided the introduction of the study exploring the learning of the turning effect of a force **(TEOF)** through the lens of the PAL in selected secondary schools in Kabwe district. The chapter presented the background to the study, statement of the problem, the purpose of the study, research objectives, research questions, the significance of the study, the scope of the study, delimitation, limitations, theoretical and conceptual frameworks, operational definitions, a chapter summary and organization of the dissertation.

Chapter two presents the effects of a force, explaining in detail the turning effect of a force, how it is calculated, industrial and everyday use and a summary of the chapter.

Chapter three presents literature reviewed from different parts of the world on Peer-Assisted Learning and other active pedagogies and aims to explore the impact of the PAL strategy on

various aspects of teaching and learning. The chapter will present an overview, background of the PAL strategy, its influence on learners' active engagement in lessons, motivation, self-concept, academic achievement, retention, teamwork and collaboration, and a chapter summary.

Chapter four presents the methodology chapter. The chapter starts with an introduction, the research paradigm, types of research methodology, justifications for using the mixed methods and its design have been presented. It also explains the study area, population, sample, sampling techniques, data collection instruments and procedure, data analysis, trustworthiness and reliability of the research instruments, ethical considerations and a chapter summary.

Chapter five presents findings on learning the turning effect of a force **(TEOF)** through the lens of the PAL strategy in selected secondary schools in Kabwe district.

Chapter six presents the discussion of findings on learning the turning effect of a force **(TEOF)** through the lens of the PAL strategy in selected secondary schools in Kabwe district.

Chapter Seven presents the conclusion and recommendations based on the study's findings.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Overview

This literature review aims to explore the impact of the PAL strategy on various aspects of teaching and learning, specifically focusing on its influence on learners' active engagement in lessons, motivation, self-concept, academic achievement, concept retention, and teamwork and collaboration. By examining existing research and scholarly articles, this review seeks to provide.

2.2 The turning effect of a force (Torque)

The application of forces to objects induces various effects, and understanding these effects is crucial in physics and engineering. Newton's second law of motion is a foundational principle in classical mechanics, stating that unbalanced forces cause objects to accelerate, decelerate, or change direction (Serway & Jewett, 2014). Mathematically, this law is expressed as F = ma, where F is the force applied, m is the mass of the object, and ‘a’ is the resulting acceleration. Forces also induce vibrations and oscillatory motions with frequency and amplitude. Vibrations find applications in mechanical and civil engineering, aerospace, automotive, electronics, and more (Rao, 2018).

Torque, a rotational force, influences rotational motion. The moment arm and the principle of moments are pivotal in rotational equilibrium analysis (Young et al., 2003). Couples, pairs of equal and opposite forces, achieve rotational equilibrium without translational motion. Torque is extensively used in engineering, robotics, biomechanics, and daily tasks. In robotics, torque is crucial for precise control and movement generation. In biomechanics, it plays a role in understanding joint movements and muscle activation patterns. In everyday life, tasks like opening doors or using tools involve applying torque to overcome resistance (Serway & Jewett, 2018).

Torque, a fundamental concept in physics and engineering, plays a pivotal role in understanding rotational motion and equilibrium. Despite its significance, studies suggest that students often encounter challenges in grasping the complexities associated with torque (Ekici, 2016; Goyal, 2014; Özcan, 2017).

However, understanding the concept of torque involves grasping abstract notions related to rotational motion, which can be challenging for learners and may impact their academic achievement. Researchers, such as Mashood (2014), have highlighted the persistent difficulties students face in translating their knowledge of linear motion to rotational motion and comprehending the concept of torque. Several studies point to conceptual challenges as a primary obstacle to students' comprehension of torque and academic achievement (Barniol et al., 2013; Duman et al., 2015; Sarıoğlan & Küçüközer, 2014). The study by Barniol et al. (2013) found that students who struggled to grasp the conceptual nuances of torque also performed less effectively on assessments measuring torque-related problem-solving skills. The abstract nature of rotational motion and misconceptions related to linear force concepts were identified as hindrances to achieving a deep understanding of torque (Kapngero, 2018; Greene, 2018). The abstract nature of rotational motion and the unique characteristics of torque, such as the moment arm and rotational equilibrium, can be difficult for students to visualize (Ekici, 2016; Goyal, 2014; Zhang et al., 2016; Kapngero, 2018). Additionally, misconceptions related to the linear force concepts, which students may be more familiar with, can hinder their transition to understanding rotational forces (Palagi & Fischer, 2018).

Research suggests that traditional teaching methods may contribute to students' difficulties in understanding torque and may not effectively enhance student performance (Chu et al., 2019). The reliance on abstract mathematical representations without sufficient real-world examples and hands-on experiences may impede students' ability to connect theoretical concepts to practical applications (Chu et al., 2019; Sarıoğlan & Küçüközer, 2014: Özcan, 2017). A lack of effective visualizations and demonstrations can further hinder students' comprehension.

Cognitive development factors also play a role in students' struggles with torque. Studies indicate that the abstract nature of TEOF may be challenging for students in the early stages of cognitive development (Redish & Smith, 2008). Developmental differences in spatial reasoning skills may impact students' ability to mentally manipulate rotational systems and understand torque relationships (Buckley et al., 2019). Tailoring instructional methods to align with students' cognitive development stages could potentially enhance their academic success in grasping TEOF (Buckley et al., 2019)

The assessment methods employed in educational settings may not adequately capture students' understanding of torque. Traditional exams and standardized tests often focus on rote memorization of formulas rather than assessing conceptual understanding or problem-solving skills related to torque (Shute et al., 2019). Pedagogical strategies that incorporate interactive simulations, hands-on experiments, and real-world applications may enhance students' comprehension of TEOF (Chu et al., 2019; Sarıoğlan & Küçüközer, 2014).

To improve student achievement in TEOF, educators should consider implementing pedagogical strategies that address conceptual challenges and cater to diverse learning styles. Incorporating visualizations, simulations, and hands-on experiments into instructional methods could enhance student engagement and understanding (Siabeycius & Poicin, 2012; Mazur & Watkins, 2010; Ritchhart et al., 2011)

2.3 The PAL Strategy

Peer Assisted Learning (PAL) has a rich historical foundation, possibly dating back to cooperative and community activities. Early British educators in the late 18th and early 19th centuries employed peer tutoring strategies before the advent of public education (Topping, 2005). This historical context underscores the enduring nature of PAL and its potential implicit occurrence through vicarious experiences. The evolution of PAL involves distinct role-taking as tutor or tutee, emphasizing curriculum material and explicit interaction protocols (Topping, 2005). PAL encompasses various forms like tutoring, cooperative learning, collaborative problem-solving, peer mentoring, and peer leadership, all geared toward promoting academic achievement, social interaction, and personal growth (Henning et al., 2008).

PAL strategies, such as peer teaching and learning, peer assessment, peer mentoring, and peer leadership, have gained significant attention in educational research and practice (Henning et al., 2008). These strategies cater to diverse aspects of the learning process and contribute to the development of students' transferable skills, key competencies, and generic attributes demanded by the competitive job market (Nomura et al., 2017; Boud et al., 2001). Employers increasingly seek graduates with effective communication skills beyond specialized knowledge, and PAL serves as a valuable tool to meet these demands.

Continuous improvement is crucial in PAL implementation, as highlighted by Crouch and Mazur (2001), Sinclair et al. (2019), and Maher et al. (1998). Topping and Ehly (2001) stress

the benefits of careful selection and training in tutoring programs, emphasizing the positive outcomes observed with disruptive students serving as tutors. Willey and Gardner's (2010) integration of peer assessment into PAL tasks showed increased engagement and effective learning support.

Fadaei's (2019) comparison of traditional and Interactive Conceptual Instruction (ICI) revealed positive effects on achievement, aligning with Hake's (2007) findings on the impact of interactive engagement (IE) strategies. These studies collectively challenge conventional teaching methods, suggesting their inadequacy in supporting students' learning and achievement in physics courses. Peer-Assisted Learning (PAL) emerges as a promising alternative, with Currens and Bithell (2003), and Cortazzi et al. (2001) indicating enhanced cognitive development through PAL strategies. However, Coliñir et al. (2021) emphasized the qualitative benefits of PAL, raising questions about its consistent impact on academic performance.

Bugaj et al. (2019) emphasize the importance of clear lesson structures in PAL to prevent student boredom and maintain engagement. This aligns with Arrand's (2014) findings, which highlight student tutors' challenges in peer tutoring, emphasizing the need for proper training and support to navigate complex interpersonal demands. The ethical implications of implementing PAL programs, and replacing staff with students, were explored by Nomura et al. (2017), emphasizing the importance of demonstrating clear educational advantages.

In terms of social benefits, enhancing support networks and interpersonal relationships of PAL strategy were underscored by Lewis et al. (2005) and Higgins et al. (2014), the researchers found that peer tutoring is most effective as supplemental instruction, acknowledging the role of peer tutors in supporting lecturers. Hutchison (2003) emphasized the need for effective pedagogy using peer learning strategies, highlighting the importance of integrating peer learning into individual curriculum areas through professional development programs. However, MacNab (2003) reported a decline in peer learning practices in Scottish schools, suggesting a potential loss of effective pedagogical tools. The effectiveness of student tutors in PAL is a debated topic, with studies suggesting that student tutors' teaching methods can be comparable or even superior to experienced teachers in certain domains (Nicky & Tonkin,

2008; Bugaj et al., 2019). However, more qualitative studies are needed to explore student tutors' perceptions of their teaching skills.

Gok and Gok's (2017) study on interactive engagement methods demonstrated their positive impact on conceptual learning and gender disparities, emphasizing the need for engaging and inclusive teaching approaches.

The gender dimension in physics education is highlighted by Hake (2007) and Fatokun and Odagboyi (2010), suggesting a need to address gender disparities in creating an inclusive learning environment. Educationalists like Biggs and Tang (2011) and Wilson (2018) support the PAL strategy for increasing cognitive development through reflective practices, yet inconsistencies in pretest scores (Bozzi et al., 2021) and concerns about evidence-based PAL components (Henke et al., 1999) underscore the need for rigorous implementation.

Ginsburg-Block et al. (2006) stress the multifaceted benefits of PAL, not only academically but also socially and behaviorally. Positive relationships between social outcomes and student achievement are identified, but the need for further research to understand causal relationships is emphasized. Challenges associated with PAL, as reported by Harvey (2013), Sevenhuysen et al. (2015), and Bennett et al. (2015), include resistance from students and teachers, emphasizing the importance of addressing these concerns for effective implementation.

Gok's (2014) study on peer instruction intervention showcases consistent improvements in academic achievement, particularly in conceptual learning and problem-solving performance. However, concerns about gender differences (Jegede, 2021) and the impact of interaction patterns (Fatokun and Odagboyi, 2010) raise important considerations for PAL strategies. The importance of same-gender groupings (Slavin, 2015) and interdependence for achieving collective goals is emphasized, providing insights into effective peer collaboration.

The effectiveness of the PAL strategy in supporting students with disabilities is underscored by Calhoon and Fuchs (2003), indicating the adaptability of PAL across diverse learner profiles. Parkinson's (2009) study demonstrates the potential scalability of PAL interventions, although challenges in consistently reporting significant gains (Donelan, 1994; Warren and Tonsetic, 1997) highlight the need for more extensive research.

Despite the positive outcomes observed in the short term, there is a call for research on the long-term effects of PAL interventions (Ginsburg-Block et al., 2006). The review recognizes the lack of exploration of teachers' perspectives and experiences in implementing PAL strategies, emphasizing the importance of understanding their challenges, training needs, and the fidelity of PAL implementation. Moreover, subject-specific investigations are called for, offering a more nuanced understanding of PAL's effectiveness across different academic disciplines.

Gok's (2012) quasi-experimental study in a college physics course demonstrated that peer instruction positively impacted students' motivation and problem-solving skills. This aligns with Zingaro's (2014) research, indicating an increase in students' self-efficacy through peer instruction. Gok and Gok (2017) extended these findings, emphasizing enhanced social and self-concept outcomes resulting from peer instruction, echoing the positive impact reported by Buckley and Zamora (2007). However, the need for further qualitative studies on the factors contributing to peer tutoring efficacy in undergraduate communication training is highlighted, referencing the cognitive congruence concept (Ten Cate & Durning, 2007; Ross & Cameron, 2007).

Bozzi et al. (2021) study integrated peer learning activities with technology in physics teaching, reporting improved conceptual understanding. The efficacy of this combined strategy is supported by meta-analyses conducted by BowmanPerrott et al. (2013) and Leung (2015), indicating significant improvement in conceptual understanding across different age groups due to peer tutoring. The study by Soller et al. (2005) explored the impact of Peer-led strategy online learning on scientific concept understanding. The findings cautioned against relying solely on peer sources for knowledge, emphasizing the need for expert guidance and reliable information sources to ensure accurate conceptual recall.

Stone et al. (2013) explored various peer learning methods in undergraduate nursing education, highlighting the positive impact on communication, critical thinking, and self-confidence which was a similar result to Atasoy et al. (2014) found although exploring students' perceptions of physics. Ginsburg-Block et al. (2006) also conducted a meta-analysis, indicating the positive effects of peer-assisted learning (PAL) strategies on social, self-concept, and behavioral outcomes. However, Rohrbeck et al. (2003) found that the success of

PAL interventions depends on group dynamics, with same-gender grouping strategies showing greater effects.

Fuhr et al. (2014), Williams et al. (2015) and Tolsgaard (2013) emphasized the cost-effectiveness of peer learning strategies and their findings indicate that the PAL strategy was found to enhance transferable social and communication skills, improve self-esteem, and foster liking for a subject area. Despite the growing interest in assessing the impact of the PAL strategy on learners' motivation and self-concept, a noticeable gap exists in the literature concerning a comprehensive examination of the intricate interplay between PAL implementation and its specific influence on enhancing learners' intrinsic motivation and fostering a positive self-concept, particularly within diverse educational contexts and age groups. This calls for further research to address these aspects and provide a more holistic understanding of PAL's effects.

Peer learning has been extensively recognized for its positive impact on concept recall, fostering active engagement and participation among students (Johnson et al. (2014). This is supported by Vygotsky's sociocultural theory, which posits that peer interactions stimulate higher-order thinking and cognitive development, ultimately enhancing concept recall (Vygotsky, 1978). However, Johnson et al. (2014) study on cooperative learning, a form of PAL strategy, found that while collaborative learning improved problem-solving skills, it limited conceptual recall. This highlights a potential limitation of certain peer-assisted approaches in ensuring comprehensive understanding.

The positive impact of peer learning extends beyond concept recall to creating a supportive learning environment where students feel comfortable seeking clarification and feedback (Schraw et al., 2006). This aligns with the notion that peer learning encourages learners to ask questions, promoting a more thorough comprehension of concepts (Topping, 2005). Additionally, peer learning facilitates the development of metacognitive skills, such as self-monitoring and reflection, further enhancing concept recall. Despite these benefits, it is crucial to acknowledge potential challenges associated with peer learning. Misconceptions or errors may arise in peer discussions, potentially reinforcing incorrect information. To address this, instructors can play a pivotal role by providing clear guidelines, monitoring discussions, and

correcting misconceptions as needed (Crouch & Mazur, 2001). This emphasizes the importance of effective facilitation to mitigate potential pitfalls in peer-assisted learning.

Social constructivist theories also underscore the importance of peer discussions in negotiating meaning, providing explanations, and sharing perspectives, contributing to enhanced concept recall (Webb et al., 2006). However, the study by Weinstein and Stone (1993) brings attention to variables such as expertise, organizational knowledge, and effective strategies that significantly impact concept recall. A meta-analysis by Springer et al. (1999) emphasized the role of peer expertise and accountability in determining the effectiveness of peer tutoring. When peers lacked subject matter expertise or were not held accountable for their teaching, the impact on conceptual recall was limited. This underscores the importance of peer instruction quality and supervision in influencing the efficacy of peer learning.

While peer learning is touted for fostering teamwork and collaboration, potential negative aspects, such as unequal workload distribution, social loafing, and negative peer influence, need to be addressed to maximize its effectiveness (Michaelsen et al., 2002; Veenman et al., 2006).

The literature also emphasizes the importance of teacher guidance in promoting effective collaboration among learners (Webb, 2009). This contradicts the study by Slavin (1996), which highlighted the potential for unequal distribution of workload and responsibilities in PAL, suggesting a need for careful structuring and facilitation.

Furthermore, peer learning is recognized for fostering positive social interactions, increased engagement, mutual support, and a sense of belonging (Kirschner et al., 2009). PAL has been shown to produce academic gains equivalent to or greater than conventional teaching methods (Greenwood et al., 1988). However, limited research directly compares PAL to other instructional approaches, highlighting a gap in understanding its relative advantages and disadvantages.

While PAL positively impacts teamwork and collaboration skills, the challenges associated with negative peer influence, conflicts, and dependency on stronger group members necessitate careful consideration and intervention strategies (Veenman et al., 2006). This

underscores the importance of structured tasks, peer accountability, and effective teacher facilitation to maximize the benefits of peer learning.

The literature review concludes by emphasizing the need for further research to explore the effects and benefits of digital platforms and tools on the PAL in the digital age. Additionally, the potential of PAL to enhance reading performance and its impact on diverse learner types, including students with disabilities, warrant further investigation to ensure the inclusivity and effectiveness of peer-assisted learning strategies.

2.4 Gaps in the literature reviewed

The existing body of literature acknowledges the positive impact of Peer-Assisted Learning (PAL) on active engagement, particularly emphasizing its ability to facilitate meaningful discussions and interactions among students. However, a notable gap exists in the literature regarding a detailed exploration of the specific components within PAL that contribute to active engagement. The literature falls short in providing a comprehensive understanding of how different PAL strategies and their variations may influence students' active participation and the mechanisms through which instructors can optimize these components to enhance overall engagement.

Furthermore, there remains a need for a more thorough examination of the factors that influence motivation within the PAL framework. The literature lacks a nuanced exploration of how specific PAL components contribute to sustained motivation and how instructors can address potential challenges to maintain high levels of motivation among students throughout the learning process.

However, there is a noticeable gap in a comprehensive examination of the intricate interplay between PAL implementation and its specific influence on enhancing learners' self-concept. Further research is essential to understand how PAL strategies contribute to shaping students' self-perception and fostering a positive sense of confidence and competence.

Studies underscore potential drawbacks, such as unequal workload distribution, social loafing, and negative peer influence. Addressing these issues and gaining a more in-depth understanding of the optimal conditions for effective collaboration within PAL is crucial. This

involves exploring group dynamics, enhancing accountability mechanisms, and elucidating the role of teacher guidance in facilitating collaborative learning.

Most studies predominantly rely on quasi-experimental designs to evaluate the effectiveness of PAL. While these studies contribute valuable insights, there is a gap in terms of methodological diversity. Exploring the potential of mixed-methods approaches, longitudinal studies, or comparative analyses, hybrid research designs would provide a more comprehensive understanding of the causal relationships between PAL implementation and various educational outcomes.

Finally, the studies highlight the immediate benefits of PAL, but there is a noticeable gap in research investigating the long-term effects of PAL interventions. Understanding whether the positive outcomes observed in the short term persist over an extended period is crucial for assessing PAL's sustainability and lasting impact on student learning and achievement. Addressing these gaps collectively would significantly contribute to refining the understanding of PAL strategies and their broader implications for educational practices.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This chapter presents the research paradigm and methodological choice of designs for the study, population, study sample, sampling procedures and data collection instruments. The chapter also presents data collection procedures, methods of data analysis, trustworthiness and reliability, ethical considerations and a chapter summary.

3.2 Research Paradigm

The philosophical framework has been referred to as a paradigm by many academics (Creswell & Garrett, 2008: Creswell & Plano Clark, 2007). A research paradigm is a collection of presumptions about how things operate in the research domain. Schumacher and McMillan (2010) state that a research paradigm encompasses a global perspective on how research knowledge is anticipated to be generated. They suggested a collection of rigid frameworks through which information must be arranged and examined.

The pragmatism paradigm underpinned the study, which was chosen to accommodate the inclusion of both qualitative and quantitative research objectives. Pragmatism is a paradigm that claims to bridge the gap between the scientific method and structuralist orientation of older approaches and the naturalistic methods and freewheeling direction of newer approaches (Creswell, 2009).

The pragmatism paradigm is based on the proposition that researchers should utilize the philosophical and methodological approach that is most appropriate for addressing the specific research problem at hand (Kaushik & Walsh, 2019). Many researchers have stressed that pragmatism can provide a philosophical justification for the mixed research approach. For example, Denscombe (2008) and Mitchell (2018) have mentioned that pragmatism is considered to be "the philosophical partner" of the mixed research approach as its underlying assumptions provide the essence for mixing research methods. Also, Creswell (2009) agrees that pragmatism is an advanced philosophy that provides the epistemology and the logic for combining quantitative and qualitative approaches and methods. Moreover, Creswell (2014) has mentioned that pragmatism is the philosophy that permits the mixing of paradigms, assumptions, approaches and methods of data collection and analysis. Pragmatism is all about the notion of "what works". This is mainly referring to the pragmatic theory of truth.

Pragmatism is simply oriented toward solving practical problems in the real world rather than being built on assumptions about the nature of knowledge (Creswell, 2014; Hall, 2013; Shannon-Baker, 2016). This means that pragmatism leads to "action-oriented" research procedures (Cameron, 2011).

