Learners' Active Engagement During Lessons on the Turning Effect of a Force (TEOF): The Impact of the Peer-Assisted Learning (PAL) Strategy.

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ABSTRACT

Physics learners encounter challenges in understanding the Turning Effect of a Force (TEOF) despite its real-world applications. Furthermore, learners in ordinary-level physics are not fully engaged in lessons due to the perpetual use of traditional teaching strategies. The purpose of this study was to examine the effectiveness of the Peer-Assisted Learning (PAL) strategy on learners' active engagement during lessons on TEOF in which a qualitative approach was used with Solomon four group and Quasi-experimental designs. Through simple and purposive sampling there were 131 learners from four secondary schools in Kabwe district were chosen. Focus group discussion guide, questionnaires and lesson observation schedules were used to collect the data and analyzed thematically. The results showed that the experimental groups had a significantly higher level of active engagement in the lessons compared to the control groups. Specifically, experimental groups had higher levels of participation in class discussions, asked more questions, demonstrated more active listening skills and increased learners' attention during lessons because they were motivated to see other learners who knew more about TEOF. In addition, the experimental groups demonstrated improved social and academic outcomes, such as better communication skills and higher academic achievement, compared to the control groups. Therefore, this study recommends physics educators consider incorporating the PAL strategy into their teaching practices. Using the PAL strategy would foster teamwork and collaboration among learners, subsequently providing opportunities for learners to enhance their communication skills, coordination abilities, shared responsibility, interdependence and the learning processes among learners.

Keyword: Peer Assisted Learning (PAL), Turning Effect of Force (TEOF) and Active engagement.

INTRODUCTION

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."(Ekici, 2016). There is a documented decline in physics performance and a lack of interest among secondary school learners (Examinations Council of Zambia 2013; Examinations Council of Zambia, 2014; Examinations Council of Zambia, 2015). Effective teaching correlates with understanding physics concepts, but traditional strategies contribute to limited learning (Behmanesh et al., 2022). Teacher quality significantly influences learning outcomes, emphasizing the crucial role of instructors (Mulenga & Luangala, 2015; Ali et al., 2015).

Various pedagogies aim to enhance physics education, including Peer Assisted Learning (PAL) (Herrmann-Werner et al., 2017; West et al., 2017). PAL encompasses cooperative strategies like peer teaching, learning,

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assessment, mentoring, and leadership (Herrmann-Werner et al., 2017). Peer teaching involves learners instructing each other, promoting critical thinking and academic gains (Boud et al., 2014). Peer leadership empowers learners to guide peers independently (Cohen & Sampson, 2014), and peer assessment evaluates others' learning results (Ginty & Harding, 2014).

The PAL strategy has gained importance in education. This study focuses on learners' active engagement using the PAL strategy during lessons on the Turning Effect of a Force (TEOF). TEOF is a topic in grade ten in the Zambian Secondary School Physics syllabus, 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. The turning effect of a force, known as torque, holds significance across various fields. In engineering and mechanics, torque is crucial for designing mechanical systems like gears, pulleys, and levers, ensuring proper functionality and efficiency. It plays a vital role in assessing the stability and equilibrium of structures, such as buildings and vehicles. In robotics, torque is utilized for precise control of robot arms and joints, and torque sensors contribute to safe human-robot interactions. In automobiles, torque determines vehicle power and performance, affecting acceleration, towing capacity, and efficiency. Biomechanics and human anatomy use torque to analyze joint mechanics, impacting activities like walking and designing prosthetic limbs. Sports and fitness applications include explaining the physics of activities like throwing and developing exercise equipment using torque principles (Goyal, 2014; Swinnen, 2016; Zhang et al., 2016; Heywood, 2018; Gillespie, 2021).

However, despite its real-world applications, learners find the Turning Effect of a Force (TEOF) challenging in physics (Badruldin & Alias, 2022; Scott & Schumayer, 2019; Muthuramalingam et al., 2020). Research indicates that students often struggle with misconceptions related to force concepts (Kelly & Sung, 2017; Stavrum et al., 2020). Particularly, there is a common misinterpretation of torque, with students facing difficulties in understanding the relationship between force, distance, and rotational effects. Misconceptions may include the inability to differentiate forces at different distances or assuming larger forces always result in greater turning effects without considering the pivotal role of distance.

