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PEER-ASSISTED LEARNING AS A STRATEGY FOR BUILDING TEAMWORK IN PHYSICS CLASSROOMS

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Abstract

This paper reports a focused analysis of one component of a broader mixed-methods study on the teaching of Turning Effect of a Force (TEOF) in selected secondary schools in Kabwe District, Zambia. Specifically, it examines how Peer-Assisted Learning (PAL) influenced learners' teamwork during physics lessons. Guided by Vygotsky's social constructivist theory and Topping and Ehly's PAL framework, the study adopted a concurrent mixed-methods quasi-experimental design with Solomon four-group features. The broader study involved 131 Grade 10 learners from four secondary schools, while this paper draws on questionnaire responses from 65 learners in the experimental classes and focus-group data from 16 participants. Qualitative findings showed that PAL strengthened teamwork mainly through improved communication and coordination during tutorials on TEOF. Learners reported that they explained ideas to one another, divided roles, and worked toward common solutions. Quantitative findings supported this pattern: 93.9% of respondents agreed or strongly agreed that PAL promoted teamwork, and there was no statistically significant difference in perceptions by gender ($\chi^2 = 3.581$, $p = .310$; Cramér's $V = .235$). The study positions teamwork not merely as a social outcome, but as a pedagogical resource for conceptual learning in physics. The findings suggest that carefully structured PAL can help physics teachers address both subject learning and 21st-century collaborative competencies, with implications for classroom practice, teacher professional development, and curriculum implementation in Zambia.

Keywords: Peer-assisted learning; Teamwork; Turning effect of a force; Collaborative learning

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1.0 INTRODUCTION

Physics is central to scientific literacy because it helps learners explain natural phenomena, understand technological processes, and solve real-world problems (Kaya & Boyuk, 2011). Yet, in many school contexts, physics is experienced as abstract, mathematically demanding, and difficult to connect to everyday experience. Learners frequently struggle with topics that require them to coordinate conceptual, procedural, and representational knowledge, even after formal instruction (Reiner et al., 2000; Streveler et al., 2003; Angell et al., 2004; Mualem & Eylon, 2007; Ekici, 2016). One such topic is Turning Effect of a Force (TEOF), which is foundational to the understanding of moment, torque, equilibrium, and many practical applications in mechanics.

Persistent low participation and weak conceptual understanding remain major concerns in school physics, both globally and in Zambia. In many classrooms, teacher-centred instruction still dominates, limiting discussion, collaborative reasoning, and active engagement (Hake, 2007; McDermott, 2001; Wieman & Perkins, 2005). These challenges are particularly visible in TEOF, where learners often struggle to connect the magnitude of force, distance from the pivot, and the resulting rotational effect. Some learners, for example, assume that increasing force alone necessarily increases turning effect, regardless of the moment arm (Barniol et al., 2013; Özcan, 2017). Zambian examiner reports have similarly pointed to persistent weaknesses in physics achievement, especially where learners are expected to apply principles rather than reproduce memorised procedures (Examinations Council of Zambia, 2015).

These classroom difficulties are not only conceptual but also pedagogical. Understanding TEOF often requires learners to talk through alternative explanations, compare reasoning, test assumptions, and collectively interpret diagrams and formulae. In that sense, teamwork is not merely an additional classroom virtue; it can operate as a cognitive resource for learning physics. When learners collaborate effectively, they ask questions, clarify misconceptions, distribute tasks, and build confidence while engaging with difficult ideas (Chilufya & Ndhlovu, 2014). Peer-Assisted Learning (PAL) offers a structured pedagogical response to these challenges. As an umbrella concept, PAL includes peer teaching, peer tutoring, peer learning, peer mentoring, and peer feedback practices organised around purposeful interaction (Topping & Ehly, 2001; Henning et al., 2008). PAL shifts part of the responsibility for learning from the teacher to the learners and creates opportunities for explanation, scaffolding, and shared problem solving. In contemporary STEM education, such learner-centred strategies are increasingly valued because they simultaneously support content learning and competencies such as communication, collaboration, and responsibility (Yaşar et al., 2024).

This paper addresses one focused question within a larger intervention study: how PAL influenced learners' teamwork during the learning of TEOF. That focus is important for at least two reasons. First, teamwork is now widely recognised as a transferable competency required in higher education, STEM workplaces, and civic participation. Second, the social organisation of scientific work itself depends on communication, coordination, critique,

and shared inquiry. Despite this, teamwork has often been treated as a by-product rather than a central learning outcome in school physics.
The present paper therefore narrows the broader study to the teamwork dimension of PAL in selected Zambian secondary schools. Its objective was to determine the impact of PAL on learners' teamwork during the learning of TEOF. The guiding research question was: What is the impact of the PAL strategy on learners' teamwork during the learning of TEOF?

