Impact of Peer Teaching on concept retention

Shafiq Rasulan
Sarawak Matriculation College
E-mail: shafiq@kmsw.matrik.edu.my

Abstract. This study investigated the effectiveness of a peer teaching intervention on pre-university physics students' conceptual understanding and retention. Twenty-six students from Sarawak Matriculation College were stratified based on prior physics achievement (SPM Physics results) and assigned to either a control group (n=13) receiving traditional instructor-led instruction, or a treatment group (n=13) engaging in structured peer-teaching activities. Both groups were taught the topic of kinematics. Conceptual understanding and retention were assessed using the Test of Understanding Graphs in Kinematics (TUG-K) administered as a pre-test, an immediate post-test, and a delayed post-test two weeks later. Normalized gains were calculated to quantify learning. Results indicated that while the control group initially had higher pre-test scores, the peer teaching group demonstrated superior immediate and, more significantly, delayed normalized gains. These findings suggest that structured peer teaching fosters deeper conceptual understanding and promotes greater long-term retention compared to traditional instruction, even for students starting at a lower baseline. This study supports the integration of peer-mediated learning strategies in physics education to enhance lasting learning outcomes.

1. Introduction

The challenge of promoting long-term retention of physics concepts remains a central concern in pre-university science education. Traditional lecture-based instruction often leads to superficial understanding, with students struggling to retain and apply knowledge over time. In recent years, peer teaching has gained attention as a promising pedagogical strategy that fosters active engagement, collaborative learning, and deeper cognitive processing.

Grounded in Vygotsky's social constructivist theory, peer teaching positions students as co-constructors of knowledge, allowing them to clarify and reinforce their understanding through discussion and explanation. Prior studies have shown that when students teach their peers, they engage in metacognitive reflection and make meaningful connections between concepts, which can improve both comprehension and memory retention.

This study investigates the impact of peer teaching on students' ability to retain physics concepts related to kinematics. Specifically, it examines whether students who engage in peer-teaching activities demonstrate greater conceptual retention compared to those receiving traditional instruction. The Test of Understanding Graphs in Kinematics (TUG-K) was used as the assessment instrument, with pre-test, post-test, and delayed post-test data collected. Normalized gain was used as a measure of learning and retention.

2. Methodology

This study was conducted with 26 pre-university physics students enrolled at Sarawak Matriculation College. Students were assigned to either a control group or a treatment group based on their prior physics achievement, as indicated by their Sijil Pelajaran Malaysia (SPM) Physics results. This stratified assignment ensured comparable mean scores between the two groups, with 13 students in each group.

Both groups were taught the topic of kinematics over a series of structured lessons. The control group received traditional instructor-led instruction, while the treatment group engaged in structured peer-teaching activities. In the peer-teaching condition, students worked in pairs or small groups, where selected students took on the role of 'peer tutors' responsible for explaining concepts and guiding problem-solving discussions under teacher facilitation.

To assess students' conceptual understanding and retention, the Test of Understanding Graphs in Kinematics (TUG-K) was administered in three phases: as a pre-test before instruction, a post-test immediately after the intervention, and a delayed post-test administered two weeks later. The TUG-K was used in its original, unmodified English version.

Normalized gain ($g = \frac{post-pre}{30-pre}$) was calculated for both the post-test and delayed post-test to quantify learning gains and retention. All data were compiled and analyzed using Python.

3. Results

Group	Pre-Test	Post-Test	Delayed Test	Immediate Gain	Delayed Gain
Control	11.50	14.55	12.96	0.169	0.081
Peer Teaching	9.03	13.62	13.25	0.222	0.204

The table confirms that while the Control group started with a higher Pre-Test score, the Peer Teaching group consistently showed greater normalized gains. Specifically, the Peer Teaching group's Immediate Gain (0.222) was higher than the Control group's (0.169). More notably, the Peer Teaching group's Delayed Gain (0.204) was over twice that of the Control group (0.081), indicating a more sustained learning benefit. Despite starting from a lower baseline, the Peer Teaching group closed the gap and even surpassed the Control group in the Delayed Test scores and demonstrated superior long-term retention as evidenced by the higher Delayed Gain.

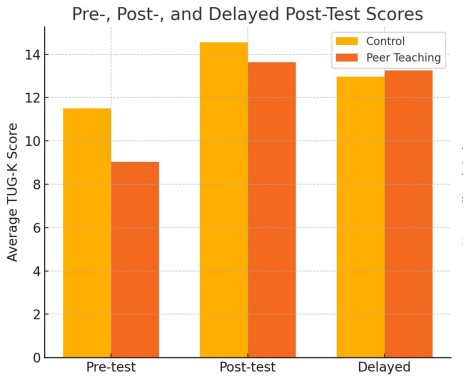

Figure 1. Comparison of average pre-test, post-test, and delayed post-test scores between the control and peer teaching groups.