According to pragmatism, research should be designed and conducted in the best way that serves to answer the research questions regardless of its underlying philosophy (Biddle & Schafft, 2015; Creswell, 2014; Saunders, 2014). As it supports using whatever research method "works" to answer the research questions, pragmatism does not only justify the mixed research approach but also opens all methodological choices in front of a researcher where the mixed research approach becomes one way of applying the pragmatic philosophy. Biddle and Schafft (2015) have mentioned that a pragmatic researcher has the option to conduct quantitative, qualitative or mixed research based on what serves his research purposes.

From an ontological perspective, the choice of pragmatism suggests a belief that reality and truth are not static entities but are continuously evolving and subject to interpretation (Kaushik & Walsh, 2019). This dynamic understanding of reality aligns seamlessly with the collaborative nature of peer-assisted learning, acknowledging that diverse perspectives and interpretations contribute to a richer and more comprehensive understanding of a subject.

On an epistemological level, pragmatism asserts that knowledge is derived from practical experience and the outcomes of actions, emphasizing the importance of hands-on engagement and experiential learning (Kaushik & Walsh, 2019). In the context of the PAL strategy, this aligns perfectly with the interactive and collaborative nature of the approach. It underscores the idea that knowledge is not merely transmitted but actively constructed through shared experiences, discussions, and collaborative problem-solving among peers.

In the PAL strategy framework, where practical outcomes and problem-solving skills are paramount, the pragmatist paradigm resonates strongly. It emphasizes the idea of understanding and improving societal issues. By embracing the dynamic and evolving nature of reality and emphasizing practical experience.

3.3 Research Approach

This study used a mixed methods approach to collect qualitative and quantitative data. The mixed methods approach incorporates a distinct set of ideas and practices that separate the approach from the other main research paradigms. This approach mixes different data collection methods, enabling the researcher to see the same phenomenon from different perspectives to understand the problem more completely (Creswell, 2017: Denscombe, 2017: Johnson & Onwuegbuzie, 2004). For instance, using quantitative and qualitative methods within the same research project is a research design that specifies the sequencing and priority given to the quantitative and qualitative data collection and analysis elements. The study used the concurrent nested strategy to mix qualitative and quantitative methods. And this involves a simultaneous collection of qualitative and quantitative data, with either method being dominant (Creswell, 2009).

3.4 Research Design

A concurrent research design, which is a combination of the quasi-experimental research design, specifically the "Nonequivalent Control Group Design'', and the Solomon Four Group Design, was used in the study. Combining these two designs resulted in a design that would control many sources that cause findings not to be valid, such as; history, maturation, instrumentation, statistical regression, selection bias, experimental mortality, demoralization and pretest-treatment interaction (Thurmond, 2001).

A concurrent research design was preferred in this study because both qualitative and quantitative data were supposed to be collected concurrently, in parallel, during the same phase of the research. This design allowed the researcher to provide a more comprehensive and nuanced understanding of a research problem by integrating the strengths of both quantitative and qualitative research approaches.

A quasi-experimental design is a research design that shares similarities with experimental designs but lacks random assignment of participants to treatment and control groups (White & Sabarwal, 2014). In quasi-experimental designs, researchers take advantage of naturally occurring groups or conditions to investigate the effects of an independent variable on a dependent variable (Maciejewski, 2020). While quasi-experimental designs have limitations compared to true experimental designs, they can still provide valuable insights when random assignment is not feasible or ethical.

The selection of a quasi-experimental design for this study was deliberate, driven by the unique characteristics of the study participants. In particular, the study focused on intact groups (classes) that were assumed to exhibit similar levels of maturity, aptitude, and intelligence. The intact nature of these classes suggested that the participants shared commonalities that could impact the study outcomes. The quasi-experimental design, therefore, proved to be a fitting choice as it accommodated the constraints posed by the pre-existing, intact classes, the study had two experimental classes and two control classes. All four classes were given a post-test but only one class from experimental and control were given a pre-test. This design was considered appropriate because it allowed the researcher to work with already established classes without the need for random assignment. Moreover, the decision to employ a quasi-experimental design stemmed from the necessity to conduct pre-tests and post-tests on the learners. This approach facilitated the assessment of changes or developments in the participants' knowledge, skills, or performance throughout the study. The quasi-experimental design, in this context, emerged as a pragmatic and effective choice, providing the necessary flexibility to accommodate the existing class structures while still enabling a rigorous examination of the variables under investigation. By opting for this design, the researcher could leverage the advantages of both experimental and non-experimental methods, ensuring a robust evaluation of the intervention's impact within the confines of intact class settings.

The Solomon Four-group design is a research design used in experimental studies to investigate the effects of an independent variable on a dependent variable. It is an extension of the classic pretest-posttest control group design. It is beneficial when researchers want to assess the impact of an experimental manipulation while controlling for potential confounding variables. It is a useful experimental design to investigate the main effect of a pre-test and the interaction effect of a pre-test and treatment (Johnston & Warkentin, 2012). The Solomon Four design helped to free from the entanglement of the treatment, the pre-test, and the interaction effects of the pre-test and treatment (Sawilowsky et al., 1994: Dare et al., 2020). The Solomon Four-group design (**Figure 3.1**) allows researchers to control for potential confounding factors such as preexisting differences between groups and testing effects by including pretests and posttests. It enables the evaluation of the independent variable's immediate and long-term effects on the dependent variable (Braver & Braver, 1988).

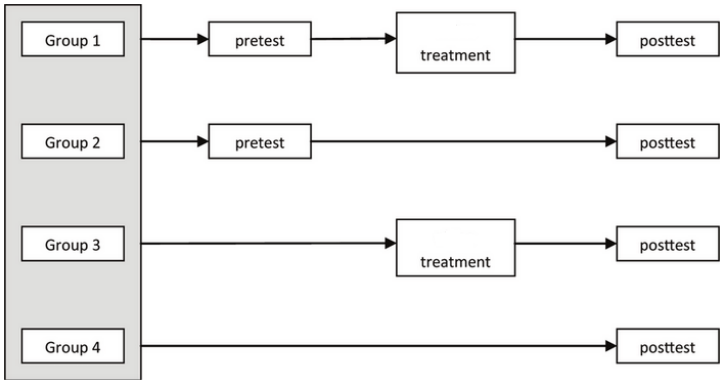

Figure 3.1 Solomon Four-group design (Johnston & Warkentin 2012).

The design helps researchers determine whether the experimental manipulation or the pretest influenced the outcomes. Comparisons between the pretest-posttest control group and the pretest-posttest experimental group can identify the effect of the independent variable. Additionally, posttest control and experimental group comparisons can reveal potential testing effects (Sawilowsky et al., 1994: Dare et al., 2020).

To address potential confounding factors and enhance the internal validity of the study, the researcher adopted the Solomon Four Group Design after the implementation of a quasi-experimental design. This sophisticated design is specifically tailored to control for preexisting differences between groups and the potential impact of testing effects. By incorporating pretests and posttests in both experimental and control groups, the Solomon Four Group Design aimed to isolate and account for any variations that could influence the study outcomes.

The study involved the selection of four Grade 10 classes, each representing a distinct school. To prevent contamination and ensure the independence of the experimental conditions, one class from each school was chosen. These selected classes were systematically labelled as classes 1 to 4. Notably, Class 1, situated at School A, and Class 2, located at School B, constituted the experimental groups subjected to both pre-testing and post-testing. The pre-tests were administered to capture baseline information, while the post-tests gauged the impact of the PAL (Peer-Assisted Learning) strategy.

Conversely, Classes 2 and 4, situated at School C and School D, respectively, served as control groups. These groups underwent only post-testing, eliminating the pre-testing phase to control for any potential testing effects. The decision to refrain from pre-testing these classes allowed

for a clearer evaluation of the intervention's efficacy by minimizing the influence of prior assessments on subsequent performance measures.

Classes 1 and 3 were designated as the Experimental groups, both exposed to the PAL strategy. This strategic division of classes and the careful selection of schools aimed to ensure a well-structured experimental design, minimizing external factors and enhancing the study's ability to attribute observed effects to the implemented PAL strategy. Overall, the integration of the Solomon Four Group Design within the quasi-experimental framework provided a robust methodological foundation for the investigation, fostering greater confidence in the validity and reliability of the study's findings.

3.5 Study area or site

In the context of this study, a meticulous selection process was undertaken to identify schools that would provide a representative sample conducive to the study's objectives. To facilitate the selection process, a purposeful and random sampling method was employed, with a specific emphasis on schools located within a 10 km radius of Kabwe town. This geographical parameter was established to ensure logistical feasibility, minimize travel constraints, and maintain reasonable proximity between the research team and the selected schools. Eight schools were purposefully chosen to ensure easy accessibility and a comprehensive understanding of the targeted population and four schools were randomly selected from the eight schools.

All selected schools eight schools were grade one schools, uniformly positioned within an urban setting, and exclusively constituted government-run institutions. Additionally, the deliberate choice was made to include co-educational schools, encompassing both boys and girls, to capture a diverse and inclusive representation of the student population.

The study was conducted in Kabwe district, located in the Central province of Zambia.

3.6 Study population

Zhao (2013) defines a target population as the aggregate or total set of objects or individuals to which inferences are made during the study. Accordingly, the population of this study consisted of grade ten (10) learners who take pure physics drawn from all secondary schools within Kabwe district.

3.7 Study sample

Lenth (2001) defines a study sample as a portion of the study population, and Majid (2018) defines a sample as a subgroup of the population the researcher is interested in. This study's sample was drawn from four secondary schools which were randomly selected. Four schools were selected to effectively use the Solomon four-group design. The study sample consisted of 131 grade ten (10) learners selected from four secondary schools. School A had 31 learners, School B had 32, school C had 34 and lastly, school D had 34 learners. The total number of girls in this study was 68 and the boys were 63.

3.8 Sampling techniques

Sampling is the process of selecting a small number of people (a sample) from a larger group (the sampling population) to estimate or predict the prevalence of an unknown piece of information, event, or consequence concerning the larger group (Majid, 2018). This study employed probability sampling, specifically simple random sampling, to select the schools included in the research. Additionally, purposive sampling was used to choose classes for data collection because the quasi-experimental design lacked randomization. The groups (classes) were picked based on their similarity in maturity, aptitude and intelligence. Cohen *et al.* (2005) describe purposive sampling as a process where researchers handpick the cases to be included in the sample based on their judgment of their typicality. Then, the classes were randomly assigned to one of four groups in the Solomon four-group design in readiness for pretesting and treatment.

3.9 Instruments for data collection

The data was collected using open and closed-ended questionnaires, achievement tests, focus group discussion guide, and lesson observation schedules.

3.9.1 Likert-type questionnaire.

Kombo and Tromp (2006) define a questionnaire as “a research instrument that gathers data over a large sample”, Questionnaires were used because they offer an objective means of collecting information about people's knowledge, beliefs, attitudes, and behaviour. It was appropriate for mixed methods research. The questionnaire used in this study was designed by the researcher and it was subjected to expert validation. The questionnaire was used to get learners' opinions, attitudes, perceptions, or experiences when they learned TEOF using the PAL strategy. The scale typically consists of statements or items, and respondents are asked

to indicate their level of agreement or disagreement with each statement (see Appendix 2). Both qualitative and quantitative data were collected from this instrument. The questionnaire included closed-ended questions with response options on a Likert scale and some open-ended questions.

3.9.2 Lesson Observation Schedules

A data collection method of generating data which involves the researcher immersing him/herself in a research setting, and systematically observing dimensions of that setting, interactions, relationships, actions, events, etc., within it, is the definition of "observation" (Tavakoli, 2012:418). According to Wilkinson and Birmingham (2003), observation is described as a type of research that involves a prolonged period of intense social interaction between the researcher and the subjects in their environment. During this time, field notes are unobtrusively and methodically collected as data.

The lesson observation schedules used in this study were designed by the researcher, and then subject to pilot testing and expert validation. This instrument was used to observe classroom behaviour during lessons on TEOF (see Appendix 2). Both qualitative and quantitative data were collected from this instrument.

3.9.3 Focus Group Discussion Guide

A focus group discussion guide was utilized as a qualitative research tool in this study. In focus group discussions, the moderator (interviewer) poses specific questions to research participants in a group setting to explore a particular topic or issue. Unlike individual interviews, focus groups provided the added dimension of member interactions. In conducting the focus group discussions, the emphasis was placed on the interaction among group members. Instead of the moderator asking questions, the group members were encouraged to communicate, exchanging ideas and comments on each other's experiences or points of view (Wong, 2008).

Two focus group discussions were conducted in two different schools, the laboratories were used to conduct them because it was conducive and a quiet place was needed where the participants were free to express themselves. The participants just volunteered to be part of the focus group discussion, since most learners wanted to be part of the discussions, 8 participants were chosen first hand comprising four girls and four boys including at least 2 learners who

were peer teachers. For the two schools, the total number of participants was 16. The sitting arrangement was U-shaped with the researcher at the centre, the first discussion took place on 20th October 2022 for 65 minutes and the last on 21st October 2022 for 68 minutes. The discussions were recorded by both note-taking and an audio recorder with the consent of the participants. The participants were assured of the privacy and confidentiality of the discussions, and the need to respect each one's views. The discussions started with engagement questions, then exploration questions and lastly an exit question (see Appendix 2 for the questions). Only qualitative data was collected from this instrument.

3.9.4 Achievement tests

Achievement tests are tools used to collect data on an individual's knowledge, skills, or proficiency in a specific subject or area. These tests are designed to assess what an individual has learned or achieved as a result of instruction or experience (Borghans et al., 2016). The data collected from this tool was quantitative and the questions were on TEOF. This research tool was administered for both pre-test and post-test (see Appendix 2).

3.10 Validity and Reliability

The validity of a study determines whether it accurately assesses what it set out to test (Golafshani, 2003). It refers to how accurately and completely an instrument captures the variables under investigation (Cohen et al., 2005). As opposed to this, reliability is the degree to which findings hold up over time and accurately reflect the whole population under investigation (Golafshani, 2003). According to Wilkinson and Birmingham (2003), a research tool is considered reliable when the results of a study can be replicated using a comparable technique. The research tools were piloted with a small sample at a secondary school which was not part of the study. All the research tools were used in the pilot test. This allowed the researcher to evaluate the clarity, comprehensibility, and relevance of the tool's items or questions. Feedback from participants was collected, and necessary revisions to improve the tool's clarity and comprehensibility were made.

The content validity of the research tool was assessed by seeking expert opinions. Experts in the field reviewed the tools and evaluated whether the items or questions adequately represented the measured constructs. Revisions were made based on their feedback to enhance the tool's content validity.

The dependability of the research instruments was evaluated regarding their consistency and stability. Test-retest reliability was employed, where the tools were administered at different periods, and the correlation between the findings was assessed. Using Cronbach's Alpha (α) the questionnaire had 0.82, the lesson observation schedule had 0.85 and the achievement test had 0.87.

3.11 Procedure for data collection

The University of Zambia Humanities and Social Sciences Ethical Research Committee initially gave the study the go-ahead to begin data collection. The School of Education Assistant Dean Postgraduate Office sent a letter authorizing the study's conduct (see Appendix 3). The Central Province Education Office granted permission by writing an introductory letter to the District Education Board Secretary (DEBS). The DEBS office authorized the study's execution in writing by the head teacher of the sampled school. The head teachers permitted the researcher and directed him to the heads of departments of Natural sciences. It was the head of the department (HOD) who introduced the researcher to the pupils.

Four grade 10 classes were selected from four schools, one class at a school to avoid contamination. The chosen classes were named classes 1 to 4. Class 1 was at School A, and Class 2 was at School B. The two classes were pre-tested and post-tested. Class 3 was at School C, and Class 4 was at School D. Both classes were not to be pre-tested but only post-tested. Classes 1 and 3 were the Experimental groups and were treated with the PAL strategy, where learners were given sections of the topic ‘turning effect of a force’ according to the syllabus, then asked to research specifically on those sections and make notes and tutorial questions with the help of the teacher (researcher). The peer teachers were trained by the researcher, and the comprehensive training encompassed crucial pedagogical abilities, incorporating fundamental elements like crafting well-structured lesson plans and deploying effective instructional techniques, including the utilization of both the lecture format and the interactive question-and-answer method. Moreover, the training was dedicated to enhancing their grasp of the subject matter, equipping them to adeptly respond to inquiries and tackle misconceptions that may arise.

Furthermore, the training experience was designed to furnish peer educators with invaluable chances to hone their teaching aptitude within a controlled setting. Through these

opportunities, participants engaged in purposeful practice sessions that enabled them to finely tune their teaching methodologies. These practice sessions were complemented by valuable feedback loops, facilitating the refinement of their approaches and aiding in the development of the skills necessary to deliver constructive evaluations to their peers.

Then learners took the role of teacher, and the researcher was the moderator. After all presentations, tutorial questions prepared by the teacher (researcher) and the student 'teachers' were discussed in groups, the student "teacher" and the teacher "researcher" moved around the room listening and ensuring the participation of all learners in the discussions, which typically lasted 10-15 minutes. After the discussion ended, the student "teacher" explained the answers to the tutorials with the help of the teacher "researcher".

No treatment was administered to Classes 2 and 4, and the two classes learned TEOF using traditional strategies of instructions characterized by non-interactive teaching methods.

The questionnaire was only administered to the experimental groups because most items on the questionnaire were based on the PAL strategy intervention, which the control groups were not part of.

Focus group discussions were conducted in Classes 1 and 3. The laboratories were chosen for conducting the FGDs because they provided a conducive environment. A quiet and suitable space was necessary to ensure that participants felt comfortable and free to express themselves during the testing process. The participants just volunteered to be part of the focus group discussion since most learners wanted to be part of the discussions. Eight participants, four girls and four boys, were purposefully selected to include at least two learners who served as peer teachers. Considering both schools, the total number of participants involved in the study was 16. The sitting arrangement was U-shaped, with the researcher at the centre. The first discussion took place on 20th October 2022 for 65 minutes and the last on 21st October 2022 for 68 minutes. Both note-taking and an audio recorder, with the consent of the participants, recorded the discussions. The researchers assured the participants about the privacy and confidentiality of the discussions, and they informed them about the significance of respecting each individual's views and opinions. The discussions started with engagement questions, then exploration questions and an exit question (see Appendix 2).

All groups underwent the administration of the second post-test seven months after the initial post-tests.

3.12 Data analysis

The quantitative data were analyzed using descriptive statistics (mean, standard deviation) and inferential statistics (t-tests), one-way ANOVA generated by the Statistical Package for Social Sciences (SPSS). Simultaneously, the qualitative data were analyzed thematically. Thematic analysis is the study of patterns of meaning. In other words, it's about exploring the themes within your data set to identify purpose.

The researcher's first step in the thematic analysis was familiarization, getting to know the data, which involved reading through the text from the questionnaire, FGDs and lesson observation schedules, taking initial notes, and generally looking through the data to get familiar with it.

In the second step, the data was prepared for analysis, including transcribing the focus group discussions and collating the responses to the questionnaire. The data was organized to facilitate analysis by creating a spreadsheet or database. Subsequently, in the third step of thematic analysis, the initial codes were generated. Codes are labels applied to data segments, such as a sentence or a paragraph, to indicate the presence of a particular concept or theme. Initial codes were developed by reading through the data and highlighting relevant segments to the research question.

For example, in the questionnaire data, a segment might be coded as "Engaged" if the respondent answered that they felt engaged during PAL lessons. In the focus group discussion data, a part might be coded as "Peer collaboration" if the participant mentioned working with others to promote engagement.

The fourth step was to identify themes, which are broader patterns that emerge from the initial codes. This involved reviewing the codes and grouping them into categories with a common theme or concept. For example, in the questionnaire data, codes such as "Engaged" and "Paid attention" were grouped under the theme of "High engagement." In the focus group discussion data, codes such as "Peer collaboration" and "Active learning" were grouped under the theme of "Collaborative learning."

The fifth step in the thematic analysis was reviewing and refining the themes, which involved checking that the themes were accurate and comprehensive and captured all the relevant

aspects of the data. If themes overlapped or did not reflect the entire range of concepts in the data, they were altered or merged.

The final step in the thematic analysis was to write a report summarizing the themes and sub-themes, with supporting quotes from the data. The report included an introduction that explains the research question, a description of the methods used to collect and analyze the data, and a summary of the key findings.

3.13 Ethical Considerations

The researcher implemented the following ethical guidelines throughout the research period:

The researchers prioritized the protection of learners' dignity and well-being throughout the research period. To foster successful and safe learner interactions, the researchers cultivated an atmosphere where participants treated each other with dignity, decency, and respect. They also encouraged an open and critical exchange of ideas among the learners. Listen to each other's points of view, recognizing that there may be disagreement. Keeping discussion and comments on the topic, and not on the learners. They were not using inflammatory or offensive language, sarcasm, or raised voices. In addition, reminding learners that if they have a disability or impairment which might affect participation, they report in advance to help them better.

Full consent was obtained from all participants before the commencement of the study (see Appendix 1). The participants had enough time to decide whether or not to be in the study and to make that decision without any pressure from the researcher. The participants were told about the purpose of the study, what would happen to them, and what they would be asked to do if they were in the study. They were told about the reasonably foreseeable risks of being in the research and the possible benefits. Participants were informed whether any fees would be connected with participation in the study and whether they would be rewarded for their time. The participants were free to ask any questions they had concerning the study.