2.0 LITERATURE REVIEW

The literature presents PAL as a learner-centred strategy with academic, social, and affective benefits. Unlike ordinary group work, PAL depends on deliberate organisation of roles, tasks, accountability structures, and interaction patterns so that learners contribute meaningfully to one another's learning. Properly structured PAL can increase participation, explanation, questioning, and peer feedback, all of which are important for conceptual development in science classrooms (Topping & Ehly, 2001; Topping, 2013).

A consistent theme in the literature is that collaborative learning creates space for communication in the language of the subject. In physics, this matters because understanding is strengthened when learners explain relationships, justify solutions, and compare interpretations of diagrams, formulae, and physical situations. Balta and Awedh (2017), for example, found that collaboration in physics problem solving improved engagement and positive perceptions of learning. More recently, Yaşar et al. (2024) synthesised evidence from science education studies and concluded that cooperative learning has positive effects not only on academic achievement, but also on communication, cooperation, creativity, and other 21st-century skills.

The literature also shows that collaborative approaches are increasingly relevant within African and other developing-country contexts where many classrooms are still transitioning from transmissive teaching to learner-centred pedagogy. In Uganda, Kanyesigye et al. (2022) reported that problem-based learning improved students' attitudes towards physics relative to traditional instruction. In Namibia, Shivolo and Mokiwa (2024) found that teachers who embraced inquiry-based instruction associated it with stronger learner engagement, critical thinking, and deeper understanding, although they also noted persistent barriers such as limited training and resources. Likewise, Twizeyimana et al. (2024) showed that inquiry-based learning was positively associated with student performance and science process skills. Taken together, these studies strengthen the case for examining PAL in a Zambian secondary school setting, where collaborative learning remains important but under-researched in topic-specific physics instruction.

At the same time, the literature does not suggest that teamwork emerges automatically whenever learners are placed in groups. Problems such as social loafing, overdependence on stronger learners, peer domination, and uneven contribution can weaken the benefits of peer learning when tasks are poorly designed or insufficiently monitored (Karau & Williams, 1993; Michaelsen et al., 2004; Veenman et al., 2002). Johnson and Johnson (1987) similarly emphasised that productive cooperation depends on positive

interdependence, individual accountability, and group processing rather than mere physical proximity.

The literature therefore points to two important conclusions. First, collaborative pedagogies such as PAL can strengthen communication, coordination, and accountability, all of which are core elements of teamwork. Second, these benefits depend on intentional structuring, not on group placement alone. What remains less explored, particularly in Zambian secondary school physics, is how PAL supports teamwork in a conceptually demanding topic such as TEOF. This paper contributes to that gap by examining teamwork as both a social and cognitive outcome of PAL.

2.1 THEORETICAL FRAMEWORK

The study was anchored in Vygotsky's social constructivist theory, which views learning as socially mediated and historically situated. From this perspective, knowledge is not constructed in isolation; rather, it develops through dialogue, cooperation, and participation in meaningful social activity (Kalina & Powell, 2009; Vygotsky, 1978). Two concepts are especially relevant to this paper: the Zone of Proximal Development (ZPD) and scaffolding. The ZPD refers to the difference between what a learner can do independently and what that learner can achieve with guidance from a more knowledgeable other. In a PAL setting, such support may come not only from the teacher but also from peers (Vygotsky, 1962).

This perspective helps explain why PAL can influence both learning and teamwork. When learners discuss problems, question one another, and explain concepts in small groups, they engage in socially mediated meaning-making. A learner receiving help may gain clarity and confidence, while the learner providing support may deepen understanding by organising and verbalising ideas. Teamwork, therefore, is not external to learning; it becomes part of the mechanism through which understanding is developed and internalised. The paper is further informed by Topping and Ehly's (2001) PAL framework, which highlights communication, organisation and engagement, scaffolding and error management, cognitive conflict, and affective support as key processes in peer learning. These processes map closely onto the teamwork findings reported in this study. Communication supports the negotiation of meaning; coordination and engagement support role allocation and task management; scaffolding helps peers respond to misconceptions; and affective support encourages confidence, participation, and persistence (Thurston et al., 2007).