Research in Zambia and the world over indicates that, due to the perpetual use of traditional teaching strategies, learners in ordinary-level physics are not fully engaged in lessons. As a result, they lack motivation and self-concept. Worse, their performance and retention of what they learn are generally below societal expectations (Examination Council of Zambia, 2013; Shumba et al., 2013; Chilufya & Ndhlovu, 2014; Haßler et al., 2015). This suggested the need to find a suitable teaching strategy that influenced learners' active engagement in the lessons.

PAL strategy has emerged through research and has proved effective for teaching and learning (West et al., 2017; Gambari & Yusuf, 2017). In this study, the question was: Could PAL be an effective strategy in the learning of the turning effect of a force in senior secondary physics in the Zambian context? This was what the study sought to investigate.

This study sought to achieve its general objective of exploring the learning of the turning effect of a force through the lens of Peer Assisted Learning strategy (PAL) in selected secondary schools in Kabwe district by focusing on the following specific objective: To assess the impact of the PAL strategy on learners' active engagement in lessons on TEOF.

This study was hinged on Vygotsky's Social Constructivism Theory which emphasizes the importance of social interaction, collaboration, and cultural context in the learning process (Vygotsky, 1962). The theory posits that learners construct knowledge through interactions with others and the mediation of cultural tools

and artefacts. Applying this theory to the PAL strategy provided a framework for understanding how collaborative learning experiences can facilitate active engagement and promote learning outcomes (Schreiber & Valle, 2013; Broman, 2018).

The Zone of Proximal Development (ZPD) concept is crucial, indicating the gap between a learner's actual and potential development. The PAL strategy encourages the pairing of learners of different expertise, allowing them to operate within their ZPD, and fostering support and guidance (Vygotsky, 1962).

Vygotsky's emphasis on social interaction in cognitive development aligns with the PAL strategy, which encourages collaborative activities, discussions, and problem-solving tasks. Peer interaction facilitates idea sharing, challenges assumptions, and promotes a deeper understanding of the Turning Effect of a Force (TEOF). Cultural tools like language and diagrams, used during PAL lessons, aid understanding. Peer scaffolding, consistent with Vygotsky's theory, involves peers offering guidance, feedback, and assistance, enhancing active participation and responsibility for learning.

The sociocultural context's influence on learning is acknowledged in PAL, connecting abstract concepts to real-world applications and cultural relevance. The study concludes by recognizing PAL's effectiveness in promoting learner engagement (Gambari & Yusuf, 2017) and calls for further research to explore PAL's ecological validity, long-term effects, and scalability.

The literature review also discusses the limitations of traditional teaching strategies and advocates for a shift to learner-centred paradigms, emphasizing deep learning and understanding (Freeman et al., 2014; Darmaji et al., 2019). Studies highlight the benefits of interactive engagement methods, careful selection and training of participants, clear lesson structures, student tutors, improved implementation, and peer assessment on various aspects of student learning, engagement, behaviour, and collaboration (Gok & Gok, 2017; Bugaj et al., 2019).

Understanding the turning effect of force, commonly known as torque, is a fundamental concept in science education, particularly in the study of physics and mechanics. This concept plays a crucial role in comprehending the principles of rotational motion and equilibrium. As students delve into the intricacies of torque, they gain insights into how forces applied at a distance from a rotational axis can result in the rotation of an object (Serway & Jewett, 2014). This understanding is foundational not only in physics but also in various engineering disciplines, where the manipulation of rotational forces is paramount (Gross et al., 2016).

Furthermore, the application of the turning effect of force extends beyond the confines of traditional physics classrooms. In a rapidly evolving technological landscape, where innovations in machinery, robotics, and aerospace engineering are commonplace, a solid understanding of torque becomes indispensable. A study by Xiang et al (2020) elucidates the role of torque in the design and optimization of mechanical systems, highlighting its significance in the development of efficient and functional technologies. This integration of theoretical knowledge with practical applications not only reinforces the educational experience but also underscores the relevance of torque in real-world scenarios.