The rights and interests of the participants were protected. Throughout the study, the participants were told who would have access to information collected about them and how their confidentiality was protected. The study guaranteed the confidentiality of information provided by the participants. Permission to use participants' real names in the research report was sought. It will be the right of the participant to refuse to be in the study at all or to stop

participating at any time after the study has begun. The research records will be kept for some time after the investigation.

3.14 Chapter Summary

This chapter discussed the research paradigm, methodology, research design, population, sample, sampling procedure, instruments for data collection Validity and Reliability, data collection procedure, data analysis and ethical considerations. The next chapter presents the findings of the study.

CHAPTER FOUR

PRESENTATION OF FINDINGS

4.1 Overview

The study's findings were based on data collected through multiple methods, including achievement tests, questionnaires, lesson observation schedules, and focus group discussions (FGDs). The themes derived from lesson observations, questionnaires, and focus group discussions (FGDs) were categorized under the five research questions based on their relevance and suitability. The following were the research questions:

1. What is the effect of the Peer-Assisted Learning (PAL) strategy on learners' active engagement in TEOF lessons?
2. How does the PAL strategy impact learners' motivation when learning the TEOF?
3. What is the effect of the PAL teaching strategy on learners' self-concept on TEOF?
4. What is the impact of the PAL teaching strategy on learners' performance on TEOF?
5. What is the effect of PAL on learners' retention of TEOF concepts?
6. What is the impact of PAL on learners' teamwork on TEOF?
7. How does the PAL strategy affect learners' collaboration when learning the TEOF?

The findings were presented based on the above research questions.

4.2 Research question 1: What is the effect of the Peer-Assisted Learning (PAL) strategy on learners' active engagement in TEOF lessons?

The first research question centred around observing learners' level of active engagement during lessons on TEOF. Learners' level of engagement during PAL lessons can vary depending on several factors, including the learners' motivation, the nature of the task, and the quality of peer interactions. The findings of research question one revealed the following three themes on TEOF; peer interaction, active learning, and teacher facilitation.

The first theme *Peer interaction* was a key factor in promoting engagement in TEOF lessons. During the FGD participants discussed the benefits of interaction and supporting each other.

L1A said, "*I like working with my peers because it makes the lesson more enjoyable and engaging.*"

L1C said, "*Sometimes my peers help me understand something that I didn't understand before, like how to make calculations using the principle of moments."*

L2A said, "*It was funny seeing our friend telling us to work together in groups*", like when the Peer Teacher School A (PTSA) said, '*Make seven groups so that you solve the following questions that I will give you*'.

Figure 4.2.1: Pupils solving tutorial questions in School A

The PTSC divided the learners into five groups.

Figure 4.2.2: Pupils solving the tutorial question in School C

The two diagrams show the learners participating in class activities when the peer teacher gave a task of calculating tutorial questions on TEOF. As can be seen from the diagram, all the learners took part in solving the questions given to them. A sample of the questions that learners were working on is shown below;

The door handle is an example of a lever application. Three points are shown by labels and arrows (https://studylib.net/doc/25426157/moment-of-force-worksheet).

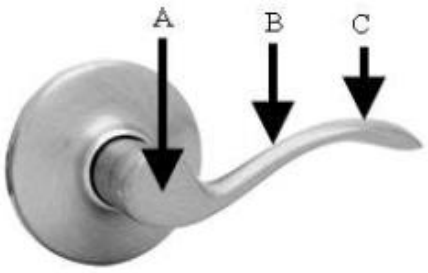

Figure 4.2.3 A Door handle

Which of the points A, B or C represent

(i) The fulcrum (turning point)

(ii) The point where the smallest force will open the door lock.

All the groups answered this question correctly, as follows (i) A and (ii) C

Question 2: Find the value of distance x in the diagram

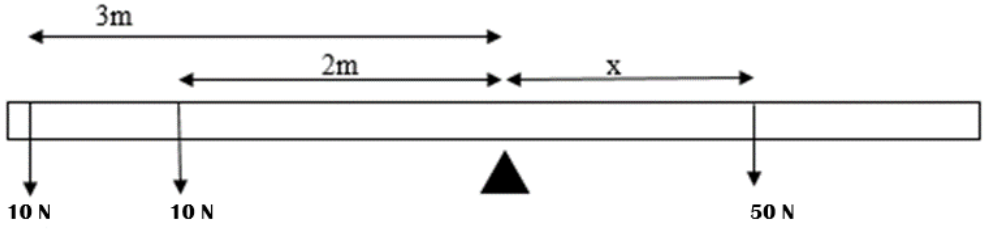

Figure 4.2.4 Question two-Principle of moments

The solution was just randomly selected from any group, the solution given is coming from group two.

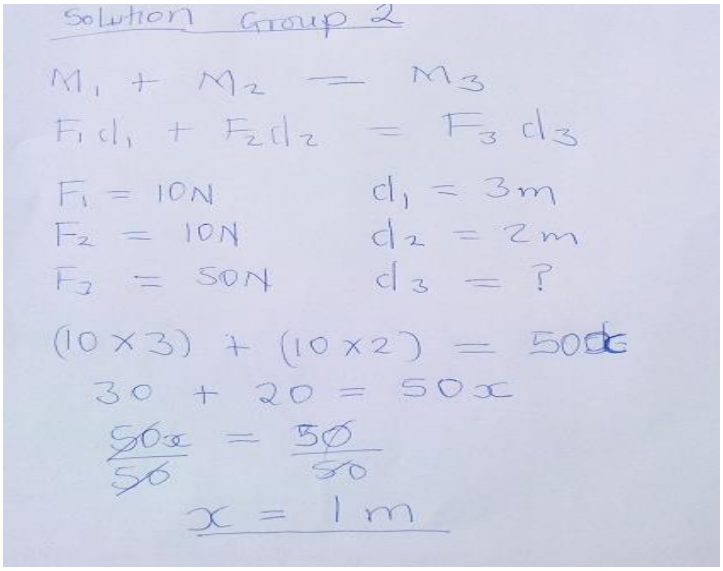

Figure 4.2.5 Solution of tutorial question 2 school A

The analysis revealed two sub-themes under the theme of peer interaction: group dynamics and sharing of knowledge.

The first sub-theme was *group dynamics*, which included communication, cooperation, and mutual respect. Participants in the FGDs emphasized the importance of having a good group dynamic to promote engagement.

L2A said, "*When everyone in the group communicates well and cooperates, it makes the lesson more engaging*."

L3A said, *"Mutual respect is important because it creates a positive learning environment, especially when I asked a question on 'couples' the peer teacher responded to me respectfully."*

The second sub-theme within *peer interaction* was, sharing of knowledge. Participants in the FDGs highlighted the importance of sharing their knowledge and skills with their peers.

L2C said, "*When I share my knowledge with my peers, it helps me understand the topic better, too, like right now. I feel more knowledgeable on the turning effect of the force because I was taking the lead on one of the sub-topics*."

L4A said, *"Sometimes I learn something new from my peers, and that's really helpful because we're all learning together*."

Active learning was the second theme identified, which was an important factor in promoting engagement. Participants' responses to the questionnaire discussed the benefits of actively participating in class activities and discussions.

L5A said, "*When we're doing activities in groups, we're actively engaged in what we're learning. It makes it more interesting and easier to remember*."

L3C wrote, *"I like when we have discussions in class because we get to hear different perspectives and ideas and that makes it more engaging.*"

The learners were motivated to work with their partners and were focused on improving their calculations. There was a high level of participation and energy in the classroom throughout the lesson.

Two sub-themes emerged within the active learning theme. The first sub-theme was *interest* and the second was *contribution*.

The first sub-theme which emerged from active learning was *Interest,* the participants were interested in TEOF and it felt relevant to their lives. Participants in the FDGs emphasized the

importance of being interested in what they were learning and feeling that it was pertinent to their lives.

L4C said, "*When I'm interested in the topic, I'm more likely to pay attention and participate, like the TEOF I was very interested."*

L5C said, "*I like when the lesson is relevant to my life because it makes it easier to understand, when you look at the application of the turning effect of the force, I see them every day."*

The second sub-theme within active learning was a *contribution* to class discussions. Participants in the FGDs and the responses from the questionnaires discussed the benefits of sharing their opinions and ideas.

L6A said, "*When we had discussions in class, it was important to be able to share our opinions and ideas because it helps us learn from each other*."

L6C wrote, "*I like when the peer teacher asked us questions about the TEOF because it made us think and share our ideas with the class*."

Teacher facilitation was the third theme that emerged from the data concerning active engagement, learners reported that PAL created a positive learning environment that encouraged participation and interaction. Participants in the FGDs spoke about the importance of teachers providing resources and materials to support learning and encourage participation.

L7A said, *"When the teacher gave us resources like charts or books, it helped us understand the topic better*."

Figure 4.2.6 shows a peer teacher using a teaching aid to explain to the peers about couples, a sub-topic of the turning effect of the force.

Figure 4.2.6 Peer teacher in school C using a teaching aid

L7C said, "*When the teacher was enthusiastic and engaged, it made me want to be involved too and I ask myself why I cannot be like my friend who is teaching."*

Two sub-themes were identified within the theme of teacher facilitation: teacher enthusiasm and teaching methods.

Teacher enthusiasm was the first sub-theme and the learners reported positive attitudes, passion for teaching, and excitement about the lesson content. Participants emphasized the importance of teachers being enthusiastic about schooling and the lesson content.

L8A stated, "*When the teacher is confident, it makes me feel more engaged and interested in the lesson, like the case of PAL lessons, all my friends were confident and appeared to know a lot."*

L8C said, "*The teacher's passion for teaching motivates me to participate and engage more effectively."*

The second sub-theme within teacher facilitation was teaching methods. Participants discussed the importance of teachers using various teaching methods to promote engagement. They mentioned the benefits of group work, discussion, and interactive activities.

L5A wrote, *"Group work helped me to learn from my peers and engage more effectively."*

L7C said, *"Interactive activities make the lesson more interesting and engaging like the activities we had when learning TEOF using PAL."*

Overall, the participants (90%) emphasized the importance of teacher facilitation in promoting engagement in peer learning lessons. Clear instructions, feedback, and support from teachers, as well as their enthusiasm and use of effective teaching methods, were key factors in creating a positive learning environment that promotes engagement.

From the responses of the learners, it was clear that about 80% of the participants were not impressed with strategies that are not learner-centred. Most learners were actively engaged in the lesson when the PAL strategy was employed. They assisted in answering questions during the question-and-answer sessions led by peer teachers, actively participated in solving examples that required volunteers, and collaborated in group work to solve tutorial questions. During TEOF lessons utilizing the PAL strategy, learners engaged in extensive discussions as the approach was learner-centred. By engaging in extensive discussions through the PAL strategy, learners had the opportunity to improve their communication skills continually.

Therefore the PAL strategy improved the communication skills of most learners, especially those taking the lead and gave confidence to them.

4.2.1 Descriptive and inferential statistics-Active engagement

The respondents (n = 65) were asked to rate the statements in the tables using the Likert scale of 1= strongly disagree, 2= Disagree, 3 = neutral, 4=Agree, and 5=Strongly Agree.

Table 4.2.1 showed that no participant disagreed that PAL promotes active engagement. Only 1.5% of the participants were not sure whether the PAL strategy promotes active engagement. The data reveals that 38.1% of male and 61.9% of female participants agreed that the PAL strategy promotes active engagement. Of the 65 full participants, 70.4% of males and 63.2% of females strongly agreed that the PAL strategy was more interactive and learners were actively engaged.

Table 4.2.1-Descriptive Statistics – Active Engagement

			Learners are actively engaged in the lessons when using the PAL strategy			Total
			Neutral	Agree	Strongly Agree	
Gender	Male	Count	0	8	19	27
		% within Gender	0.0%	29.6%	70.4%	100.0%
		% within Learners are actively engaged in the lessons when using the PAL strategy	0.0%	38.1%	44.2%	41.5%
		% of Total	0.0%	12.3%	29.2%	41.5%
	Female	Count	1	13	24	38
		% within Gender	2.6%	34.2%	63.2%	100.0%
		% within Learners are actively engaged in the lessons when using the PAL strategy	100.0%	61.9%	55.8%	58.5%
		% of Total	1.5%	20.0%	36.9%	58.5%
Total		Count	1	21	43	65
		% within Gender	1.5%	32.3%	66.2%	100.0%
		% within Learners are actively engaged in the lessons when using the PAL strategy	100.0%	100.0%	100.0%	100.0%
		% of Total	1.5%	32.3%	66.2%	100.0%

Table 4.2.2 Chi-Square Tests-Active Engagement

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.937[a]	2	0.626
Likelihood Ratio	1.300	2	0.522
Linear-by-Linear Association	0.581	1	0.446
N of Valid Cases	65		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 0.42.

Pearson Chi-Square was sig = 0.626 showing no significant difference between males and females in how they viewed the PAL strategy concerning promoting learners' active engagement on TEOF.

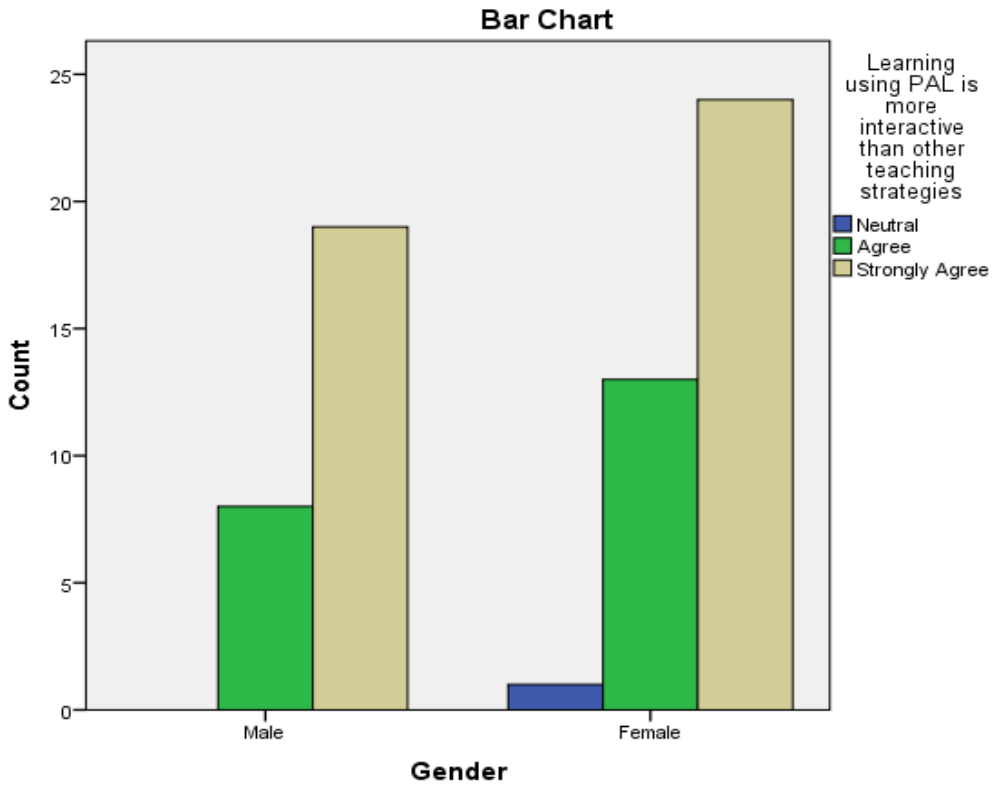

Figure 4.2.7 Interaction and Active Engagement

Data collected from the questionnaire revealed that most learners (98.5%) reported actively engaging in the lessons when using the PAL strategy on TEOF. Specifically, 66.2% of the

respondents strongly agreed, 32.3% agreed, 1.5% were neutral, 0% disagreed, and 0% strongly disagreed with the statement ‘Learners are actively engaged in the lessons when using the PAL strategy''. The most frequent response to this question was five, meaning participants strongly agreed, indicating a high level of agreement with the statement. These findings suggest that the PAL strategy effectively promotes learner engagement in the lessons in the lessons on TEOF.

4.3 Research question 2: How does the PAL strategy impact learners' motivation when learning the TEOF?

The second research question examined the impact of PAL on motivation during TEOF lessons. Several variables, including the nature of the work and the quality of peer relationships, influenced learners' drive and self-concept during studies. The findings of research question 2, revealed the following theme; Increased Motivation.

This theme emerged from the data, participants noted that learning using the PAL strategy increased their motivation to learn the topic, TEOF. Two sub-themes emerged; Interest in learning and Sense of accomplishment. Participants reported that they found learning of TEOF using the PAL strategy interesting and engaging. They were more motivated to know when they were able to participate in hands-on, interactive activities with their peers during FGD’s L1A said,

“*I find it more interesting to learn from my peers because they explain things in a way that is easier for me to understand. It makes me feel more motivated to participate.”*

L2A said,

“*PAL strategy makes concepts easy to understand because each learner contributes according to their understanding which also exposes learners to more knowledge on the given topic like the one we just learned.”*

L3A also said,

“The PAL strategy is interesting and affects motivation positively on TEOF in the sense that learners can make corrections as their friends are teaching, hence the concentration increases.”

L4A said,

"PAL strategy makes concepts easy to understand and interesting because each learner contributes according to their understanding which also exposes learners to more knowledge on the given topic."

The lesson observation also noted that during lessons, the learners were motivated to work with their partners and were focused on understanding the TEOF concepts. There was a high level of participation and energy in the classroom throughout the lesson.

The second sub-theme from increased motivation, was *Sense of accomplishment* and participants reported feeling a sense of accomplishment when they could complete given activities. They felt more motivated to continue learning when they could see the results of their efforts, like solving the tutorial questions on TEOF. In the questionnaire, L4A wrote,

"When we completed answering tutorial questions on TEOF successfully, I felt proud of myself and my group. It motivated me to keep working hard, especially after answering question 3 which seemed hard"

The following is the question L4A was referring to from the tutorial: A uniform metre rule is hung from the ceiling as shown below, the rule balances when a 50g mass is hung from one end of the ruler, what is the mass of the metre rule?

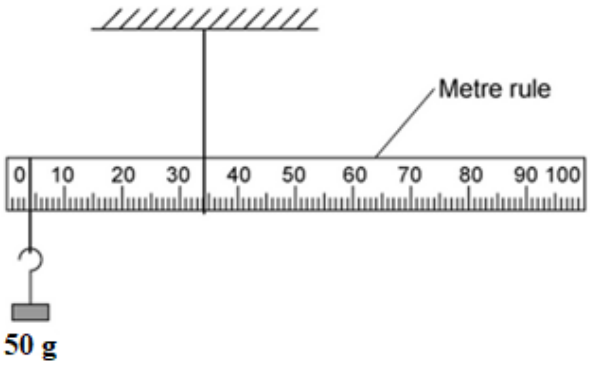

Figure 4.3.1 Mass of a rule

This tutorial question required learners to understand stability, equilibrium and the principle of moments to answer it, the solution extracted from one of the groups from school A;

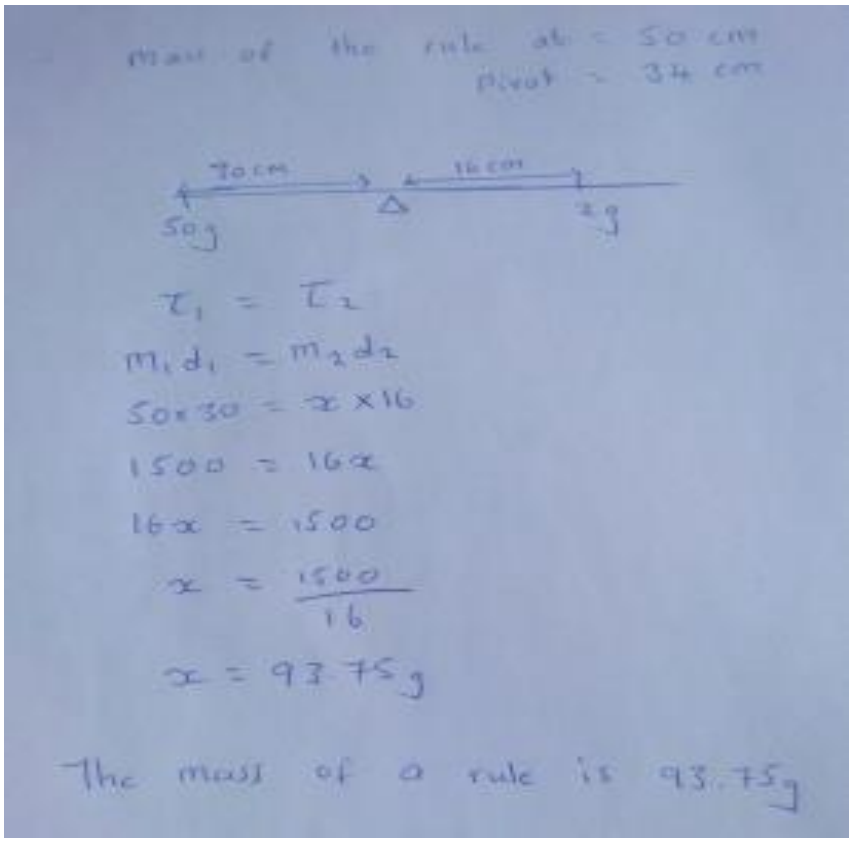

Figure 4.3.2 Solution of Tutorial Question 3

L5A, who was taking the lead as a peer teacher, wrote,

"PAL strategy made me want to know more, especially when I was the one teaching, it made me feel very educated."