The framework is particularly useful for interpreting the empirical findings. Improved communication among learners can be read as evidence of social mediation; improved coordination can be read as evidence of shared regulation and collaborative task management. In this way, Vygotsky's theory and the PAL framework jointly provide a strong explanatory basis for understanding how structured peer interaction can strengthen teamwork in the learning of physics.

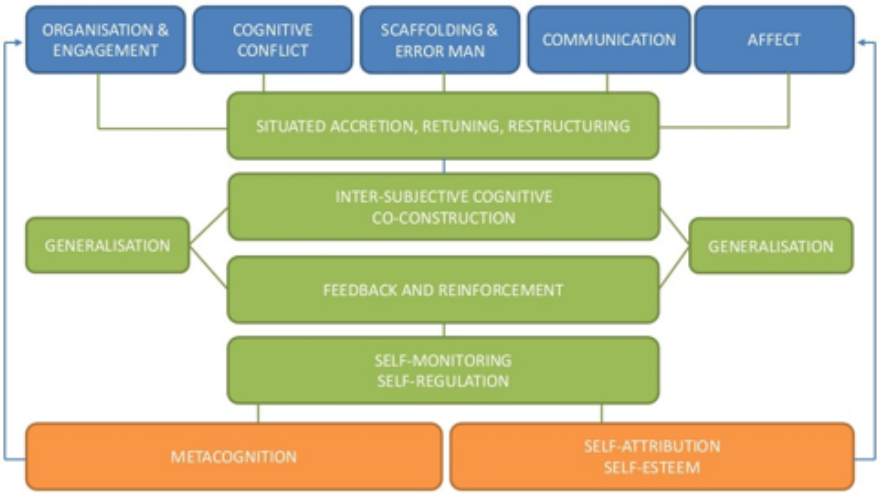

***Figure 1**. PAL framework adapted from Topping and Ehly (2001)*

3.0 METHODOLOGY

This paper reports one focused component of a broader mixed-methods investigation that examined several learning outcomes associated with teaching TEOF. The broader study involved both experimental and control classes. However, the present paper concentrates specifically on teamwork within the PAL condition because teamwork was conceptualised here as a process variable generated by the intervention itself. The experimental classes were therefore the most appropriate site for examining how PAL shaped learners' communication, coordination, and collaborative participation.

The broader study was guided by a pragmatist paradigm and employed a concurrent mixed-methods approach that incorporated quasi-experimental and Solomon four-group features (White & Sabarwal, 2014). The design made it possible to collect qualitative and quantitative evidence during the same phase of the study while reducing common threats to validity such as pre-test effects, maturation, and selection bias. The research was conducted in Kabwe District, Central Province, Zambia. For reasons of accessibility and feasibility, the participating schools were selected from within approximately 10 kilometres of Kabwe town. Eight schools were first purposively identified, after which four were randomly selected. All four were urban, government-run, co-educational, and classified as Grade One secondary schools. The broader study involved 131 Grade 10 learners drawn from one class in each school.

For the intervention, two classes were assigned to the experimental condition and were taught TEOF using PAL, while two classes formed the control condition and received conventional instruction. Some classes received both pre-test and post-test measures, while others received only the post-test, consistent with the Solomon-type structure. For the purposes of this paper, quantitative data on teamwork were drawn from 65 learners in the experimental classes, while qualitative data were obtained from two focus groups comprising eight learners each, giving a total of 16 participants. The groups included both boys and girls and at least two peer teachers in each school.

The PAL intervention was implemented as structured peer instruction rather than unregulated group work. Learners in the experimental classes were assigned sections of the TEOF topic to study with teacher guidance. Selected peer teachers were prepared in lesson planning, presentation, questioning, and ways of addressing misconceptions. During implementation, peer teachers presented portions of the lesson, guided tutorials, and worked with classmates in small groups, while the researcher moved between groups to monitor participation and provide support where necessary. A Likert-type questionnaire was used to gather quantitative data on learners' perceptions of teamwork. Learners responded to the statement, "The PAL strategy promotes teamwork when learning TEOF," using a five-point scale ranging from strongly disagree to strongly agree. Qualitative data were generated through focus-group discussions and classroom observations.