This study reveals that understanding the challenges and misconceptions associated with the turning effect of a force (TEOF) can lead to more effective and engaging learning experiences for students. The implementation of the PAL strategy can enhance students' conceptual grasp, problem-solving skills, and overall academic performance (West et al., 2017). Teachers can gain insights from the study, as they can tailor their instructional strategies to address common misconceptions and challenges faced by students in TEOF lessons. The study also highlights the potential benefits of the PAL strategy, providing teachers with a valuable pedagogical tool to enhance engagement and comprehension in challenging physics topics which is in agreement with the study of Herrmann-Werner et al., (2017). Researchers can further explore the

intricacies of the PAL strategy in physics education, investigate the transferability to other physics concepts, and contribute to the broader body of research on student misconceptions in physics. School administrators and policymakers can use the study's findings to inform decisions about instructional practices and resource allocation, leading to more effective physics education programs and better academic performance. Peer educators can draw inspiration from the study's success with the PAL strategy, and the study serves as a foundation for future research in physics education.

METHODOLOGY

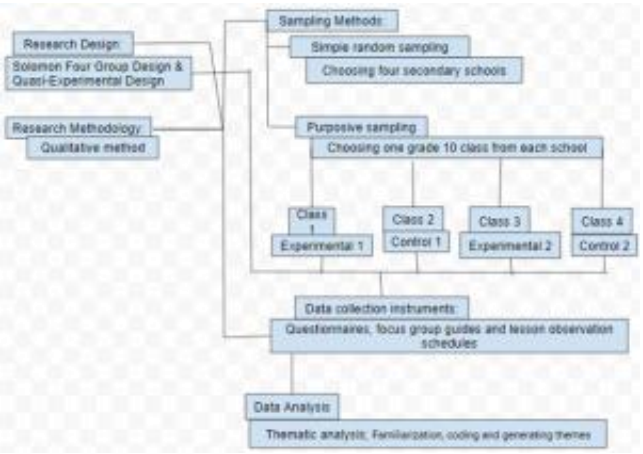

Figure 1: Methodology flow chart

The research employed a qualitative method approach with a combination of the quasi-experimental research design, specifically the "Nonequivalent Control Group Design'', and the Solomon Four Group Design. Combining these two designs resulted in a design that would control for many sources of invalidity, such as; history, maturation, instrumentation, statistical regression, selection bias, experimental mortality, demoralization and pretest-treatment interaction (Kirisci et al., 2020).

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). A quasi-experimental design was preferred in this study because the groups (classes) were intact and assumed to have similar maturity, aptitude and intelligence.

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. 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 (Dare et al., 2020).

The study took place in four selected secondary schools located in the Kabwe district of the Central province in Zambia, with a total of 131 participants. 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. The classes had a distribution of learners as follows: Class 1(n =31), Class 2 (n =32), Class 3 (n =34) and Class 4 (n =

34). Class 1 was at School A, Class 2 was at School B, Class 3 was at School C, and Class 4 was at School D. 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. The learners were trained, 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 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.

Data collection instruments included questionnaires, a focus group discussion guide, and a lesson observation schedule. The data collected was thematically analyzed. Ethical considerations were taken into account throughout the research process. Informed consent was obtained from the participants, including learners, teachers, and school administrators, before their involvement in the study. Confidentiality and anonymity were ensured by using unique identifiers instead of personal information in data analysis and reporting. The study also adhered to ethical guidelines by obtaining necessary permissions from relevant educational authorities and ensuring that the study did not cause harm or disrupt the regular educational activities of the participating schools.

PRESENTATION AND DISCUSSION OF FINDINGS

This study focused on observing how learners are actively engaged during lessons on TEOF. The level of engagement of learners during PAL lessons can vary depending on several factors, including the learners' motivation, the nature of the task, and the quality of peer interactions. Three instruments were used to determine the extent of engagement, focus group discussions, questionnaires and lesson observation schedules. All the data collection instruments were in conformity, and the findings were as follows; When the PAL strategy was applied, learners could express themselves during classes. The findings of the research revealed the following three themes; *Peer Interaction, Active Learning and Teacher Facilitation.*

The first theme *Peer Interaction* was a key factor in promoting engagement in TEOF lessons. The FGD participants discussed the benefits of working together 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."*

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The PTSA (Peer Teacher School A) said, 'Make seven groups so that you solve the following questions that I will give you'.

Figure 2: Pupils solving tutorial questions in School A

Figure 3 Pupils solving the tutorial question in School C

Figure 2 and Figure 3 show a picture of pupils solving questions in a group from two different schools A and 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. Some questions and learners responses were;

Question 1: 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).