In the questionnaire, L3C wrote,

"The PAL strategy boosts learners' confidence and knowledge that they have."

4.3.1 Descriptive and Inferential Statistics - Motivation

Quantitative analysis was also employed for this research question, which aimed to investigate the impact of the PAL strategy on learners' motivation. A Likert-type scale questionnaire was used to collect data on learners' perceptions of the effectiveness of the PAL strategy in enhancing their motivation and self-concept.

According to **Table 4.3.1,** 4.6% of the participants disputed that the PAL strategy promotes motivation to learn TEOF. Only 3.1% were neutral, 63.1 agreed and 29.2 strongly agreed.

Table 4.3.1 PAL is more motivating than other teaching strategies

			Learning using PAL is more motivating than other teaching strategies				Total
			Disagree	Neutral	Agree	Strongly Agree	
Gender	Male	Count	1	0	15	11	27
		% within Gender	3.7%	0.0%	55.6%	40.7%	100.0%
		% within Learning using PAL is more motivating than other teaching strategies	33.3%	0.0%	36.6%	57.9%	41.5%
		% of Total	1.5%	0.0%	23.1%	16.9%	41.5%
	Female	Count	2	2	26	8	38
		% within Gender	5.3%	5.3%	68.4%	21.1%	100.0%
		% within Learning using PAL is more motivating than other teaching strategies	66.7%	100.0%	63.4%	42.1%	58.5%
		% of Total	3.1%	3.1%	40.0%	12.3%	58.5%
Total		Count	3	2	41	19	65
		% within Gender	4.6%	3.1%	63.1%	29.2%	100.0%
		% within Learning using PAL is more motivating than other teaching strategies	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	4.6%	3.1%	63.1%	29.2%	100.0%

Table 4.3.2 Chi-Square-Motivation

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.607[a]	4	0.462
Likelihood Ratio	4.071	4	0.396
Linear-by-Linear Association	0.009	1	0.923
N of Valid Cases	65		

a. 6 cells (60.0%) have expected count less than 5. The minimum expected count is 0.42.

Table 4.3.2 shows the value of the Pearson Chi-Square, which was sig = 0.462 showing no significant difference in how female and male participants view the PAL strategy as motivating more than other strategies.

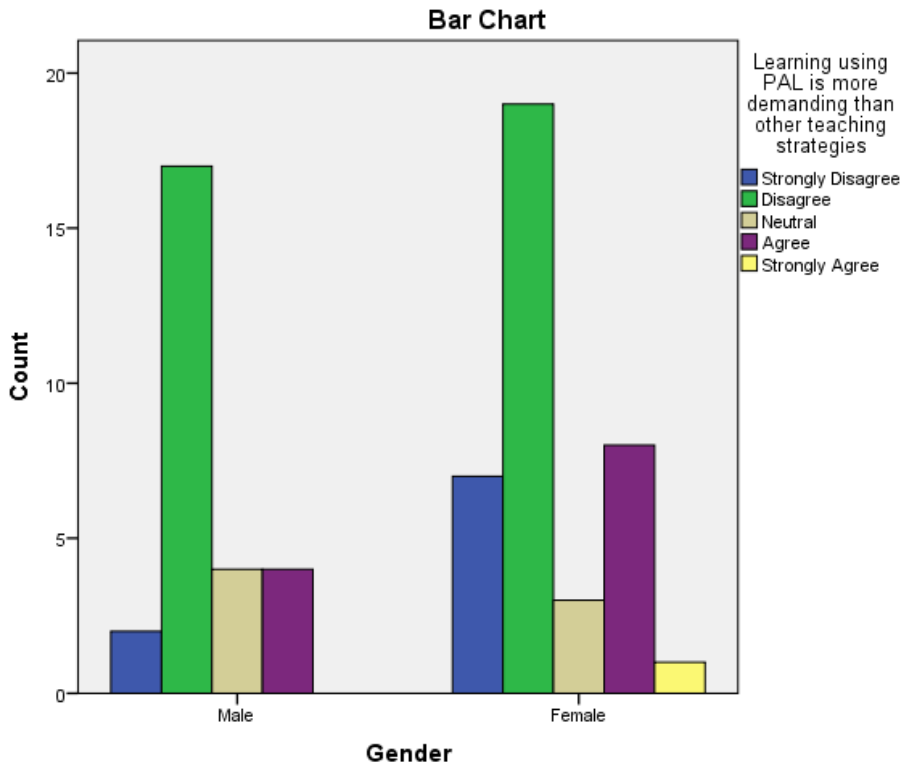

Figure 4.3.3 Bar chart-Motivation

The PAL strategy was more engaging and motivating than other teaching strategies because it allowed learners to participate in their learning actively. Learners were able to understand the material and developed important collaborative and problem-solving skills.

4.4 Research question 3: What is the effect of the PAL strategy on learners' self-concept on TEOF?

Learners' self-concept during their studies can be influenced by several factors, such as the type of work they are doing and the calibre of their peer interactions. The findings of research question 3, revealed the following theme; Improved self-concept.

Participants noted that using the PAL strategy helped enhance their self-concept and self-esteem. Two sub-themes that emerged were increased confidence and positive feedback.

Increased confidence was the first sub-theme that emerged from improved self-concept and participants reported feeling more confident in their abilities when they completed learning TEOF using the PAL strategy. They felt more comfortable trying a new strategy. During FGD's L1B said,

"Working with my peers has helped me to build my confidence and try new things that I might not have done on my own. It's a safe environment to learn and make mistakes."

L2C also said,

"The PAL strategy encourages self-confidence in the learners and also helps learners to have access to information they did not know about the topic through research and interaction with others"

Positive Peer Feedback was the second sub-theme and participants reported that positive feedback from their peers helped improve their self-concept. They felt more confident in their abilities when their peers acknowledged their strengths and skills. During the FGD's L4C said,

"When my peers told me that I taught well, it made me feel better about myself and my abilities. It helped me to see my strengths and what I am capable of."

Another one from the same discussion L5B said,

"*When our group was the first to finish solving questions on TEOF when everyone clapped for us, it felt great, it was a good feeling."*

The findings suggest that the PAL strategy positively affects self-concept. Participants reported feeling more confident in their abilities when they could participate in hands-on, interactive activities with their peers and solve TEOF questions easily.

4.5 Research question 4: What is the impact of the PAL teaching strategy on learners' performance on TEOF?

The fourth research question focused on the impact of the PAL strategy on learners' performance. The findings of research question 4 were based on quasi-experimental and Solomon's four-group designs.

From Table 4.4.1, it can be seen that the mean scores for the pre-test for Experimental Group 1 were 42.7, and the post-test was 84, while for the control Group 1, the pre-test mean was 41.9 and the post-test was 53.8, Experimental group 2 had a mean post-test of 82.1 and control group 2 had the mean post-test scores were 52.6.

Table 4.4.1 Pre-test and Post-test 1

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Pre-Test	Experimental 1	31	42.7419	10.18485	1.82925	39.0061	46.4778	25.00	60.00
	Control 1	32	41.9063	8.68948	1.53610	38.7734	45.0391	25.00	55.00
	Experimental 2	0	.	.	.	.	.	.	.
	Control 2	0	.	.	.	.	.	.	.
	Total	63	42.3175	9.38741	1.18270	39.9533	44.6816	25.00	60.00
Post-Test	Experimental 1	31	84.0323	8.36853	1.50303	80.9627	87.1019	70.00	95.00
	Control 1	32	53.8125	7.10037	1.25518	51.2525	56.3725	40.00	65.00
	Experimental 2	34	82.0882	7.08976	1.21588	79.6145	84.5620	60.00	95.00
	Control 2	34	52.6471	8.27879	1.41980	49.7585	55.5357	40.00	80.00
	Total	131	68.0000	16.81483	1.46912	65.0935	70.9065	40.00	95.00

Table 4.4.2 ANOVA PRE-TEST

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.721	1	12.721	0.112	0.739
Within Groups	5449.279	48	113.527		
Total	5462.000	49			

Table 5.4.2 shows results that were used to test for significance $\alpha = 0.05$and $p \leq 0.05$ show that pre-tests between and within Experimental 1 and Control 1 scores did not differ significantly.

Table 4.4.3 ANOVA-POST TEST

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	24697.938	3	8232.646	115.068	.000
Within Groups	7583.880	106	71.546		
Total	32281.818	109			

The post-test $p \leq 0.05$ shows that the post-test scores differed significantly between the groups.

The PAL strategy significantly impacted test performance, F(3,106) = 115.068 $p \leq 0.05$.

TABLE 4.4.4 Multiple Comparisons- Post-Test

Tukey HSD

(I) Experimental and control groups	(J) Experimental and control groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Experimental 1	Control 1	30.21976*	1.94747	0.000	25.1498	35.2898
	Experimental 2	1.94402	1.91908	0.742	-3.0521	6.9401
	Control 2	31.38520*	1.91908	0.000	26.3891	36.3813
Control 1	Experimental 1	-30.21976*	1.94747	0.000	-35.2898	-25.1498
	Experimental 2	-28.27574*	1.90333	0.000	-33.2308	-23.3207
	Control 2	1.16544	1.90333	0.928	-3.7896	6.1205
Experimental 2	Experimental 1	-1.94402	1.91908	0.742	-6.9401	3.0521
	Control 1	28.27574*	1.90333	0.000	23.3207	33.2308
	Control 2	29.44118*	1.87427	0.000	24.5617	34.3206
Control 2	Experimental 1	-31.38520*	1.91908	0.000	-36.3813	-26.3891
	Control 1	-1.16544	1.90333	0.928	-6.1205	3.7896
	Experimental 2	-29.44118*	1.87427	0.000	-34.3206	-24.5617

*. The mean difference is significant at the 0.05 level.

Table 4.4.4 shows how all four groups compare with each other, and the comparisons are summarized in **Table 4.4.5**

Table 4.4.5 Groups comparison

Groups	**p-value (sig.)**	**Significant**
Experimental 1 vs. Control 1	0.000	Yes
Experimental 1 vs. Experimental 2	0.742	No
Experimental 1 vs. Control 2	0.000	Yes
Experimental 2 vs. Control 1	0.000	Yes
Experimental 2 vs. Control 2	0.000	Yes
Control 1 vs. Control 2	0.961	No

Table 4.4.5 summarises the multiple comparisons as it can be seen that there was no significant difference between experimental groups, as can be supported using their mean scores as shown in **Table 4.4.6** for the post-test. There was a significant difference between Experimental 1 and the two Control groups. There was also a significant difference between Experimental

Group 2 and the Control groups. It has also been seen that there is no significant difference between Control Group 1 and Control Group 2. The findings indicate that the PAL strategy improved the grades of experimental groups.

Table 4.4.6 Homogeneous Subsets-Post-Test

Tukey HSD

Experimental and control groups	N	Subset for alpha = 0.05	
		1	2
Control 2	34	52.6471	
Control 1	32	53.8125	
Experimental 2	34		82.0882
Experimental 1	31		84.0323
Sig.		0.929	0.740

From **Table 4.4.6** above, it can be noted that the groups that share the same column are not significantly different. As can be seen, Experimental 1 and Experimental 2 share the same column; hence, they are insignificant. Control 1 and Control 2 also share the same column; hence, they are insignificant. Groups that do not share the same column are significantly different like Control 1 is in column 1 while both experimental groups are in column 2; hence there is a significant difference between the groups.

As seen from the graph (**Figure 4.4.1**), the Control groups' mean is almost the same, and the mean of the Experimental groups is practically the same. The steepness of the slope shows that the treatment worked. In this case, the PAL strategy helped the learners improve their test scores on TEOF (**Figure 4.4.1**).

It can be concluded that when the treatment groups which are Experiment 1 and Experiment 2, used the PAL strategy as the treatment to teach TEOF, the performance of the learners improved as compared to the Control groups 1 and 2, to answer the research question '*to what extent does PAL teaching strategy improve learners' performance on TEOF?*' there is a significant difference when PAL strategy was used to teach TEOF as compared to when it was it was not used. The graph clearly illustrates the effectiveness of PAL, as evidenced by its steep

slope. In this visualization, the lower points represent mean values without PAL, while the upper points represent mean values when PAL is utilized.

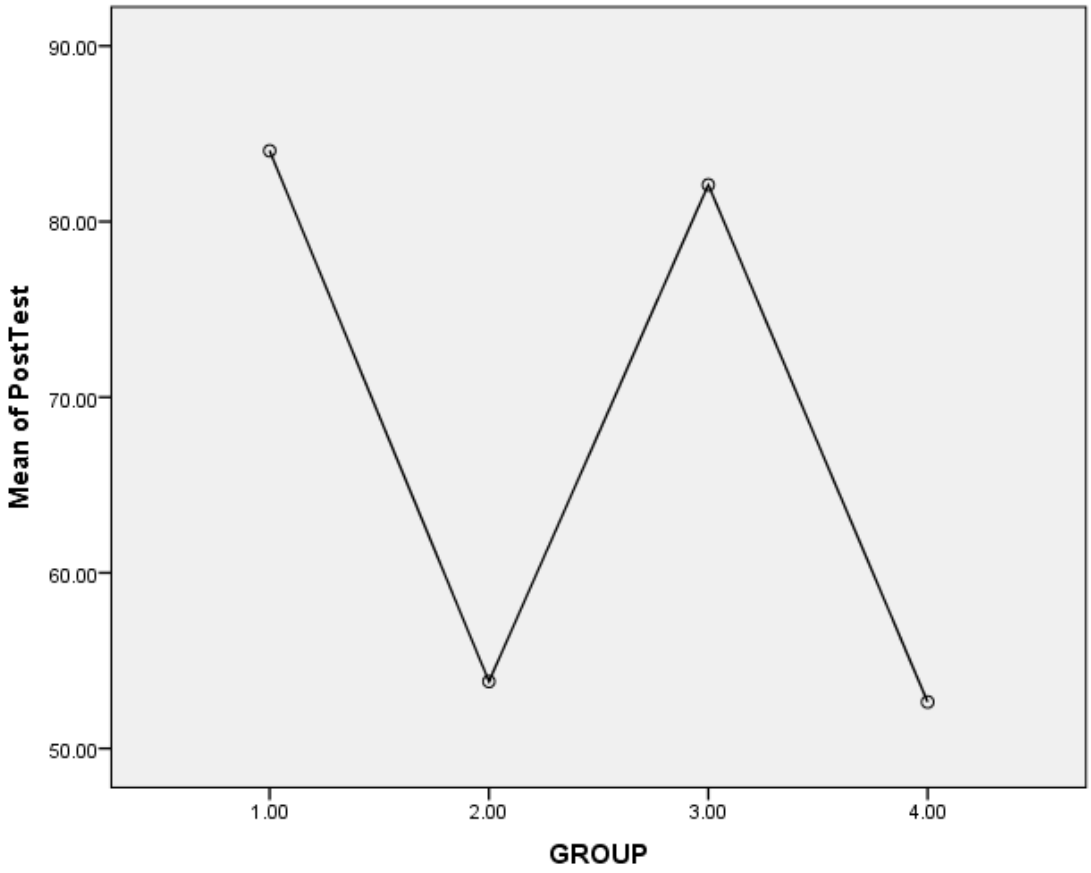

Figure 4.4.1 The Graph of Groups vs. Mean of post-test.

4.5 Research question 5: What is the effect of the PAL Strategy on learners' retention of TEOF concepts?

The study investigated whether learning using the PAL strategy could help learners retain TEOF concepts and understand them more deeply. Both quantitative and qualitative approaches were used to collect and analyze data from FGGs, lesson observation schedules, questionnaires and achievement tests with learners who had participated in learning TEOF using the PAL strategy. Two themes emerged during thematic analysis Improved Retention and Improved Understanding.

Improved retention was the first theme that emerged from the data, and participants reported that learning using the PAL strategy helped them retain concepts better. Two sub-themes were identified: Active learning and repetition.

Active learning was the first sub-theme and participants reported that they were more engaged in the learning process when the PAL strategy was used to learn TEOF, which helped them to retain TEOF concepts better. They could participate in discussions, ask questions, and apply what they learned in practical ways. For example, one participant, L3A, said,

"During lessons on TEOF, we were actively engaged with the material, and that helps me to remember it better. We discuss it, we ask questions, we apply it, and that makes it more memorable, for example, I am able to remember the principle of moments and know how to use it."

L4C said,

"It assisted me to remember because my fellow peers simplified terms and used simple English, like definition of a couple; A couple is a system of two parallel, equal, but opposite forces not acting along the same line."

Repetition was the second sub-theme that emerged, and participants noted that repetition of concepts during lessons on TEOF helped them to remember the information better. They were able to reinforce what they learned through discussion and application. For example, L6C wrote in the questionnaire that,

"During lessons on TEOF, we repeated the concepts over and over again by different peer teachers, and that helped me to remember them better. It's like practising something until it becomes part of you."

The second theme from the data was an improved understanding. Participants reported that learning using the PAL strategy helped them to understand concepts better. The following sub-themes were identified: Different perspectives and Peer feedback.

Different perspectives was the first sub-theme and participants reported that hearing different perspectives from their peers helped them to understand concepts better. They could see the information from different angles and gain new insights. For example, during the FGD's LC7 said,

"During lessons on TEOF, we get to hear different points of view, and that helps me to understand the concept better. I may not have thought of it that way before, and that makes it more meaningful."

The second sub-theme was peer feedback and participants noted that receiving feedback from their peers during TEOF lessons helped them to understand concepts better. They were able to identify areas where they needed to improve and get suggestions from their peers. During FGD's L1A said,

"During TEOF lessons, we give each other feedback, and that helps me to understand the concept better. My peers may point out something that I missed or offer a different way of thinking about it."

Another from the same FGD's L3A said,

"I am remembering all concepts because the learning was fun and work so simplified, and I paid attention waiting for my friend to make a mistake so that I laugh or correct it."

Also, L5C said,

"Learners can remember all the concepts just by looking at my friend who was teaching. I remembered all they said during the lesson."

When the researcher observed the lesson, L4C taught TEOF and used the question-and-answer method to teach and evaluate peers throughout the study. He walked around the classroom and provided individual feedback to each pair of learners. He also asked learners to share their knowledge of TEOF with the class and provided input to the class as a whole.

The findings of this study suggest that learning using the PAL strategy positively affects the retention of concepts and understanding of concepts. Participants reported feeling more engaged in the learning process during TEOF lessons and were able to reinforce what they learned through repetition and application. They also gained new perspectives and received feedback from their peers, which helped them to understand the concepts better.

The findings highlight the importance of active learning, repetition, different perspectives, and peer feedback in facilitating learning through peer interactions.

From Table 4.5.1, it can be seen that the mean scores for the pre-test for experimental group 1 were 42.9, and the post-test 1 was 84 showing an increase in the mean by 96%, post-test 2 was 83.9, while the control group 1 the pre-test mean was 41.9 and the post-test1 was 53.8 showing an increase of 28% and post-test 2 was 45.2 showing decrease in the mean score.

Experimental group 2 had a mean post-test 1 of 82.1 and post-test 2 of 83.1, indicating a minimal increase. Control group 2 had a mean post-test 1 score of 52.6 and a post-test score of 43.9.

Table 4.5.1 Descriptives-Post-test 1 and Post-test 2

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Post-Test 2	Experimental 1	31	83.8710	7.38350	1.32612	81.1627	86.5793	65.00	95.00
	Control 1	32	45.1563	4.48733	0.79325	43.5384	46.7741	40.00	60.00
	Experimental 2	34	83.0882	5.90515	1.01272	81.0278	85.1486	65.00	95.00
	Control 2	34	43.9412	4.29193	0.73606	42.4437	45.4387	40.00	59.00
	Total	131	63.8473	20.32182	1.77553	60.3347	67.3600	40.00	95.00
Post-Test 1	Experimental 1	31	84.0323	8.36853	1.50303	80.9627	87.1019	70.00	95.00
	Control 1	32	53.8125	7.10037	1.25518	51.2525	56.3725	40.00	65.00
	Experimental 2	34	82.0882	7.08976	1.21588	79.6145	84.5620	60.00	95.00
	Control 2	34	52.6471	8.27879	1.41980	49.7585	55.5357	40.00	80.00
	Total	131	68.0000	16.81483	1.46912	65.0935	70.9065	40.00	95.00
Pre-Test	Experimental 1	31	42.9032	10.17957	1.82830	39.1693	46.6371	25.00	60.00
	Control 1	32	41.9063	8.68948	1.53610	38.7734	45.0391	25.00	55.00
	Experimental 2	0	.	.	.	.	.	.	.
	Control 2	0	.	.	.	.	.	.	.
	Total	63	42.3968	9.38863	1.18286	40.0323	44.7613	25.00	60.00

Table 4.5.2 ANOVA-Pre-test, post-test 1 and post-test 2

		Sum of Squares	df	Mean Square	F	Sig.
Post-Test 2	Between Groups	49668.626	3	16556.209	523.263	0.000
	Within Groups	4018.320	127	31.640		
	Total	53686.947	130			
Post-Test 1	Between Groups	29171.657	3	9723.886	162.827	0.000
	Within Groups	7584.343	127	59.719		
	Total	36756.000	130			
Pre-Test	Between Groups	15.651	1	15.651	0.175	0.677
	Within Groups	5449.428	61	89.335		
	Total	5465.079	62			

The post-test 1 $p \leq 0.05$ shows that the post-test scores differed significantly between the groups.