Quantitative data were analysed using SPSS through descriptive statistics, crosstabulation, and chi-square testing. Because the reviewer noted the need for a stronger statistical account, Cramér's V was also calculated to estimate effect size for the gender comparison. Qualitative data were analysed thematically. Focus-group responses and observation records were read repeatedly, initial codes were generated inductively, similar codes were grouped into categories, and broader themes were refined through iterative review across the research team. Representative learner excerpts were then selected to illustrate the major themes. Instrument quality and trustworthiness were supported through pilot testing, expert review, and internal consistency checks. Cronbach's alpha coefficients were .82 for the questionnaire, .85 for the lesson observation schedule, and .87 for the achievement test, indicating acceptable reliability. Ethical approval was obtained from the relevant university and education authorities. Because participants were Grade 10 learners, appropriate assent and consent procedures for minors were followed through the approved school and authority channels. Confidentiality, voluntary participation, and the right to withdraw were maintained throughout the study.

4.0 **RESULTS**

The qualitative findings showed that PAL improved learners' teamwork during the learning of TEOF. One overarching theme emerged from the thematic analysis - improved teamwork—with two interrelated sub-themes: communication and coordination. Communication emerged as a central way in which PAL supported teamwork. Learners indicated that working with peers required them to explain ideas, defend reasoning, and express themselves more clearly. Illustrative learner statements included the following: "PAL helped us communicate better with peers because we had to explain our ideas and thoughts to one another," and "learners express themselves more when using PAL because the topic is discussed in detail." These accounts suggest that teamwork under PAL was not limited to sharing tasks; it involved subject-based dialogue through which learners clarified concepts and increased confidence in academic interaction.

Coordination was the second sub-theme. Learners described how they organised themselves during tutorials, divided responsibilities, and worked toward common goals. Typical learner statements included: "during TEOF tutorials, the group coordinated efforts to solve questions and improve organisational skills," and "group members divided roles, with some writing, others reading the questions, and one member summarising the final

answer." Such responses indicate that PAL helped learners practise role allocation, planning, collective accountability, and task integration. The quantitative findings reinforced the qualitative evidence. Out of the 65 learners who completed the questionnaire, 31 (47.7%) agreed and 30 (46.2%) strongly agreed that PAL promoted teamwork when learning TEOF. Only one learner (1.5%) strongly disagreed, none disagreed, and three learners (4.6%) were neutral. In total, 61 out of 65 respondents (93.9%) expressed a positive view of PAL as a strategy for promoting teamwork.

The crosstabulation results showed similar patterns for male and female learners. Among males, 48.1% agreed and 48.1% strongly agreed. Among females, 47.4% agreed and 44.7% strongly agreed, while 7.9% were neutral. The chi-square test yielded $\chi^2 = 3.581$ with $p = .310$, indicating no statistically significant gender difference in perceptions of PAL's role in promoting teamwork. The associated effect size was small (Cramér's $V = .235$), suggesting that any gender-related variation was modest.

Table 1. *Learners' responses on whether PAL promoted teamwork*

Response category	Frequency	Percentage
Strongly disagree	1	1.5%
Disagree	0	0.0%
Neutral	3	4.6%
Agree	31	47.7%
Strongly agree	30	46.2%
Total	**65**	**100.0%**

Note. N = 65.

5.0 DISCUSSION

The findings indicate that PAL had a positive impact on learners' teamwork during the learning of TEOF. This impact was visible in both the social process of learning and the organisation of collaborative work. The qualitative data showed that PAL enabled learners to communicate more effectively and coordinate their efforts, while the quantitative data showed strong agreement that the strategy promoted teamwork. Taken together, the findings suggest that PAL created classroom conditions in which learners could collaborate meaningfully around a conceptually demanding physics topic. The communication gains are especially significant from a social constructivist perspective. Vygotsky's framework suggests that learning is mediated through language and interaction, and the present findings support that view. When learners explained moment, pivot, and torque relationships to one another, they were not merely rehearsing answers; they were engaging in the kind of dialogue through which ideas are tested, clarified, and internalised. The communication theme therefore reflects more than classroom participation. It represents the social mediation of conceptual learning within the learners' ZPD.

The coordination theme similarly extends the theoretical argument. The learners were not simply seated in groups; they allocated roles, sequenced tasks, and integrated their contributions into shared answers. This pattern is consistent with Topping and Ehly's emphasis on organisation, engagement, and scaffolding as essential PAL processes. It also strengthens the argument that teamwork can function as an epistemic resource in physics, where collective problem solving often requires discussion, calculation, checking, and negotiation.

These results align with earlier studies showing that collaboration can strengthen engagement and learning in science and physics. Balta and Awedh (2017) found that collaborative work around physics problem solving improved student engagement, while Yaşar et al. (2024) concluded that cooperative learning in science education supports communication, cooperation, and other 21st-century skills. The present study contributes to this literature by adding topic-specific evidence from TEOF and by locating teamwork within a Zambian secondary school context. It also responds to reviewer concerns by moving beyond simple description: the key point is not just that learners liked PAL, but that the structure of PAL appeared to organise participation in ways that supported both teamwork and conceptual reasoning.