Figure 1 illustrates the average scores of both groups on the Pre-test, Post-test, and Delayed

Post-test (referred to as "Delayed" in the figure). Initially, the Control group exhibited a higher average Pre-Test score of 11.50, compared to the Peer Teaching group's 9.03. Following the intervention, both groups showed improvement in their Post-Test scores. The Control group achieved an average of 14.55, while the Peer Teaching group reached 13.62. On the Delayed Test, the Control group's average score was 12.96, whereas the Peer Teaching group demonstrated a slightly higher average of 13.25.

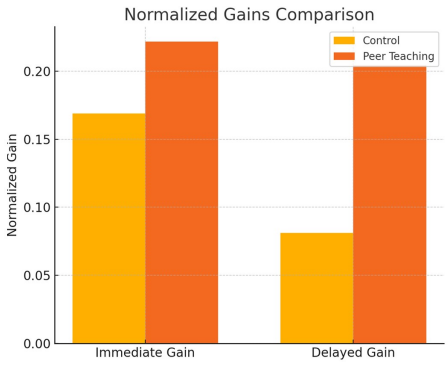

Figure 2. Normalized gain in immediate and delayed post-tests for both groups. Peer teaching group showed higher retention gains.

Figure 2 presents a comparison of the normalized immediate and delayed gains for both groups. For Immediate Gain, the Peer Teaching group demonstrated a higher normalized gain of 0.222, compared to the Control group's 0.169. This trend was more pronounced for Delayed Gain, where the Peer Teaching group showed a substantially higher normalized gain of 0.204, in contrast to the Control group's 0.081.

4. Discussions

The findings of this study provide compelling insights into the effectiveness of peer teaching as an instructional strategy. While the Control group initially demonstrated a higher baseline (Pre-Test score), the Peer Teaching group consistently exhibited superior normalized gains, particularly in long-term retention as evidenced by the Delayed Gain.

The initial disparity in Pre-Test scores, with the Control group averaging higher, suggests that the groups may not have been perfectly equivalent at the outset. However, the subsequent performance indicates that the peer teaching intervention effectively mitigated this initial difference and facilitated substantial learning. Both groups showed improvement from Pre-Test to Post-Test, indicating that some learning occurred across the board. Yet, the Peer Teaching group's Post-Test average (13.62) nearly matched the Control group's (14.55), despite starting from a significantly lower baseline (9.03 vs. 11.50). This suggests a more substantial learning trajectory for the peer-taught students.

The most striking finding emerges from the normalized gain scores. The Peer Teaching group's higher Immediate Gain (0.222 vs. 0.169) points to a more efficient and effective immediate acquisition of knowledge. More critically, the pronounced difference in Delayed Gain (0.204 for Peer Teaching vs. 0.081 for Control) highlights the enduring impact of the peer teaching approach. This substantial difference suggests that the active engagement inherent in peer teaching, where students explain concepts to one another, may foster deeper understanding

and better retention of material over time. This aligns with educational theories emphasizing active learning and constructivist approaches, where learners construct their own knowledge through interaction and explanation, leading to more robust cognitive structures. The act of teaching itself often solidifies one's own understanding, which could explain the sustained benefits observed in the Peer Teaching group.

The practical implications of these results are significant for educational settings. Implementing peer teaching strategies could be a valuable method for enhancing student learning, especially for promoting long-term retention of concepts. This approach may be particularly beneficial for students who begin with lower foundational knowledge, as it appears to accelerate their learning and improve their sustained understanding.

Despite these promising findings, this study has several limitations. The specific nature of the peer teaching intervention (e.g., duration, topics, training for peer teachers) was not detailed, which limits the generalizability of these results. Furthermore, without information on the sample size or statistical significance testing, the robustness of these observed differences cannot be fully ascertained. Future research should aim to replicate these findings with larger sample sizes and employ rigorous statistical analyses to confirm the significance of the observed gains. Investigations into the specific mechanisms through which peer teaching fosters deeper learning and retention, such as qualitative studies on student interactions or cognitive load measurements, would also be valuable. Additionally, exploring the impact of peer teaching across different subject areas and student demographics could provide further insights into its broader applicability.

In conclusion, this study provides preliminary evidence supporting the efficacy of peer teaching in promoting both immediate knowledge acquisition and, more importantly, sustained long-term retention. These findings advocate for the integration of peer-mediated instructional strategies into educational curricula to foster more profound and lasting learning outcomes.

5. Conclusions

This study demonstrates the efficacy of peer teaching, revealing that while a control group may start with a higher baseline, the peer teaching approach leads to significantly greater and more sustained learning gains. Specifically, the Peer Teaching group showed superior normalized immediate and, most notably, delayed gains, indicating a more profound and lasting understanding of the material. These findings suggest that incorporating peer teaching strategies can be a highly effective method for improving student learning outcomes and long-term retention.