The PAL strategy significantly impacted test performance, F(3,127) = 162.827, $p \leq 0.05$.

The post-test 2 $p \leq 0.05$ shows that the post-test scores differed significantly between the groups.

The PAL strategy significantly impacted test performance, F(3,127) = 523.263, $p \leq 0.05$.

Table 4.5.3 Post-Hoc Tests- Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Experimental and control groups	(J) Experimental and control groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Post-Test 2	Experimental 1	Control 1	38.71472*	1.41754	0.000	35.0243	42.4051
		Experimental 2	.78273	1.39687	0.944	-2.8538	4.4193
		Control 2	39.92979*	1.39687	0.000	36.2932	43.5664
	Control 1	Experimental 1	-38.71472*	1.41754	0.000	-42.4051	-35.0243
		Experimental 2	-37.93199*	1.38541	0.000	-41.5387	-34.3252
		Control 2	1.21507	1.38541	0.817	-2.3917	4.8218
	Experimental 2	Experimental 1	-.78273	1.39687	0.944	-4.4193	2.8538
		Control 1	37.93199*	1.38541	0.000	34.3252	41.5387
		Control 2	39.14706*	1.36426	0.000	35.5954	42.6987
	Control 2	Experimental 1	-39.92979*	1.39687	0.000	-43.5664	-36.2932
		Control 1	-1.21507	1.38541	0.817	-4.8218	2.3917
		Experimental 2	-39.14706*	1.36426	0.000	-42.6987	-35.5954
Post-Test 1	Experimental 1	Control 1	30.21976*	1.94747	0.000	25.1498	35.2898
		Experimental 2	1.94402	1.91908	0.742	-3.0521	6.9401
		Control 2	31.38520*	1.91908	0.000	26.3891	36.3813
	Control 1	Experimental 1	-30.21976*	1.94747	0.000	-35.2898	-25.1498
		Experimental 2	-28.27574*	1.90333	0.000	-33.2308	-23.3207
		Control 2	1.16544	1.90333	0.928	-3.7896	6.1205
	Experimental 2	Experimental 1	-1.94402	1.91908	0.742	-6.9401	3.0521
		Control 1	28.27574*	1.90333	0.000	23.3207	33.2308
		Control 2	29.44118*	1.87427	0.000	24.5617	34.3206
	Control 2	Experimental 1	-31.38520*	1.91908	0.000	-36.3813	-26.3891
		Control 1	-1.16544	1.90333	0.928	-6.1205	3.7896
		Experimental 2	-29.44118*	1.87427	0.000	-34.3206	-24.5617

*. The mean difference is significant at the 0.05 level.

Table 4.4.5 summarises the multiple comparisons as it can be seen that there was no significant difference between experimental groups, as can be supported using their mean scores as shown in **Table 4.5.3** for the post-test. There was a significant difference between Experimental 1 and the two Control groups. There was also a significant difference between Experimental

Group 2 and the Control groups. It has also been seen that there is no significant difference between Control Group 1 and Control Group 2.

Table 4.5.4 Groups comparison-post-test 2

Groups	p-value (sig.)	Significant
Experimental 1 vs. Control 1	0.000	Yes
Experimental 1 vs. Experimental 2	0.742	No
Experimental 1 vs. Control 2	0.000	Yes
Experimental 2 vs. Control 1	0.000	Yes
Experimental 2 vs. Control 2	0.000	Yes
Control 1 vs. Control 2	0.817	No

The results of the multiple comparisons are summarized in **Table 4.5.5**. The experimental groups' mean scores for the post-test, are clear that there was no statistically significant difference between them. The two Control groups and Experimental 1 differed significantly from each other. Additionally, there was a noteworthy distinction between Experimental Group 2 and the Control groups. A substantial difference between Control Group 1 and Control Group 2 has likewise not been seen. **Table 4.5.4** for the post-test. There was a significant difference between Experimental 1 and the two Control groups. There was also a significant difference between Experimental Group 2 and the Control groups. It has also been seen that there is no significant difference between Control Group 1 and Control Group 2.

Table 4.5.5 Homogeneous Subsets-Post-Test 2

Tukey HSD

Experimental and control groups	N	Subset for alpha = 0.05	
		1	2
Control 2	34	43.9412	
Control 1	32	45.1563	
Experimental 2	34		83.0882
Experimental 1	31		83.8710
Sig.		0.819	0.943

The results in **Table 4.5.5** show that the groups that share the same column are not significantly different. As you can see, Experimental 1 and Experimental 2 share the same column; hence, they are insignificant. Control 1 and Control 2 also share the same column; hence, they are insignificant. Groups that do not share the same column are significantly different like Control 1 is in column 1 while both experimental groups are in column 2; hence there is a significant difference between the groups.

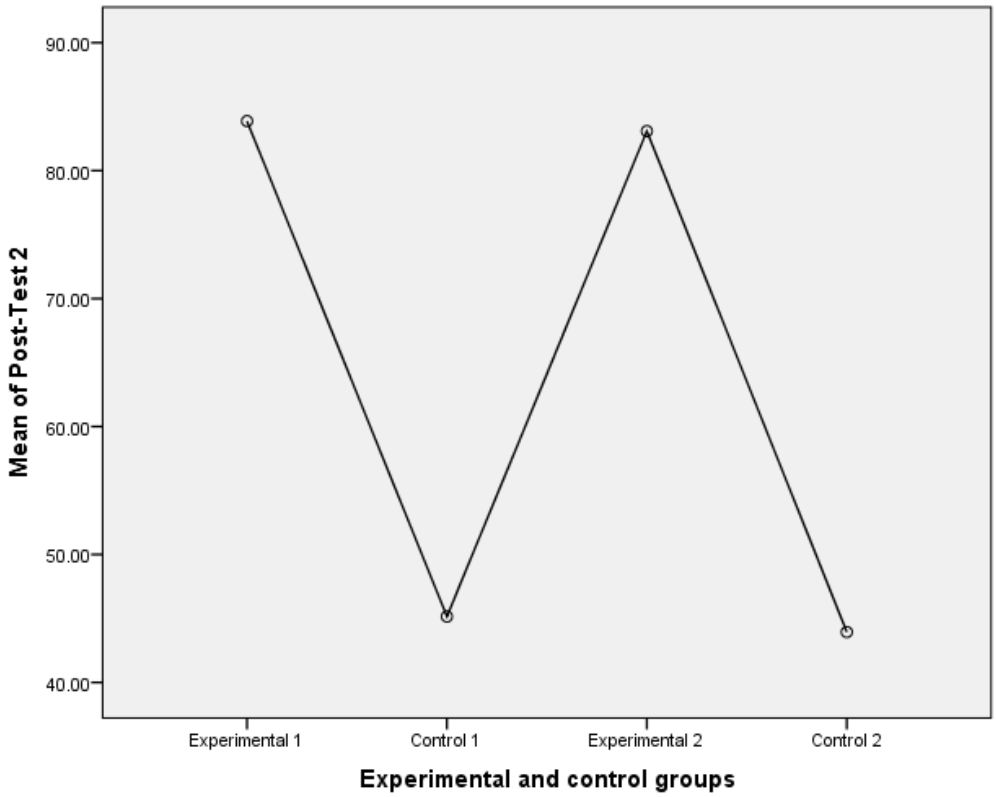

Figure 4.5.1 The Graph of Groups vs. Mean of Post-test 2

The graphical representation provides a visual insight into the efficacy of the Peer-Assisted Learning (PAL) strategy. It is readily discernible from the graph that PAL exerts a substantial impact on the outcomes. The lower points on the graph correspond to the mean values achieved in the absence of the PAL strategy, indicating the baseline performance. In contrast, the upper points on the graph represent the mean values attained when PAL is actively employed as an instructional strategy. The steepness of this transition is indicative of the considerable

improvement brought about by PAL, underscoring its positive influence on the measured outcomes.

The graph shows that the mean of the Experimental groups and the Mean of the Control groups are essentially the same. The slope's steepness indicates that the treatment was effective the learners retained the concepts; To answer the research question " What is the effect of PAL on learners' retention of concepts on TEOF?" it can be said that when the treatment groups, which are Experiment 1 and Experiment 2, used the PAL strategy as the treatment to teach TEOF, the learners' retention of concepts as compared to the Control groups 1 and 2. When the PAL strategy was employed to teach TEOF, a noticeable difference in performance was observed.

4.6 Research question 6: What is the impact of the PAL strategy on learners' teamwork on TEOF?

The study investigated whether using the PAL strategy could enhance learners' teamwork. From the qualitative thematic analysis approach, one theme emerged from the data; Improved Teamwork. Participants reported that learning using the PAL strategy helped them to develop better teamwork skills. The following sub-themes were identified: Communication and coordination.

Communication was the first sub-theme and participants reported that learning using the PAL strategy improved their communication skills. They were able to express their ideas more clearly and effectively. During FGD's L8C said,

"Learning TEOF using the PAL strategy helped me to communicate better with my peers. We had to explain our ideas and thoughts to each other, and that improved my communication skills."

Another learner from the same discussion L5C said,

"Learners express themselves more when using the PAL strategy because a topic is discussed in detail."

Coordination was the second sub-theme that emerged from improved teamwork, and participants noted that learning using the PAL strategy improved their coordination skills. They were able to work together more effectively and efficiently. For example, L2A said,

"During tutorials on TEOF, we had to coordinate our efforts and work together towards a common goal. That helped us to solve questions and improve our organisation skills."

L1C said, "we divided ourselves within the group others to write others to read the questions and one to summarise the final answer for example question 4 from the tutorial."

Below is a question and solution from one of the groups from school C for Question 4 which L1C has mentioned; *describe the concept of a moment arm in the context of torque. How does changing the length of the moment arm affect torque?*

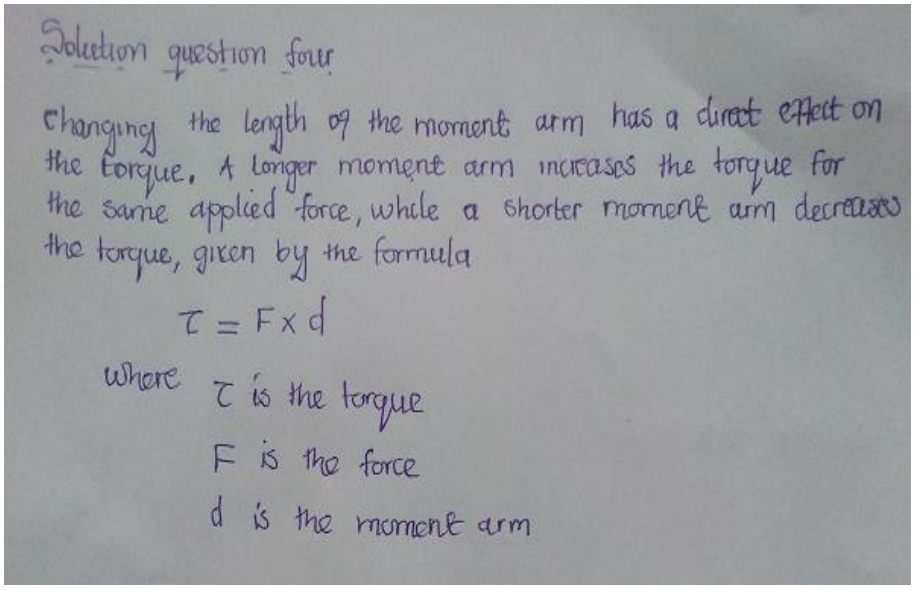

Figure 4.6.1 Solution to Tutorial Question 4

4.6.1 Descriptive and inferential statistics - Teamwork

A quantitative approach was used to collect data from a Likert-type scale questionnaire distributed to 65 learners who had participated in TEOF lessons.

The questionnaire included this statement, "The PAL strategy promotes teamwork when learning TEOF", and respondents were asked to indicate their level of agreement with the statement on a five-point Likert scale, where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree. A total of 65 students responded to the questionnaire, and the results are presented in **Table 4.6.1**

Only 3.7% of the total males strongly disagreed that PAL promotes teamwork. No participant disagreed with the assertion that PAL promotes teamwork. 7.9% of the total females were not sure that the PAL strategy promotes teamwork. A total of 58.19% of females and 41.9% of males strongly agreed that the PAL strategy promotes teamwork.

Table 4.6.1- PAL strategy promotes teamwork on TEOF

			PAL strategy promotes teamwork				Total
			Strongly Disagree	Neutral	Agree	Strongly Agree	
Gender	Male	Count	1	0	13	13	27
		% within Gender	3.7%	0.0%	48.1%	48.1%	100.0%
		% within PAL strategy promotes teamwork	100.0%	0.0%	41.9%	43.3%	41.5%
		% of Total	1.5%	0.0%	20.0%	20.0%	41.5%
	Female	Count	0	3	18	17	38
		% within Gender	0.0%	7.9%	47.4%	44.7%	100.0%
		% within PAL strategy promotes teamwork	0.0%	100.0%	58.1%	56.7%	58.5%
		% of Total	0.0%	4.6%	27.7%	26.2%	58.5%
Total		Count	1	3	31	30	65
		% within Gender	1.5%	4.6%	47.7%	46.2%	100.0%
		% within PAL strategy promotes teamwork	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	1.5%	4.6%	47.7%	46.2%	100.0%

Table 4.6.2- Chi-Square Tests- Teamwork

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.581[a]	3	0.310
Likelihood Ratio	5.020	3	0.170
Linear-by-Linear Association	0.000	1	0.991
N of Valid Cases	65		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is 0.42.

Table 4.6.2 showed the Pearson Chi-Square, sig = 0.310, showing no significant difference in how female and male participants viewed the PAL strategy concerning promoting teamwork.

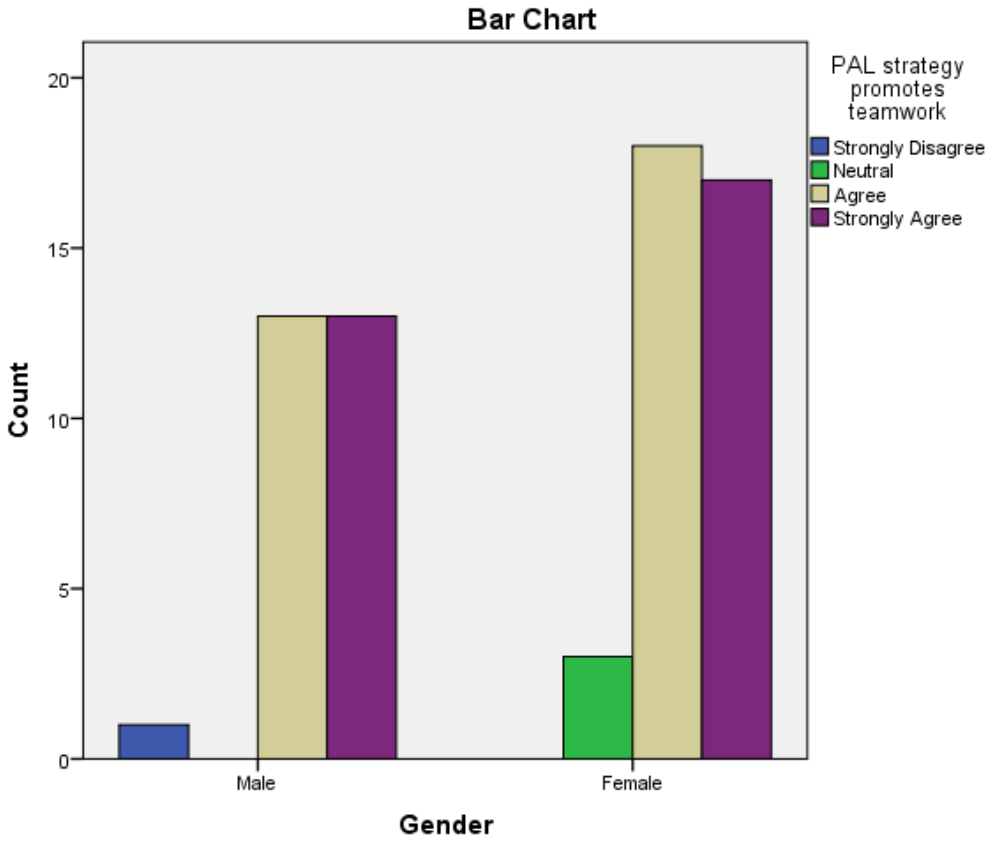

Figure 4.6.2 Bar chart-Teamwork

4.7 Research question 7: How does the PAL strategy affect learners' collaboration when learning the TEOF?

The findings of research question 7 using thematic analysis, revealed the following theme; enhanced collaboration. The participants reported that learning TEOF using the PAL strategy helped them to develop better collaboration skills. Two sub-themes were identified: Shared responsibility and interdependence

Shared responsibility emerged as the first sub-theme, and participants reported that learning using the PAL strategy helped them understand the importance of shared responsibility. They were able to work together towards a common goal and take responsibility for their roles. For example, one participant L8B during the FGD said,

"During lessons on TEOF, we learned that everyone has a role to play in achieving our common goal. I could not teach not until my friend has defined some concepts to my friends for them to understand what I will teach them. That helped us work together."

Interdependence was the second sub-theme and participants reported that learning the PAL strategy helped them understand the importance of interdependence. They could appreciate the value of working together and supporting each other.

L3A said,

"During TEOF lessons, I discovered that we depend on one another. In order to understand TEOF, we had to cooperate and assist one another."

Another learner L4A also said,

"The PAL strategy encourages group work and makes the learners research more and does not

promote laziness in learners because your friends are depending on"

From the thematic analysis, it was deduced that learning TEOF using the PAL strategy positively impacts learners' teamwork and collaboration skills. Participants reported improved communication and coordination skills and an enhanced understanding of shared responsibility and interdependence. Learning using the PAL strategy allowed learners to work together and learn the concepts of TEOF from each other, which was valuable in developing these important skills. The study highlights the importance of communication, coordination, shared responsibility, and interdependence in facilitating teamwork and collaboration through peer interactions.

4.7.1 Descriptive and inferential statistics-collaboration

A quantitative approach was used to collect data from a Likert-type scale questionnaire distributed to 65 learners who had participated in TEOF lessons.

The questionnaire included this statement, "The PAL strategy promotes collaboration when learning TEOF", and respondents were asked to indicate their level of agreement with the statement on a five-point Likert scale, where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree. A total of 65 students responded to the questionnaire, and the results are presented in **Table 4.6.3**

Table 4.6.3 shows that 7.4% of participants disagreed that the PAL strategy promotes collaboration, and only 7.9% of participants were unsure if PAL promotes collaboration. A total of 40% of participants agreed that the PAL strategy promotes collaboration. 52.3% of participants strongly agreed that the PAL strategy promotes collaboration.

Table 4.6.3 PAL strategy promotes Collaboration.

			PAL strategy promotes collaboration				Total
			Disagree	Neutral	Agree	Strongly Agree	
Gender	Male	Count	2	0	12	13	27
		% within Gender	7.4%	0.0%	44.4%	48.1%	100.0%
		% within PAL strategy promotes collaboration	100.0%	0.0%	46.2%	38.2%	41.5%
		% of Total	3.1%	0.0%	18.5%	20.0%	41.5%
	Female	Count	0	3	14	21	38
		% within Gender	0.0%	7.9%	36.8%	55.3%	100.0%
		% within PAL strategy promotes collaboration	0.0%	100.0%	53.8%	61.8%	58.5%
		% of Total	0.0%	4.6%	21.5%	32.3%	58.5%
Total		Count	2	3	26	34	65
		% within Gender	3.1%	4.6%	40.0%	52.3%	100.0%
		% within PAL strategy promotes collaboration	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	3.1%	4.6%	40.0%	52.3%	100.0%

Table 4.6.4 Chi-Square Tests-Collaboration

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.327[a]	3	0.149
Likelihood Ratio	7.115	3	0.068
Linear-by-Linear Association	0.589	1	0.443
N of Valid Cases	65		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is 0.83.

Table 5.6.4 showed the Pearson Chi-Square, sig = 0.149, showing no significant difference in how female and male participants view the PAL strategy concerning promoting collaboration.

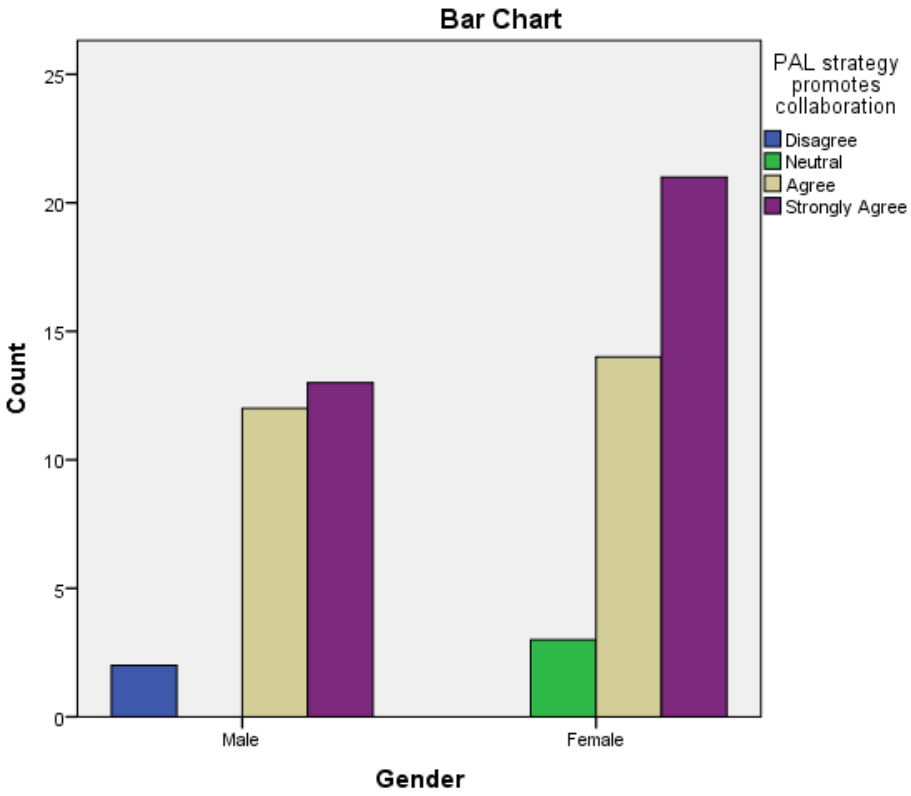

Figure 5.6.3 Bar chart-Collaboration

The findings from the questionnaire suggested that the PAL strategy is an effective way to promote teamwork and collaboration among learners. The results highlight the importance of peer interactions in facilitating teamwork and collaboration. The positive responses from the

majority of the respondents indicated that the PAL strategy has a positive impact on learners' teamwork and collaboration skills.