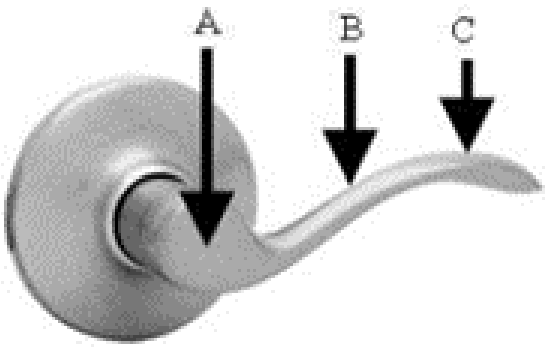

Figure 4 A Door handle

Which of the points A, B or C represent (Figure 4)

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

The second question from the tutorial was as follows; Find the value of distance x in the diagram below

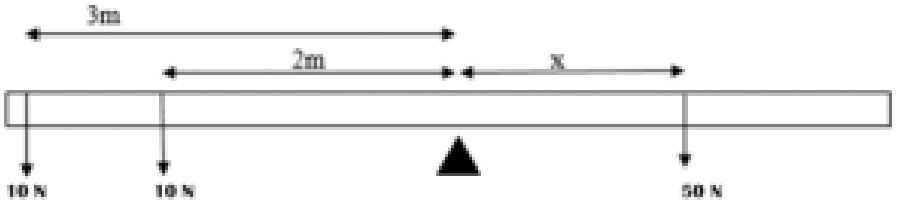

Figure 5 Principle of moments

Most of the groups answered the second question correctly, showing a good understanding of the principle of moments, the extract from one of the groups is shown below in Figure 6;

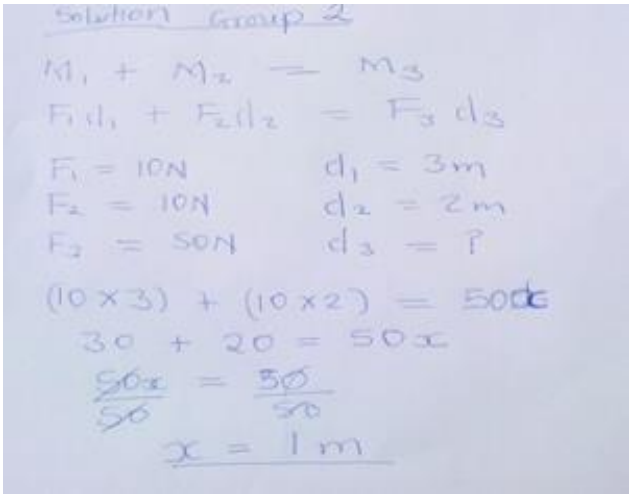

Figure 6 Solution of tutorial question 2 School A

During the FGD one notable aspect emphasized by the participants was the substantial positive impact of collaborative efforts. Working together, they found, not only enhanced their understanding of the lesson content but also facilitated a sense of camaraderie among the learners. Collaboration seemed to create a dynamic learning environment, where individuals were able to draw upon each other's strengths and experiences, ultimately enriching their learning process.

Moreover, the FGD participants emphasized the crucial role of peer support. The exchange of ideas, feedback, and assistance among peers was identified as instrumental in overcoming challenges and hurdles encountered during the TEOF lessons. Participants highlighted how peer interactions provided them with alternative perspectives and approaches to problem-solving, creating a more comprehensive and supportive learning ecosystem.

The theme of *Peer Interaction* revealed two sub-themes: 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.

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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."*

Participants highlighted that working with peers increased engagement and facilitated the exchange of ideas and knowledge. This finding is supported by previous research on the benefits of collaborative learning, as noted by Barkley et al., (2014) and Gok (2014). Cooperative learning fosters engagement and enhances learning outcomes, further substantiating the effectiveness of the PAL strategy in promoting learner engagement.

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*."

Furthermore, the study revealed that the PAL strategy was particularly effective for students struggling with specific 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 which relates with the findings of West et al., (2017) and Herrmann-Werner et al., (2017). 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.

Active Learning is 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.

The results indicated that when the PAL strategy was applied, learners were actively engaged in the lessons and demonstrated openness in expressing themselves. This finding is consistent with Gok & Gok's (2017) study, which found that interactive engagement methods significantly increased conceptual understanding and decreased the gender gap in learning.

Two sub-themes emerged within the *Active Learning* theme. The first sub-theme was *Interest* and the second was *Contribution*.