The African literature also helps to situate the findings. Studies from Uganda, Namibia, and Rwanda indicate that learner-centred science pedagogies can improve attitudes, engagement, science process skills, and deeper understanding, even though implementation challenges remain (Kanyesigye et al., 2022; Shivolo & Mokiwa, 2024; Twizeyimana et al., 2024). The present findings resonate with that broader shift away from teacher-dominated instruction toward more interactive and inquiry-oriented approaches. In the Zambian case, PAL appears to offer a practical route for embedding collaboration in everyday classroom practice without separating teamwork from subject learning. he absence of a statistically significant gender difference is also noteworthy. Both male and female learners overwhelmingly perceived PAL as supportive of teamwork, and the effect size for gender variation was small. This suggests that the collaborative value of PAL was broadly shared across the participating classes. That result enhances the practical value of the strategy because it indicates that PAL can create an inclusive environment in which most learners can participate in collective learning tasks.

At the same time, the findings should not be romanticised. The literature is clear that collaboration can fail when groups are poorly structured or when stronger learners dominate the process. The positive outcomes observed here were likely connected to the deliberate design of the intervention: peer teachers were prepared, tasks were tied to lesson objectives, and the researcher actively monitored the groups. This is an important point for both theory and practice. PAL works best not as casual group work, but as guided collaborative pedagogy.

5.1 Limitations Of The Study

This paper has several limitations. First, the teamwork findings were drawn from a relatively small sample in four urban secondary schools, which limits the transferability of the results to other school types and locations. Second, the quantitative measure of

teamwork was based on learners' perceptions rather than on a broader multi-item behavioural scale. Third, the paper focused on one topic in mechanics TEOF so the findings should not be generalised automatically to all areas of physics. Fourth, because this paper is a focused subset of a broader study, it does not provide a full comparative treatment of teamwork in the control classes. Finally, the study did not track teamwork outcomes over time, so the durability of the reported gains remains unclear. These limitations do not weaken the value of the findings, but they do indicate the need for cautious interpretation and for follow-up research across topics, settings, and time frames.

5.2 Practical Implications and Recommendations

The study has implications at classroom, school, and policy levels. At classroom level, physics teachers should consider integrating PAL into the teaching of conceptually demanding topics such as TEOF because it appears capable of improving both teamwork and conceptual engagement. However, the effectiveness of PAL depends on deliberate structure. Teachers should define group tasks clearly, allocate roles, monitor participation, and ensure that all learners are accountable for group outcomes.

At school level, peer teachers require preparation. The findings suggest that learner leadership in PAL is more effective when peer teachers are oriented in lesson preparation, questioning techniques, and ways of responding to misconceptions. Schools should therefore support short orientation sessions and collaborative planning for such interventions. At policy level, curriculum implementers and teacher educators in Zambia should treat teamwork not merely as a soft skill but as a pedagogical asset in science learning. Schemes of work, teacher professional development programmes, and school-based continuing professional development could include structured collaborative approaches such as PAL, particularly in areas of physics where learners commonly struggle. Greater support for learner-centred STEM pedagogy would also align classroom practice with broader competency-based aspirations in education. Future research should examine PAL across other physics topics, compare it directly with other interactive strategies, and investigate how group composition, classroom culture, and teacher facilitation shape teamwork outcomes over longer periods.

6.0 CONCLUSION

This paper examined the impact of Peer-Assisted Learning on learners' teamwork during the learning of Turning Effect of a Force in selected secondary schools in Kabwe District, Zambia. Drawing on qualitative and quantitative evidence from the experimental classes, the study showed that PAL positively influenced teamwork by improving communication and coordination among learners. Participants described PAL as a context in which they explained ideas more clearly, divided responsibilities, and worked toward shared academic goals. Questionnaire evidence reinforced those perceptions, with 93.9% of learners agreeing or strongly agreeing that PAL promoted teamwork.

The findings support the view that teamwork can be cultivated through carefully structured peer-learning activities in physics classrooms. More importantly, the study shows that teamwork should not be treated as a secondary by-product of instruction. In PAL settings, it becomes part of the mechanism through which conceptual learning is achieved. For that

reason, PAL offers a practical and pedagogically meaningful strategy for transforming teacher-dominated TEOF lessons into collaborative learning spaces that support both disciplinary understanding and broader competencies needed for further study and work.

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