4.8 Chapter Summary

The study's outcomes illuminate the significant impact of the Peer Assisted Learning (PAL) strategy on fostering learning through the Turning Effect of Force (TEOF). The findings underscore the efficacy of PAL in not only enhancing participation but also positively influencing the motivation and self-concept of the learners involved. By employing the PAL strategy, learners exhibited a noteworthy boost in their overall performance, with a substantial 30-32% improvement, as evidenced by the comparative means of the experimental groups against the control groups.

Furthermore, the PAL strategy proved to be a valuable mnemonic tool, aiding learners in retaining and recalling complex concepts with remarkable efficacy. Impressively, even after a substantial period of 7 months, the experimental groups maintained their performance levels, demonstrating a sustained retention of knowledge compared to their counterparts in the control groups.

Beyond academic achievement, PAL emerged as a catalyst for fostering teamwork and collaboration among learners. The collaborative nature of PAL was reflected in learners' reports of increased ease in solving questions through collective effort. This not only highlights the academic benefits but also underscores the social and interpersonal advantages of implementing PAL as an educational strategy.

CHAPTER FIVE

DISCUSSION OF FINDINGS

5.1 Overview

The previous chapter presented findings on exploring learning of the turning effect of a force **(TEOF)** through the lens of the PAL in selected secondary schools in Kabwe district. This chapter will present a discussion of the findings. The study will refer to the theories and literature presented in the earlier chapters of this study to reflect, confirm and extend the current knowledge base. In presenting the analysis and discussion, the discussion is presented generally under research questions.

5.2 Research Question 1: What is the effect of the Peer-Assisted Learning (PAL) strategy on learners' active engagement in TEOF lessons?

The findings presented in this study align closely with Vygotsky's social constructivism theory (1978), emphasizing the importance of guided and unguided interactions among learners. The study reveals that the Peer-Assisted Learning (PAL) strategy effectively implements Vygotsky's principles, leading to active engagement, knowledge construction, and improved learning outcomes in the context of TEOF.

Vygotsky's theory underscores the collaborative nature of learning, where learners actively participate in constructing their knowledge and sharing it with others. The engagement observed during TEOF lessons, including peer debates and critical thinking, further supports Vygotsky's emphasis on learners actively participating in their learning process.

The study's positive outcomes also echo previous research on collaborative learning, reinforcing the idea that the PAL strategy can be a valuable tool for enhancing student engagement and learning. Gok and Gok (2017) found that collaborative strategy significantly increased conceptual understanding and decreased gender gaps in learning. The evidence presented in this study further substantiates the benefits of PAL, particularly in improving communication skills, confidence, and overall engagement.

Moreover, the study highlights the importance of clear expectations and guidelines for PAL activities. This aligns with Bugaj et al. (2019) and emphasizes the need for a well-structured learning environment to maintain student engagement. Educators are encouraged to provide clear instructions and guidance to ensure the effectiveness of the PAL strategy.

The study's connection to broader research, such as Snyder et al. (2016) and Linton et al. (2014), reinforces the notion that collaborative learning strategies, including PAL, foster meaningful student engagement and the positive impact on learners' active engagement suggests that PAL is a promising approach for promoting collaborative learning, knowledge construction, and improved learning outcomes across different subjects.

The results showed that when the PAL strategy was used, most learners were actively engaged in the TEOF lessons. PAL strategy played a pivotal role in identifying and correcting learners' misconceptions regarding TEOF. Misconceptions about this concept often included difficulties in comprehending the interplay between force, distance, and rotation. Students engaged in open discussions where they challenged and corrected each other's misunderstandings. For instance, peers collaborated to explain that a larger force applied at a shorter distance from the axis of rotation may have the same turning effect as a smaller force applied at a greater distance.

PAL strategy allowed learners to apply torque principles to real-world scenarios. For example, they discussed how wrenches work, where applying force at the end of the wrench handle (increasing the distance) amplifies the turning effect. This practical application reinforces the comprehension of torque and its relationship with force and distance. PAL strategy fostered peer debates and critical thinking. Learners debated the intricacies of torque, such as how changing the angle of force application affects the turning effect. These debates encouraged active engagement as students strived to reconcile their misconceptions with the correct physics principles.

Participants highlighted that working together with peers not only helped to increase engagement but also facilitated the exchange of ideas and knowledge. This finding is consistent with previous research on the benefits of collaborative learning, indicating that the PAL strategy can be a valuable tool for enhancing student engagement and learning (Gok, 2014).

The PAL strategy increased learners' attention during lessons and involvement because they were motivated to see other learners who knew more about TEOF. Each learner participated in at least one or two classes worth of activities, was fully involved in the lessons, and had a chance to express their opinions. It was observed that learners in the experimental groups reported higher levels of engagement and interest in the subject matter compared to those in

the control groups. It can be inferred that about 80% of the participants were unimpressed by non-learner-centred strategies. Since the PAL strategy was used in learner-centred TEOF lessons, learners talked a lot to one another, and as a result, their communication skills improved each time. In sum, it helped most learners' communication skills, particularly those who took the initiative and gave them confidence.

Furthermore, the study revealed that PAL could be particularly effective for students struggling with specific subjects or concepts. Working with peers who better understood the material increased engagement and motivation for these students. This finding supports the notion that PAL can be a valuable intervention for learners at risk of falling behind or disengaging from their studies. Topping and Ehly (2001) conducted comprehensive research on tutoring programs. They found that carefully selected and trained participants and continuous progress monitoring led to improved attitudes, increased interactions, and consistent gains. Although focused on tutoring programs, these findings suggest the broader benefits of peer-assisted strategies such as PAL.

In conclusion, this study provides valuable insights into the effectiveness of the PAL strategy in implementing Vygotsky's social constructivism theory. The PAL strategy emerges as a promising strategy that aligns with contemporary educational principles and has the potential to address challenges related to student disengagement and misconceptions in physics education.

5.3 Research Question 2: How does the PAL strategy impact learners' motivation when learning the TEOF?

The findings from the study underscore the significant impact of the Peer-Assisted Learning (PAL) strategy on learners' motivation and understanding of TEOF concepts. One of the notable observations was the negative effect of misconceptions on learners' motivation, leading to frustration and a perception of physics as challenging. The PAL strategy emerged as a powerful tool to address these challenges, offering a collaborative platform for students to collectively tackle misconceptions.

Through the PAL strategy sessions, learners engaged in peer discussions and shared problem-solving, effectively dismantling misconceptions about TEOF. This collaborative approach not only revitalized their motivation but also enhanced their understanding of the subject matter. Specifically, the study highlights how the PAL strategy allowed learners to test and challenge

misconceptions collectively, leading to a more comprehensive grasp of the role of force magnitude and distance in determining torque.

The positive impact of PAL on motivation was further supported by participants' self-reported feelings of high motivation, as evidenced by their willingness to attend classes and fully participate. The statistical data showing that 90% of learners felt motivated to perform tasks related to TEOF is particularly noteworthy. Additionally, the study revealed that the PAL strategy contributed to higher academic and social self-concept levels in the experimental groups compared to the control group. This emphasizes the role of the PAL strategy in creating a positive learning environment that fosters a sense of belonging and social support.

The alignment of these findings with previous studies, such as those by Gok (2012) and Zingaro (2014), further strengthens the case for the PAL strategy as an effective strategy for improving motivation and self-efficacy. The positive effects on students' problem-solving skills and self-regulated learning, as indicated in the literature, provide additional support for the broader applicability of PAL across various educational contexts.

However, the study also acknowledges concerns raised by participants, such as the time commitment required for the PAL strategy activities and potential unproductive group dynamics during TEOF lessons. These concerns highlight the need for careful management of the PAL strategy implementation to ensure productive and efficient learning experiences. The studies of Fuhr et al. (2014) and Williams et al. (2015) emphasize the importance of addressing potential challenges and optimizing the cost-effectiveness of PAL strategies.

Drawing connections to related studies by Gazula et al. (2017) and Crossley et al. (2016) showcasing the versatility of PAL across different educational domains. These studies further affirm the positive impact of PAL on collaborative learning, student engagement, motivation, and performance. The results

5.4 Research Question 3: What is the effect of the PAL teaching strategy on learners' self-concept?

The findings not only align with existing research but also contribute to a nuanced understanding of how PAL interventions influence various dimensions of self-concept. The findings from this study provided strong evidence for the positive effects of the PAL strategy on learner self-concept. Participants reported that positive feedback from their peers helped improve their self-concept. They felt more confident in their abilities when their peers

acknowledged their strengths and skills the findings which Stone et al. (2013) provide valuable insights into the domain of nursing education, demonstrating that the PAL strategy fosters the development of students' self-confidence. This aligns with Vygotsky's emphasis on the zone of proximal development, where peer support facilitates the achievement of tasks that might be challenging individually.

Gok and Gok's (2017) study is consistent with the present findings and highlights the role of peer instruction within the PAL strategy in enhancing self-concept outcomes. Moreover, the observed significantly higher levels of academic and social self-concept in experimental groups compared to the control group echo the meta-analysis conducted by Ginsburg-Block et al. (2006), emphasizing the positive impact of academic PAL interventions on self-concept.

The studies by Bozzi et al. (2021) and Atasoy et al. (2014) not only corroborate the positive impact on self-concept but also emphasize the effectiveness of integrating PAL activities and technology.

Slavin (2015) adds to the discourse by emphasizing that PAL fosters a sense of belonging, aligning with Vygotsky's notion that social interactions contribute to cognitive development and improved self-concept. Positive reinforcement and support from peers, as facilitated by PAL, directly impact learners' self-concept.

The exposure to diverse perspectives and ideas, as noted by Chan et al. (2016), is consistent with this study’s findings that social interactions with individuals from different backgrounds contribute to the development of identity and self-concept.

This study found that constructive feedback and self-reflection contribute to a more positive and balanced self-concept the findings are similar to the findings of Stigmar (2016) who introduced the element of constructive feedback within PAL and found that there is a positive effect on self-concept.

It was anticipated that learners who engaged in TEOF lessons using the PAL strategy demonstrated improved self-concept, as they witnessed improvements in their ability to apply concepts correctly. Their self-concept in the lessons became more positive as they experienced success in mastering previously challenging material. In conclusion, the PAL strategy fosters a positive learning environment and enhances self-concept.

5.4 Research Question 4: What is the impact of the PAL teaching strategy on learners' performance on TEOF?

There were 131 participants in the study, with 68 females representing 52% and 63 males representing 48%. Solomon's four-group design was employed in this study to assess any potential effects of the testing effect on the study's findings. This effect was not numerically significant, according to the results.

This feature was further investigated by comparing the mean results of learners who did not take the pre-test and those who did within the control and experimental groups. The variation was not statistically significant, even within the experimental or control groups. Since they did not receive any remedial feedback after the pre-test, it is possible that learners were not aware of the correct answers to the questions, which would explain why there was no testing impact. Additionally, learners did not know that the post-test items were the same as the pre-test.

Post-test scores were examined across the four groups, comprising two Experimental groups (Classes 1 and 3) subjected to the PAL strategy and two Control groups (Classes 2 and 4) subjected to the traditional teaching strategy. The F-value obtained from the one-way ANOVA was found to be $F(3, 106) = 115.068$, indicating a statistically significant difference among the groups ($p < 0.05$) the findings are similar to the findings of Okilwa and Shelby (2010) found that peer tutoring had a positive academic effect on students with disabilities in Grades 6 through 12 across subject areas and settings. These findings were further supported by the study conducted by Hager (2018), which found improved grades towards mathematics through PAL among first-year undergraduate students.

Post-hoc tests, employing the Tukey HSD, were subsequently conducted to explore pairwise comparisons. The results of these tests revealed that the post-test scores of Class 1 (84.3 ± 8.4) and Class 3 (82.1 ± 7.1) were significantly higher than those of Class 2 (53.8 ± 7.1) and Class 4 (52.7 ± 8.3) suggesting a positive impact of the PAL strategy on learning outcomes. Notably, there was no significant difference between Classes 1 and 3 (p-value = 0.845). The findings suggest that the PAL strategy implemented in Classes 1 and 3 had a statistically significant and practically meaningful impact on post-test scores compared to the Control groups Gender bias was eliminated because there was no statistically significant variation in scores based on gender in all the groups, which contradicted the study conducted by Eryilmaz (2004), suggesting that gender played a role in the poor achievement of students in physics.

The results found in this study can be supported by the study of Topping and Ehly (1998), which indicated that Peer-Assisted Learning (PAL) groups showed significant improvements in students' mathematical abilities compared to traditional instruction. The positive impact of PAL strategies on learning outcomes is further supported by a meta-analysis conducted by Roscoe and Chi (2007), which found consistent improvements in learning outcomes across various subject areas when PAL was implemented with a structured approach. Similarly, the study by Johnson et al. (1993) conducted a meta-analysis of over 200 studies on cooperative learning, including PAL, and found significant improvements in academic achievement. These findings align with the study by Sharan and Sharan (1994), which revealed that PAL groups led to significant improvements in conceptual understanding of social studies topics. However, Webb and Farivar (1999) also conducted a meta-analysis in higher education and found improved attitudes towards learning but no significant difference in academic achievement. Similarly, Topping (2013) reported improved social skills and attitudes towards learning but no significant difference in academic performance in primary school students.

The null hypothesis (H0), which posited no significant difference in learners' performance on TEOF between the PAL teaching strategy and traditional methods, was rejected. Based on the statistical information given above, the rejection of the null hypothesis indicated that the PAL strategy had a statistically significant positive impact on learners' performance on TEOF. This finding has important implications for educators seeking effective teaching methods to enhance student outcomes.

Furthermore, the study by Litt (2013) examined the impact of PAL on reading achievement and found that PAL was associated with significant improvements in students' reading comprehension skills, particularly for struggling readers. Similarly, Abdullah et al. (2020) found that PAL interventions positively impacted nursing students' academic performance, indicating that PAL can be effective across different disciplines.

In the medical field, Roh (2021) conducted a study on clinical education and found that PAL effectively improved students' critical thinking ability, particularly in analysis and evaluation. PAL interventions have also shown positive effects in higher education. Falchikov and Goldfinch (2000) conducted a meta-analysis that revealed PAL was associated with significant improvements in higher-education students' academic achievement and retention rates.

Similarly, Okilwa and Shelby (2010) noted that not all studies have shown significant differences in academic achievement through the PAL strategy.

In the study of Mueanploy (2016), with a sample size of 72 students who passed in Physic I Course, The control groups learned magnetic fields by Traditional Method (TM), and the experimental groups learned magnetic fields by peer-assisted learning. The students did a pretest before and a post-test after the lesson with 20 items of achievement tests of the magnetic field. The post-test was higher than the pretest achievement significantly at 0.01 level. The study further found that PAL improved students' conceptual understanding of magnetic fields and problem-solving ability. In conclusion, PAL groups greatly enhanced students' conceptual understanding of physics compared to traditional lecture-based instruction. And this aligns with the findings of Dancer et al. (2015), who reported that PAL improved the academic performance of first-year university students in a business course.

While the PAL strategy is an effective teaching strategy in many contexts, the evidence suggests that it may not always lead to improved learning outcomes. Factors such as the subject area, student characteristics, and the implementation of PAL may all influence its effectiveness in improving academic performance. Therefore, it is important for educators to carefully consider the specific context and goals of their instructional practices when selecting teaching strategies such as the PAL strategy. The evidence suggests that the PAL strategy is an effective teaching strategy that can improve learners' performance across various subject areas and educational levels. The collaborative and interactive nature of the PAL strategy appears to be particularly effective in promoting deeper learning and improving learners' understanding of complex concepts. PAL can improve learners' knowledge of course content. When learners work together in pairs or small groups, they can discuss course material and explain concepts to one another. And this can help learners to develop a deeper understanding of the material, improving their academic performance.

The PAL strategy can increase learners' engagement in the learning process. Learners who work collaboratively with their peers are more likely to engage in the learning process actively. And this can lead to increased motivation, effort, and focus, which can improve academic performance. Also, the PAL strategy can help learners to develop problem-solving skills. Learners working in pairs or small groups must identify problems, discuss potential solutions,

and evaluate the effectiveness of different strategies. And this can help learners develop critical thinking and problem-solving skills, improving their academic performance.

The PAL strategy can improve learners' communication skills. When learners work in pairs or small groups, they are required to communicate effectively with one another. And this can help learners to develop communication skills, which can be useful in academic settings and future careers.

The PAL strategy can be applied to various subjects and grade levels, from elementary school to post-secondary education. PAL is particularly effective in improving academic performance in STEM subjects such as math and science. It is a powerful teaching strategy that leverages the strengths of peer collaboration and support to enhance learners' performance and foster a positive learning environment.

Overall, the PAL strategy can positively impact learners' academic performance by improving their understanding of course content, increasing engagement in the learning process, helping them develop problem-solving skills, reducing anxiety and stress, and improving communication skills.

5.5 Research Question 5: What is the effect of PAL on learners' retention of concepts on TEOF?

Participants reported that learning using the PAL strategy helped them retain TEOF concepts better. They felt more engaged in the learning process, actively participating in discussions, asking questions, and applying what they learned in practical ways. This active involvement enhanced their ability to remember the concepts. The use of simplified language by peers also contributed to better retention. Additionally, repetition of the concepts during lessons played a crucial role in reinforcing the information. Participants found that repeated discussions and applications of the concepts helped them internalize and remember the information more effectively.

Participants also reported that learning using the PAL strategy helped them understand the concepts better. Hearing different perspectives from their peers allowed participants to view the information from various angles and gain new insights. Furthermore, receiving feedback from their peers during TEOF lessons helped participants identify areas where they needed improvement and provided alternative ways of thinking about the concepts. Peer feedback

served as a valuable tool for enhancing their comprehension the findings are consistent with the Meta-analysis done by Roseth et al. (2008) which emphasized that the PAL strategy promoted deeper learning and improved the retention of concepts in higher education, which is supported by the study of Topping (2013), whose findings showed the positive effects of PAL on academic achievement and retention across various educational settings.

This study's findings suggest that learning through the PAL strategy positively impacts the retention and understanding of concepts on TEOF. Active learning, repetition, different perspectives, and peer feedback were key to facilitating effective learning through peer interactions. Participants expressed increased engagement and reported the ability to reinforce their learning through discussion, application, and repetition. They also emphasized the value of hearing different perspectives and receiving feedback from their peers, which deepened their understanding of the concepts.

The quantitative results indicate the mean scores for the pre-test in Experimental Group 1 were 42.9, and the post-test 1 score was 84, the post-test 2 score slightly decreased to 83.9. In Control Group 1, the pre-test mean was 41.9, and the post-test 1 score was 53.8. However, the post-test 2 scores decreased further to 45.2. Experimental Group 2 had a mean post-test 1 score of 82.1, which increased slightly to 83.1 in post-test 2. Control Group 2 had a mean post-test 1 score of 52.6, which decreased to 43.9 in post-test 2.

The F-statistic ($F(3,127) = 162.827$, $p < 0.001$) indicated that the PAL strategy had a significant impact on test performance. The post-test results also demonstrated significant differences between the groups ($F(3,127) = 523.263$, $p < 0.001$). Post-hoc tests, specifically Multiple Comparisons, were conducted to analyze the differences between the groups further. The results indicate no significant difference between the two experimental groups based on their mean scores for the post-tests. However, significant differences were found between Experimental Group 1 and Control groups and between Experimental Group 2 and Control groups. Importantly, there was no significant difference between Control Group 1 and Control Group 2.

The control groups, particularly Control Group 1, also showed some improvement in post-test scores compared to their pre-test scores. However, the increase was smaller in magnitude compared to the experimental groups, indicating that the PAL strategy substantially impacted knowledge retention.

There was no significant difference in knowledge retention between Control Group 1 (pre-test and post-test without treatment) and Control Group 2 (post-test only). And this suggests that the absence of a pre-test did not significantly affect knowledge retention.

The second post-test conducted after seven months indicates the durability of the retained knowledge. Although some slight decreases in post-test scores were observed in certain groups, the knowledge acquired through the PAL strategy remained relatively stable over time.