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Interest included being interested in the topic and feeling 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.

L4B said, "*When I'm interested in the topic, I'm more likely to pay attention and participate, like the TEOF I was very interested."*

L5B 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."*

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.

The second sub-theme within *Active Learning* was *contribution*. 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*."

The findings suggest that the PAL strategy was an effective method of promoting learner engagement and improving learning outcomes on TEOF. 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 (Herrmann-Werner et al., 2017).

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. Learners 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.

The third theme that emerged was *Teacher Facilitation*. It was essential for creating 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*."

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."*

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Figure 7 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 7: Peer teacher in school C using a teaching aid

Two sub-themes were identified within the theme of *Teacher Facilitation*: *Teacher Enthusiasm* and *Teaching Methods*.

Teacher Enthusiasm included positive attitudes, passion for teaching, and excitement about the lesson content. Participants emphasized the importance of teachers being enthusiastic about schooling and thelesson 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 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.

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."*

L7B said, *"Interactive activities make the lesson more interesting and engaging like the activities we had when learning TEOF using PAL."*

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Overall, the participants (90%) emphasized the importance of teacher facilitation and support in promoting engagement in peer learning lessons. Clear instructions, feedback, and support from teachers, as well astheir 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.

Another key finding was the importance of clear expectations and guidelines for PAL activities. Participants noted that when expectations and guidelines were unclear, PAL activities could become disorganized and unproductive. Therefore, educators must provide learners with clear instructions and guidance to ensure that PAL activities are focused and effective.

Furthermore, the FGD revealed that PAL can be particularly effective for students struggling with a particular subject or concept. Participants noted that working with peers who better understood the material helped increase their engagement and motivation to learn. This finding suggests that PAL could be a valuable intervention for learners who risk falling behind or disengaging from their studies.

The findings of this FGD suggest that the PAL strategy can effectively promote learners' active engagement. However, educators must provide clear expectations and guidelines to ensure that PAL activities are focused and productive. Evaluating the effect of PAL on learners' active engagement and conceptual understanding, assessments went beyond traditional tests. Observing participation levels in PAL discussions, analyzing the quality of peer explanations, and assessing the degree to which misconceptions were rectified provided valuable insights into the effectiveness of PAL in addressing misconceptions related to TEOF.

Another significant finding from the study was the importance of clear expectations and guidelines for PAL activities. Participants noted that when expectations and guidelines were unclear, PAL activities became disorganized and unproductive. This finding aligns with Bugaj et al. (2019), who emphasized the need for a well-structured learning environment to maintain student engagement. Educators must provide learners with clear instructions and guidance to ensure that PAL activities are focused and effective.

In conclusion, the study's findings provide valuable insights into effective strategies for promoting active student engagement and learning. Educators can utilize the PAL strategy and other evidence-based methods to foster collaboration, increase engagement, and improve learning outcomes on TEOF.

CONCLUSIONS

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.

The implementation of the Peer-Assisted Learning (PAL) strategy in classes 1 and 3 had a positive impact on learner active engagement in the topic of the "turning effect of a force" and clearing the misconceptions held by the learners. The PAL strategy positively influences active engagement among learners. The interactive nature of the PAL strategy, where learners actively participate in teaching and learning processes, enhances their engagement with the subject matter. This active involvement leads to increased motivation, deeper understanding, and improved learning outcomes.

The PAL strategy fosters collaborative and cooperative learning environments. Learners working together in pairs or small groups create opportunities for discussion, problem-solving, and sharing of knowledge. This collaborative strategy encourages active engagement as learners actively contribute, listen, and respond to their peers' ideas and perspectives.

RECOMMENDATIONS

Integrate the PAL strategies into regular classroom instruction. Teachers should be encouraged to incorporate PAL activities such as pair work, group projects, and peer teaching into their lesson plans. This will provide learners with more opportunities for active engagement and interaction.

Provide training and support for teachers in implementing the PAL strategy effectively. Teachers should receive professional development programs that focus on PAL strategies, classroom management techniques, and facilitation skills. This will enhance their ability to create a conducive learning environment that promotes active engagement.

Foster a positive and inclusive classroom culture that values and encourages peer collaboration. Teachers should promote a supportive and respectful atmosphere where students feel comfortable working with their peers. This can be achieved through establishing clear expectations, fostering positive relationships, and celebrating the contributions of all learners.

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