The post hoc tests revealed no significant difference between the two experimental groups, indicating that the PAL strategy had a similar impact on knowledge retention in both cases. And this suggests that the specific variations in the experimental design (pre-test vs. no pre-test) did not significantly affect the PAL strategy's effectiveness in knowledge retention.

The findings highlight the positive impact of Peer-Assisted Learning (PAL) on learners' retention of TEOF concepts.

The study by Freeman et al. (2014) provided additional insights into the effectiveness of PAL strategy in promoting the long-term retention of complex concepts, while Freeman et al. (2014) noted that active learning strategies, including PAL, improved student performance. However, the effect on retention was not statistically significant in their analysis.

The book by Falchikov (2001) provides a comprehensive overview of PAL in higher education and explores its effectiveness in promoting deep learning and improving knowledge retention. It highlights various factors that can influence the success of PAL, such as group composition, peer feedback, and tutor training.

While the majority of the studies support the positive impact of PAL on the retention of concepts, Van de Pol et al. (2010) found that the impact of PAL strategy on knowledge retention varies and is influenced by factors such as learner attributes and the specific nature of the learning task. It is important to consider these factors when implementing PAL strategies.

It should be noted that PAL is not without potential drawbacks. Some studies have highlighted the possibility of students becoming overly reliant on their peers for help, which may hinder independent learning. Unequal participation within groups can also create frustration or resentment among students. Proper facilitation, guidance from instructors, and clear guidelines can help mitigate these issues and ensure the effectiveness of PAL.

The findings discussed provide consistent evidence that PAL is an effective strategy for improving learners' retention of concepts. PAL encourages active engagement, deeper understanding, reinforcement of knowledge, identification of knowledge gaps, and the development of metacognitive skills. Working collaboratively on TEOF enhanced the long-term retention of the concepts. When learners learn from their peers and actively engage in discussions and problem-solving, they are more likely to remember and apply torque principles in future physics studies or practical situations. While there may be some studies with mixed results or no significant effects, the overall consensus supports the positive impact of PAL on retention.

5.6 Research Question 6: What is the impact of PAL on learners' teamwork?

The study found that the PAL strategy positively impacted learners' teamwork. Participants reported that learning using the PAL strategy improved their communication skills, allowing them to express their ideas more clearly, effectively and which is crucial for successful teamwork. It was also found that the PAL strategy had a positive impact on learners' teamwork skills, enhancing their ability to collaborate, communicate effectively, and work cohesively in a team setting which is in agreement with Topping (2013) who observed that PAL strategy improves learners' collaborative abilities, including their capacity to provide and receive feedback and their willingness to assist and support one another.

This study used Vygotsky's social constructivism theory where lessons involved peer teaching, where one student explained a TEOF concept to another. Teaching a concept required a deep understanding of it, and this process helped clarify misconceptions. For example, a learner may correct a peer's misunderstanding of TEOF by explaining the role of the lever arm and force. Moreover, the literature highlights the positive effects of the PAL strategy on learners' social interactions and sense of belonging. Guraya and Abdalla (2020) emphasized the role of PAL in fostering socialization and emotional support among learners. Johnson et al. (2014) found that students participating in PAL reported feeling more connected to their peers and engaged in learning. Narayanan (2021) identified various benefits of PAL, including improved collaboration, communication skills, self-confidence, and socialization. These findings corroborate the current study's results, demonstrating enhanced teamwork skills resulting from the PAL strategy. The study by Karau and Williams (1993) argued the earlier findings and reported a peer-led strategy to promote social loafing in group tasks where individual efforts

are less visible in a team setting, learners are more likely to exert less effort, leading to decreased collaboration and compromised teamwork, some learners may actively contribute, while others might rely more on their peers.

This study's findings align with several previous studies that have examined the impact of the PAL strategy on learners' teamwork, Falchikov and Goldfinch (2000) found that PAL improved learners' collaborative skills, communication abilities, and sense of responsibility towards their peers. Brierley et al. (2022) reported that the PAL strategy enhanced learners' communication, interpersonal, and problem-solving skills, which are crucial for effective teamwork.

This study and other studies generally support the positive impact of the PAL strategy on learners' teamwork and collaboration skills. Acknowledging the potential challenges and negative effects of the strategy is essential. For example, the study by Michaelsen et al. (2002) explored the impact of team-based learning on learners' collaboration. It highlighted that weaker team members may defer decision-making and problem-solving responsibilities to the more dominant individuals, resulting in reduced active participation and limited development of teamwork skills

Topping (2013) highlights PAL's role in creating a supportive learning environment, contributing to positive social interactions. This social support, according to Vygotsky, is integral to the internalization of knowledge and the development of a positive self-concept.

5.7 Research Question 7: How does the PAL strategy affect learners' collaboration when learning the TEOF?

This study found that the PAL strategy contributed to enhanced communication skills among learners, improved verbal and non-verbal communication, active listening, and the ability to express ideas clearly. The participants reported that the PAL strategy led to an increase in peer interaction both inside and outside of the learning environment, and learners developed a sense of belonging, trust, and mutual respect within their peer groups. Collaborating with peers from diverse backgrounds increased learners' cultural and diversity awareness.

The participants also reported that exposure to different perspectives and experiences enriched the collaborative learning environment. Some learners face challenges in adapting to collaborative learning environments, issues such as conflicts, unequal participation, or communication difficulties might arise, and increased ability to collectively analyze and solve

TEOF problems as a team which conforms with the study of Mercer and Littleton (2007) highlighted the possibility of unequal participation and learning opportunities, with some learners dominating group discussions while others may be less engaged or have limited opportunities to contribute. In collaborative settings, learners identified and corrected each other's errors and misconceptions regarding TEOF. When a team member made a mistake in their TEOF calculation, for instance, others pointed it out and explained the correct approach. This process helped in error recognition and correction, leading to improved accuracy in understanding TEOF. Johnson et al. (2014) warned about conflicts that may arise among learners with different learning styles or personalities, potentially hindering the effectiveness of group work. Additionally, some studies have shown that PAL may lead to overdependence on peers for guidance and support, impeding independent thinking and critical reasoning (Topping et al., 2017).

However, it is important to note that potential negative impacts are also associated with the PAL strategy. Collaborative problem-solving related to TEOF can be challenging, but it encourages learners to think critically and apply their knowledge. Working together, learners tackled complex TEOF problems, breaking them down into manageable steps and discussing strategies for solving them. Many studies have recorded the positive effect of the PAL strategy, but the study by Veenman et al. (2006) examined the impact of cooperative learning on learners' group interactions.

When learners work together, they communicate effectively, listen actively, and provide feedback to one another.

The PAL strategy can enhance learners' social skills. Working in pairs or small groups can help learners develop social skills such as empathy, active listening, and the ability to give and receive feedback. These skills are essential for building positive relationships and effective collaboration.

When learners are actively involved in their learning, they are more likely to be motivated and engaged in the learning process. And this can lead to increased participation and collaboration in group work. The PAL strategy promoted equal participation among learners. Learners in pairs or small groups are encouraged to take turns as tutors and tutees. And this helped ensure that all learners have an equal opportunity to participate in group work and contribute to the learning process. The PAL strategy helped reduce learners' anxiety and stress levels. Learners

who work collaboratively with their peers feel more supported and less isolated. And this helped reduce anxiety and stress levels, in turn improving academic performance which is in line with the study of Dumitrescu et al. (2014) findings.

The study by Johnson et al., (2014) explored the effects of peer assisted learning on collaboration in a college classroom setting. The findings showed that students who participated in peer assisted learning reported higher levels of collaboration, including increased communication and teamwork skills. Another study conducted by Zhang and Maconochie (2022) investigated the impact of peer assisted learning on collaboration. The study found that students who engaged in PAL demonstrated improved collaboration skills, such as cooperating with others, sharing ideas, and resolving conflicts. Furthermore, research by Harney et al. (2017) highlighted the development of a PAL strategy in computer-supported collaborative learning environments for elementary school students. The study found that the PAL strategy enhanced collaboration among students, promoting effective communication and cooperation. Similarly, a study by Tenenbaum (2020) explored the effects of intelligent peer tutoring on the quality of students' collaborative and perceived support interactions. The results indicated a significant improvement in collaboration compared to non-adaptive modalities. These findings suggest that the PAL strategy is an effective strategy for promoting collaboration among learners in various educational contexts.

5.7 Chapter Summary

Peer-assisted learning (PAL) is an instructional strategy where learners work together in pairs or small groups to teach and learn from each other. In this strategy, learners can actively participate in their learning by working collaboratively with their peers. PAL strategy can take many forms, including peer tutoring, peer mentoring, and cooperative learning. In peer tutoring, one student takes on the role of a tutor while the other takes on the part of a tutee. The tutor provides support and guidance to the tutee, helping them to master the material. In peer mentoring, students work together to develop skills or knowledge in a particular area. In cooperative learning, students work in small groups to complete a task or solve a problem.

This study showed that the PAL strategy enhanced learning of TEOF by allowing learners to explain and discuss ideas with their peers. And this helped them to understand the material and identify areas where they were struggling. Additionally, peers teaching other peers helped

solidify their understanding of TEOF. It was also noticed that there was increased engagement, and the PAL strategy increased learners' attention by allowing them to take an active role in the learning process. Working with their peers made learning of TEOF more enjoyable and interactive, giving learners ownership and responsibility.

The PAL strategy positively affected learners' retention of concepts by helping them to develop a deeper understanding of concepts, reinforce their knowledge, identify gaps in their knowledge, engage in active learning, and develop metacognitive skills.

It also positively impacted student motivation and self-concept across various age groups and academic settings. The benefits of PAL on TEOF included improved academic performance of learners by improving their understanding of course content, increasing engagement in the learning process, helping them to develop problem-solving skills, reducing anxiety and stress levels, and improving communication skills. It has also been shown to be an effective strategy for promoting inclusivity and reducing achievement gaps among students from different backgrounds. PAL strategy has been shown to positively impact learners' teamwork and collaboration skills, as well as their motivation, engagement, and social-emotional development.

The PAL strategy helped learners develop important social skills like communication, collaboration, and teamwork. By working together, learners learned to listen to one another, express their ideas clearly, and provide constructive feedback to their peers.

The PAL strategy also has several demerits, such as unequal participation. It is a potential drawback of the PAL strategy in that some learners may dominate the discussion while others may not contribute as much. And this can lead to unequal participation and may impact some learners' learning quality. The PAL strategy may not be suitable for all subjects or topics, particularly those that require a high level of technical expertise. For example, issues like advanced physics may be difficult to teach effectively through PAL. It can lead to the spread of misinformation if learners do not have accurate knowledge of the subject matter. However, this can be mitigated by ensuring learners access authentic resources and providing guidance and feedback as needed.

The PAL strategy may be time-consuming, requiring learners to work together and understand the content before they teach others, which may take longer than individual learning. Lack of accountability: In some cases, PAL may not provide the necessary responsibility for individual student performance, which may affect grading or assessment.

Overall, the PAL strategy has a positive impact on learners' academic performance by improving their understanding of course content, increasing engagement in the learning process, improving retention of concepts, promoting learners' teamwork and collaboration and promoting motivation and self-concept, helping them to develop problem-solving skills, reducing anxiety and stress levels, and improving communication skills.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

Science educators are continuously exploring strategies to enhance learners' abilities. One such strategy is Peer-Assisted Learning (PAL), which involves students working together in pairs or small groups to support and improve their learning experiences. This study explored the learning of TEOF through the lens of the PAL strategy.

This chapter will begin by concluding the findings, and then the contribution to the field from the conclusions provided. Recommendations will be made for educators and practitioners based on the study's findings. Lastly, further research will be suggested to advance the field.

6.2 Conclusion

Learners grapple with the intricate concept of TEOF, primarily due to persistent misconceptions that obstruct their ability to effectively apply this concept in problem-solving. These misconceptions extend to their interpretations of pivotal torque-related notions, particularly their struggles in comprehending the intricate relationship between force, distance, and the resultant rotational effects. Often, they falter in distinguishing between the magnitudes of forces applied at various distances from an axis of rotation, leading to erroneous predictions regarding the ensuing turning effect. Additionally, a common misunderstanding prevails wherein learners mistakenly assume that a greater force inherently yields a more substantial turning effect, neglecting the crucial role played by the distance factor.

However, the implementation of the PAL strategy yielded promising results. It not only contributed to improved test scores but also played a pivotal role in diminishing misconceptions and fostering increased engagement within the learning process. The peer-to-peer dynamic facilitated a mutual reinforcement of comprehension when students explained concepts to one another, elevating the clarity and depth of their understanding. Furthermore, this collaborative approach encouraged critical thinking and the practical application of their knowledge. As students collaborated to dissect complex TEOF problems into manageable steps, their confidence grew, leading to heightened participation.

Crucially, PAL strategy lessons incorporated real-world applications of TEOF, involving tasks such as designing simple machines and tackling practical engineering challenges. This contextualization enabled learners to appreciate the relevance and applicability of TEOF

principles, imbuing the learning experience with a sense of meaning and purpose. When learners engage in peer-led discussions and problem-solving activities, they are more likely to retain and effectively apply TEOF principles in subsequent physics studies or practical, real-life situations.

The study examined the extent of learners' active engagement in lessons on TEOF when the Peer-Assisted Learning (PAL) strategy was implemented. The findings demonstrated that the PAL strategy effectively promoted learner engagement and resulted in increased participation and expression of opinions. Learners in the experimental groups reported higher concentration and interest levels than those in the control groups. Additionally, PAL was particularly beneficial for students struggling with specific subjects or concepts, increasing their engagement and learning motivation.

The study also demonstrates that the PAL teaching strategy positively impacts learners' motivation and self-concept. The study employed multiple instruments, including focus group discussions, questionnaires, lesson observation schedules, and achievement tests, to gather qualitative and quantitative data. The focus group discussions revealed that learners felt highly motivated and engaged when the PAL strategy was implemented. The questionnaire responses further supported these findings, showing that the PAL strategy motivated learners to perform tasks and increased their interest in TEOF. Moreover, the study found that the experimental groups had higher academic self-concept and social self-concept levels than the control group. Participants also reported improved communication skills and increased collaboration with peers. However, concerns were raised about the time commitment required for the program and potential unproductive group dynamics.

Based on the study's findings, it can be concluded that the PAL teaching strategy significantly positively impacts learners' performance on the TEOF. The experimental groups receiving PAL intervention showed higher post-test scores than the control groups receiving traditional instruction. This performance improvement was consistent across different age groups and genders, indicating that the PAL strategy is effective regardless of these factors. The results of this study align with previous research that has shown the positive impact of PAL strategies on learning outcomes in various subject areas.

The study findings also indicate that using Peer-Assisted Learning (PAL) positively affects learners' retention of concepts on TEOF. The qualitative analysis revealed two main themes:

improved retention and understanding of concepts. Active learning, repetition, different perspectives, and peer feedback were key to facilitating effective learning through peer interactions. The quantitative results using Solomon's four-group design further supported the positive impact of PAL on test performance and knowledge retention. The control groups showed smaller improvements than the experimental groups, highlighting the effectiveness of the PAL strategy. The durability of the retained knowledge was demonstrated through the second post-test conducted after seven months.

In conclusion, the study's findings indicate that the Peer-Assisted Learning (PAL) strategy positively impacts learners' teamwork and collaboration skills. The qualitative analysis identified improved teamwork skills in terms of communication and coordination and enhanced collaboration skills in terms of shared responsibility and interdependence. These findings were further supported by the quantitative data collected through a Likert-type scale questionnaire.

6.3 Contribution to the Field

This study contributes to the field by revealing the effectiveness of the PAL strategy in promoting learner engagement and improving learning outcomes on TEOF. It provides empirical evidence on the effectiveness of the PAL teaching strategy in improving learner performance on TEOF, motivation, self-concept and retention of physics concepts which were previously not well documented in the Zambian context.

6.4 Recommendations

i. Science educators should consider incorporating the PAL strategy in their teaching practices to foster teamwork and collaboration among learners, providing opportunities for students to work in small groups, which can enhance their communication skills, coordination abilities, shared responsibility, and interdependence.

ii. Educators must ensure that learners have clear instructions and guidance for PAL activities. And this will help maintain focus and productivity during collaborative learning sessions.

iii. Careful selection and training of participants involved as peer teachers can enhance its effectiveness. Educators should identify students who better understand the material and equip them with the skills to facilitate peer learning.

iv. Integrating peer assessment into PAL activities can further enhance learner engagement and collaboration. Educators should explore peer assessment as a tool for feedback and self-reflection.

v. Educators and practitioners should consider implementing the PAL teaching strategy to enhance learner motivation and self-concept.

vi. Educators should consider incorporating the PAL teaching strategy into their instructional practices, particularly in STEM subjects such as physics and mathematics. PAL can be a powerful tool for enhancing learners' understanding of complex concepts and improving their academic performance

vii. Schools and educational institutions should create a supportive and collaborative learning environment that encourages the PAL strategy to thrive.

6.5 Further research

i. Future research should explore the potential benefits of the PAL strategy for different learner populations, including students with diverse backgrounds and abilities. And this will help identify the applicability and effectiveness of PAL across various educational contexts.

ii. Investigating the long-term impact of PAL on learners' engagement and learning outcomes would provide a comprehensive understanding of its effectiveness. Longitudinal studies can assess the sustainability and lasting effects of PAL implementation.

iii. Future studies could investigate the long-term effects of PAL on learners' teamwork and collaboration skills. Tracking students' progress over an extended period would provide a better understanding of how PAL influences their abilities beyond immediate outcomes.

iv. Conducting comparative studies between PAL strategies and other teaching strategies could shed light on PAL's unique advantages and limitations in promoting teamwork and collaboration, learner engagement, retention of concepts and learner performance. And this would help educators make informed decisions about the most appropriate instructional approaches for specific learning goals.

v. Investigating the factors that influence the effectiveness of PAL strategies, such as group size, composition, and instructional support, would contribute to optimizing the implementation of PAL in educational settings.

vi. Exploring the impact of PAL on other dimensions of motivation, such as intrinsic motivation and self-regulation.

vii. Examining the role of technology in facilitating PAL strategies and its impact on motivation and self-concept.

viii. Investigating the long-term effects of PAL on learners' academic performance and knowledge retention. Longitudinal studies can provide insights into the sustainability of PAL interventions and their impact on learners' long-term learning outcomes.

ix. Exploring the role of different instructional variables, such as group size, composition, and task design, in influencing the effectiveness of PAL. By examining these factors, researchers can identify the optimal conditions for implementing PAL strategies.

x. Examining the transferability of PAL skills to real-world contexts and future careers. Research focusing on applying PAL skills in professional settings can shed light on the broader benefits of this teaching strategy beyond academic performance.

xi. Investigating the optimal design of PAL activities, including group composition, peer feedback mechanisms, and tutor training. Identifying the key factors contributing to PAL's effectiveness can inform instructional practices and enhance its impact on retention.

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APPENDICES

Appendix 1: Consent Form for Learners

Research Title: Exploring the effects of peer assisted learning strategy on grade 10 pupils' learning of turning effect of a force in selected secondary schools of Kabwe district

Researcher: Mr H.M Fungamwango. PhD Student, University of Zambia

Cell Number: 0979524179, email; fungamwangohashel@gmail.com

Introduction:

You are invited to participate in a research study titled "Exploring the effects of peer assisted learning strategy on grade 10 pupils' learning of turning effect of a force in selected secondary schools of Kabwe district'', your participation in this study is voluntary, and this consent form provides information about the study's purpose, procedures, potential risks, and benefits. Please take the time to read this form thoroughly and ask any questions you may have before deciding whether to participate.

Purpose of the Study:

The purpose of the study was to explore the effects of peer assisted learning strategy on grade 10 pupils' learning of TEOF in selected secondary schools of Kabwe District.

Procedures:

If you agree to participate in this study, you will be asked to engage in lessons on TEOF using the PAL strategy with other participants. This strategy may involve working in small groups to complete tasks, solve problems, or teach your friends as a peer teacher. Participation will include engaging in discussions, sharing ideas, and collaborating with peers. The duration of your involvement in the study will depend on the specific activities assigned.

i. Write the tests on the Turning Effect of a Force
ii. Participate in the focus group discussion
iii. Respond to statements in the questionnaire
iv. Volunteer to be a peer teacher.

Potential Risks and Benefits:

Learning TEOF using the PAL strategy poses minimal risks. However, you may experience slight discomfort or disagreement during group discussions or encounter challenges related to working collaboratively. We will ensure a supportive and respectful environment throughout the study.

The potential benefits of participating in this study include enhancing your teamwork and collaboration skills, improving your communication and coordination abilities, developing a better understanding of shared responsibility and interdependence, and learning the topic of TEOF. Your participation will also contribute to advancing knowledge in physics education.

Confidentiality:

Your privacy and confidentiality are of utmost importance. All data collected during this study will be anonymized and securely stored. Only the research team will have access to the data, which will be used solely for research purposes. Any reports or publications from this study will not contain identifiable information.

Voluntary Participation and Withdrawal:

Participation in this study is voluntary, and you have the right to withdraw at any time without penalty or loss of benefits to which you are otherwise entitled. If you choose to withdraw, any data collected up to that point will be retained but not included in the analysis.

Contact Information:

If you have any questions or concerns about this study, you may contact the principal researcher, Fungamwango Hashel M, at fungamwangohashel@gmail.com or call +260979524179. If you have any questions regarding your rights as a participant, you may contact the University of Zambia Ethics Committee.

By signing below, you confirm that:

- You have read and understood the information provided in this consent form.
- You voluntarily agree to participate in the study.
- You understand that you may withdraw from the study without penalty.
- You acknowledge that any data collected during the study will be used for research purposes only and will remain confidential.

I’m interested in participating in this study, and the following are my details:

Name:……..……..……

School:…….…….……...…….

Cell:……..…….

Email address:……...

Signature:……..

Date:……..

.

Appendix 2. Research tools (Questionnaires, Lesson observation schedules, Focus group discussion questions, achievement tests and tutorial questions)

Participant Questionnaire

Instructions:

Please tick [✓] in the box next to the answer of your choice or write in the space provided as the case may be.

Sex

Male ☐ Female ☐

Age

14-15 ☐ 16-17 ☐ 18-19 ☐ Above 20 ☐

1. Please tick the box next to the answer of your choice [✓]. Which of the following teaching strategies are you familiar with?

NO	Teaching Strategy	Definition of the teaching strategy	Tick
a	Collaborative learning/Cooperative learning	Learners work together in groups to solve problems and complete tasks	
b	Inquiry-based learning	Learners learn by asking questions, and problems learners can investigate independently, exploring and reporting what they see.	
c	Project-based learning	Learners learn by producing personally meaningful projects over an extended period.	
d	Flipped classroom	Learners first engage the content online (through readings and video lectures) and then come to class for guided practice.	
e	Lecture or Direct instruction	It is a teacher-centred strategy used to provide information to the learners. Learners listen and write notes as the teacher is teaching.	

2. If there are any strategies that you know and are not in question 1, please state them, and if you do not know any, skip to question 3.

……
……
……

3. **Instructions**:

For each statement, please check whether you Strongly Agree, Disagree, or Strongly agree.

Disagree by ticking the box. ☑

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
PAL strategy is more demanding than other strategies for teaching					
PAL strategy is more interesting than other strategies for teaching					
Learners are more actively engaged in the lessons when using the PAL strategy than other strategies for teaching.					
PAL strategy is more motivating than other strategies for teaching					
PAL strategy enables learners to improve Communication skills					
PAL strategy promotes teamwork					
PAL strategy promotes collaboration					
PAL strategy enables learners to improve their research skills					
PAL strategy promotes the exploration of ideas					

4. Do you think PAL helped you remember more physics concepts you learned?

Yes ☐ No ☐

5. Did you participate in teaching your fellow learners?

Yes ☐ No ☐

If yes to question 5 please proceed to answer 5(i) and 5(ii) and if no skip to question 6;

5 (i) How was your experience?

……
……
……
……

5 (ii) 'Teaching is learning twice', did you learn twice, explain.

……
……
……
……

6. How was your experience learning from your peers?

……
……
……
……

7. Has your confidence in physics improved after learning using the PAL strategy?

……

End of questionnaire

Researcher's Focus Group Discussion Guide

Engagement questions

1. Describe how you learn physics or the activities during a physics lesson. (What is the common teaching strategy used by your teacher of physics?)

2. What is your experience with how your teacher teaches you? Do you like how you learn?

3. What do you think of the PAL strategy?

Exploration questions

4. Are learners actively engaged in the lessons when using the PAL strategy?

5. Does the PAL strategy affect learners' motivation and self-concept? If so, how?

6. Does the PAL strategy help learners perform better in physics? Explain

7. Do you think PAL affects student retention of concepts/ Did PAL assist you to remember concepts on the turning effect of the force?

8. Do you think the PAL strategy improves communication skills, teamwork, collaboration and exploration of ideas of the learners?

Exit Question

Is there anything else you would like to say about what you feel about PAL?

5.3 Researcher's Lesson Observation Schedule

Observe the classroom environment, teacher behaviour, learner participation and interaction as in the following given elements and mark according to their occurrences.

4 = Very Good 3 = Good 2 = Fair 1 = Bad

No.	Element observed				
1	Learning Objectives: Were the learning objectives clear and achievable for the learners?				
2	The peer teacher's ability to scaffold the learning process for learners				
3	Assessment for learning: Were the assessment methods appropriate and effective for evaluating knowledge?				
4	Engagement: Were learners actively engaged in the lesson?				
5	Collaboration: Did learners work well together in pairs or groups?				
6	Confidence of the peer teacher				
7	Reflection: Did learners reflect on their learning and peer learning experiences				
8	Learners respect fellow learners by considering their points of view.				
9	Quality of differentiation, particularly for learners who have specific learning difficulties				
10	Motivation: Did learners show interest in the learning?				
11	Self-concept: Learner's ability to explain concepts of TEOF.				
12	Retention: Learners remember what they learnt on TEOF by responding to the peer teacher's questions after the lesson				

Achievement Test on TEOF

Identification no: ……

Circle the correct answer.

1. The torque depends upon
   A. force only B. Moment arm only
   C. Mass D. Force and momentum arm
2. If, after a slight tilt, the body returns to its previous equilibrium, then it is said to be in
   A. Zero equilibrium B. Stable equilibrium
   C. Unstable equilibrium D. Neutral equilibrium
3. A force of 120 N is applied perpendicularly on a spanner at a distance of 9 cm from a nut. The torque produced by the force will be
   A. 12 Nm B. 10.8 Nm C. 15 Nm D. 12.59 Nm
4. A nut has been tightened by a force of 180 N using an 8 cm long spanner. What length of a spanner is required to loosen the same nut with 150 N force
   A. 11 cm B. 8.5 cm C. 9.6 cm D. 10.9 cm
5. If the net force acting on the body is zero, then the body is said to be
   A. Imbalanced B. Balanced C. In equilibrium D. Not in equilibrium
6. If, after a slight tilt, the body does not return to its previous equilibrium, then it is said to be in
   A. Unstable equilibrium B. Stable equilibrium
   B. Zero equilibrium D. Neutral equilibrium
7. The Greek letter used for summation is
   A. $\sum$ B. μ C. π D. ω
8. If the force 'F' is multiplied by the arm 'L', we get
   A. Momentum B. Distance C. Torque/moment D. Inertia
9. The steering of a car has a radius of 15 cm. The torque produced by a couple of 40 N will be
   A. 12 Nm B. 10.8 Nm C. 15 Nm D. 12.59 Nm
10. The moment arm is the…..
    A. Parallel distance B. Perpendicular distance
    C. Normal distance D. Resultant force

11. If the sum of clockwise moments acting on a body is equal to the sum of anticlockwise moments acting on it, then the body is

A. Balanced B. Unbalanced C. Rigid D. Flexible

12. If the force is applied at the centre of mass, then torque is

A. Maximum B. zero C. 1 D. Infinity

13. The turning effect of a force is called the force's

A. Momentum B. Distance C. Torque/moment D. Inertia

14. The door is opened or closed due to the

A. Weight B. Turning effect on it C. Distance from roof D. height

15. Two children sitting on a see-saw are not swinging. The net torque is

A. Greater than 1 B. Less than 1 C. Zero D. Infinite

16. A couple is produced by

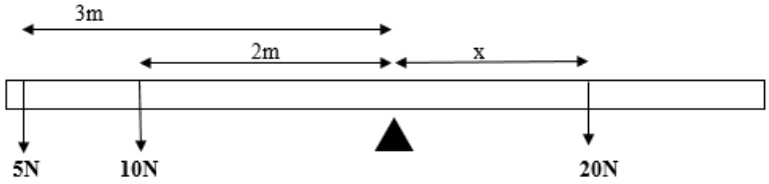
A. One unlike parallel force B. Two unlike parallel forces

C. Like parallel force D. Two alike parallel force

17. If A and B are the endpoints of a spanner and force applied is F, then the torque of the couple is equal to

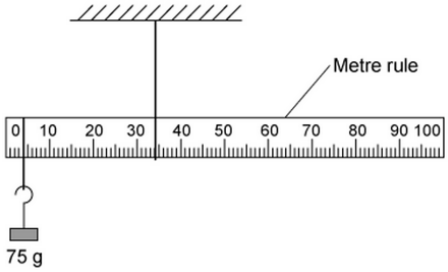
A. F – AB B. F/ AB C. F × AB D. F + AB

18. A light (weightless) bar is pivoted at its centre, and weights of 5N and 10N, 3m and 2m from the pivot on one side. How far is the 20N weight from the pivot?



A. 1.57 B. 35 C. 20 D. 1.75

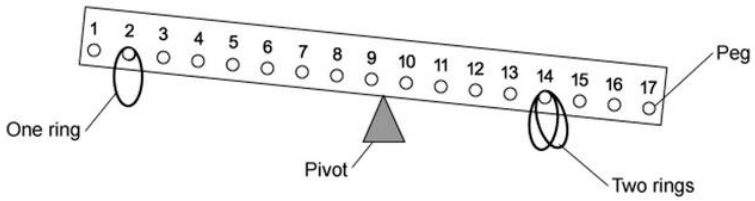
19. A uniform metre rule is hung from the ceiling, as shown.



The rule balances when a 75g mass is hung from one end of the ruler. What is the mass of the metre rule?

A. 38g B. 51g C. 141g D. 159g

20. The diagram shows a child's balancing game.



The wooden rod is uniform, and all the rings are of equal mass. Two rings are hung on peg 14 and one on peg 2. On which hook must a fourth ring be hung in order to balance the rod?

A. 2 B. 3 C. 5 D. 6

The end

Tutorial Questions

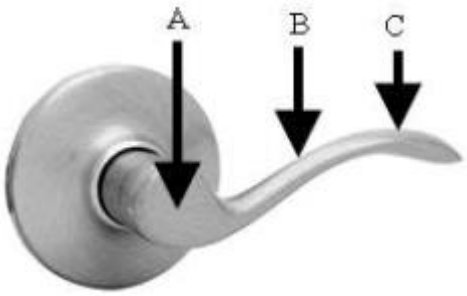
Question 1

The door handle is an application of a lever. The labels and arrows show three points.

Which of the points A, B or C represent

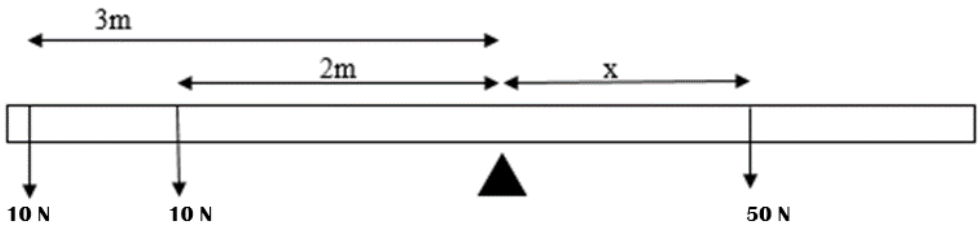
(i) The fulcrum (turning point)

(ii) The point where the smallest force will open the door lock.



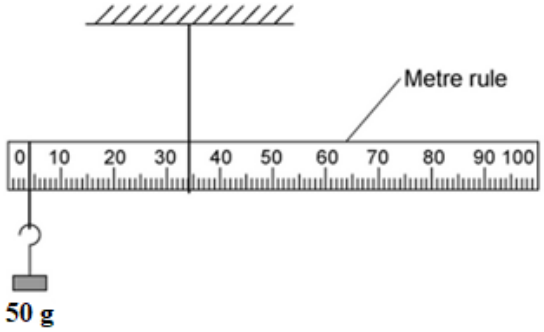
Question 2:

Find the value of distance x in the diagram



Question 3

A uniform metre rule is hung from the ceiling as shown below, the rule balances when a 50g mass is hung from one end of the ruler, what is the mass of the metre rule?



Question 4

Describe the concept of a moment arm in the context of torque. How does changing the length of the moment arm affect torque?

Question 5

Can you explain how the distribution of weight in an object affects its stability and tendency to topple over?

Question 6

A 5-meter-long seesaw is balanced with two children sitting on it. One child, weighing 40 kg, sits 2 meters from the fulcrum. The other child, weighing 60 kg, sits on the other side. How far from the fulcrum should the second child sit to balance the seesaw?

Question 7

A lever is used to lift a heavy object. If a force of 200 Newtons is applied at one end of a 1.5-meter-long lever, and the other end is used to lift a load, what is the weight of the load that can be lifted?

The end

Appendix 3: Ethical Clearance

THE UNIVERSITY OF ZAMBIA
DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

Great East Road Campus | P.O. Box 32379 | Lusaka10101 | Tel: +260-211-290 258/291 777 Fax: (+260)-211-290 258/253 952 | E-mail: director.drgs@unza.zm | Website: www.unza.zm

APPROVAL OF STUDY

IORG No. 0005376
HSSREC IRB No. 00006464

6th September, 2022

REF NO. HSSREC-2022-JUL-052

Funganwango Hashel Mwansa
The University of Zambia
P.O. Box 32379
LUSAKA

Dear Mr. Mwansa,

RE: "EXPLORING THE LEARNING OF TURNING EFFECTS OF A FORCE THROUGH THE LENS OF PEER ASSISTED LEARNING STRATEGY IN SELECTED SECONDARY SCHOOLS OF KABWE DISTRICT"

Reference is made to your submission of the protocol captioned above. The HSSREC resolved to approve this study and your participation as Principal Investigator for a period of one year.

REVIEW TYPE	ORDINARY REVIEW	APPROVAL NO. HSSREC-2022-JUL-052
Approval and Expiry Date	Approval Date: 6th September, 2023	Expiry Date: 5th September, 2023
Protocol Version and Date	Version - Nil.	5th September, 2023
Information Sheet, Consent Forms and Dates	☐ English.	To be provided
Consent form ID and Date	Version - Nil	To be provided
Recruitment Materials	Nil	Nil
Other Study Documents	Questionnaire.	
Number of Participants Approved for Study		

Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

CONDITIONS OF APPROVAL

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to HSSREC within 5 days.
- All protocol modifications must be approved by HSSREC prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to HSSREC within 5 working days.
- All recruitment materials must be approved by HSSREC prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. HSSREC will only approve a study for a period of 12 months.
- It is the responsibility of the PI to renew his/her ethics approval through a renewal application to HSSREC.
- Where the PI desires to extend the study after expiry of the study period, documents for study extension must be received by HSSREC at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Documents received within 30 days after expiry will be labelled "late submissions" and will incur a penalty fee of K500.00. No study shall be renewed whose documents are submitted for renewal 30 days after expiry of the certificate.
- Every 6 (six) months a progress report form supplied by The University of Zambia Humanities and Social Sciences Research Ethics Committee as an IRB must be filled in and submitted to us. There is a penalty of K500.00 for failure to submit the report.
- When closing a project, the PI is responsible for notifying, in writing or using the Research Ethics and Management Online (REMO), both HSSREC and the National Health Research Authority (NHRA) when ethics certification is no longer required for a project.
- In order to close an approved study, a Closing Report must be submitted in writing or through the REMO system. A Closing Report should be filed when data collection has ended and the study team will no longer be using human participants or animals or secondary data or have any direct or indirect contact with the research participants or animals for the study.
- Filing a closing report (rather than just letting your approval lapse) is important as it assists HSSREC in efficiently tracking and reporting on projects. Note that some funding agencies and sponsors require a notice of closure from the IRB which had approved the study and can only be generated after the Closing Report has been filed.

- A reprint of this letter shall be done at a fee.

- All protocol modifications must be approved by HSSREC by way of an application for an amendment prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address or methodology and methods. Many modifications entail minimal risk adjustments to a protocol and/or consent form and can be made on an Expedited basis (via the IRB Chair). Some examples are: format changes, correcting spelling errors, adding key personnel, minor changes to questionnaires, recruiting and changes, and so forth. Other, more substantive changes, especially those that may alter the risk-benefit ratio, may require Full Board review. In all cases, except where noted above regarding subject safety, any changes to any protocol document or procedure must first be approved by HSSREC before they can be implemented.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of HSSREC, we would like to wish you all the success as you carry out your study.

Yours faithfully,

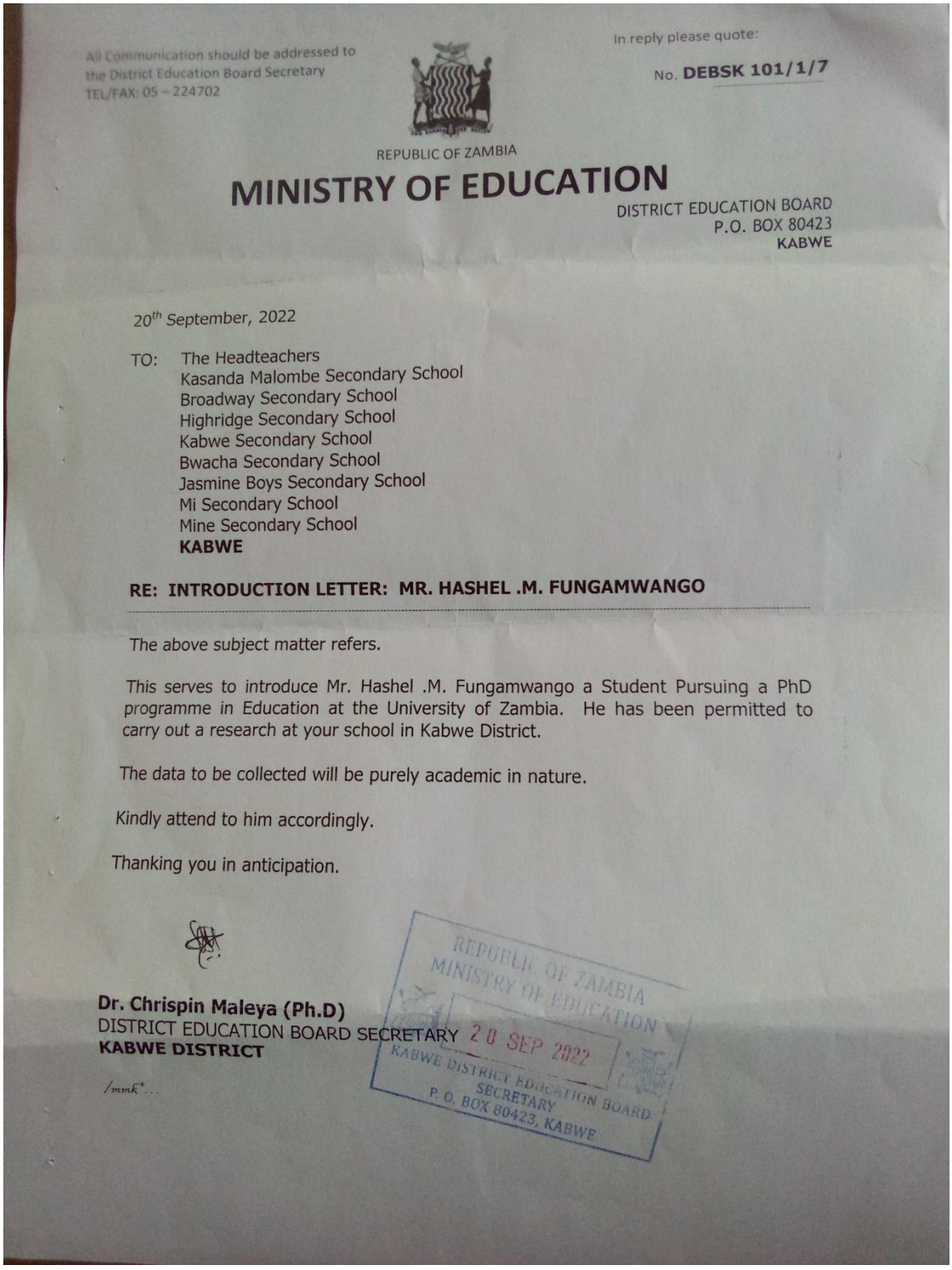
Dr. J.I. Ziwa

DR. J. I. Ziwa

ACTING CHAIRPERSON
THE UNIVERSITY OF ZAMBIA HUMANITIES AND
SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE - IRB

cc: Director, Directorate of Research and Graduate Studies
Assistant Director (Research), Directorate of Research and Graduate Studies Assistant
Registrar (Research), Directorate of Research and Graduate Studies

Appendix 4 Introductory letter from the District Education Office



All Communication should be addressed to
the District Education Board Secretary
TEL/FAX: 05 – 224702

In reply please quote:

No. DEBSK 101/1/7

REPUBLIC OF ZAMBIA

MINISTRY OF EDUCATION

DISTRICT EDUCATION BOARD
P.O. BOX 80423
KABWE

20th September, 2022

TO: The Headteachers
Kasanda Malombe Secondary School
Broadway Secondary School
Highridge Secondary School
Kabwe Secondary School
Bwacha Secondary School
Jasmine Boys Secondary School
Mi Secondary School
Mine Secondary School
KABWE

RE: INTRODUCTION LETTER: MR. HASHEL .M. FUNGAMWANGO

The above subject matter refers.

This serves to introduce Mr. Hashel .M. Fungamwango a Student Pursuing a PhD programme in Education at the University of Zambia. He has been permitted to carry out a research at your school in Kabwe District.

The data to be collected will be purely academic in nature.

Kindly attend to him accordingly.

Thanking you in anticipation.

REPUBLIC OF ZAMBIA
MINISTRY OF EDUCATION
20 SEP 2022
KABWE DISTRICT EDUCATION BOARD
SECRETARY
P. O. BOX 80423, KABWE

Dr. Chrispin Maleya (Ph.D)
DISTRICT EDUCATION BOARD SECRETARY
KABWE DISTRICT

/mmk*...