Peer Discussion in Teaching High School Physics

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In today's "Age of Science," physics plays a vital role not only in advanced fields such as engineering, medicine, technology, and space sciences but also in everyday life. Beyond its professional applications, physics enhances analytical thinking and provides a strong foundation for other sciences, including biology and chemistry (Kumar, 1995). At its core, physics seeks to explain the natural world by examining the fundamental constituents of the universe, their interactions, and the systems that emerge from them. It does so through logical reasoning, theoretical modeling, observation, and experimentation the central processes of the scientific method (Dayal, 2007).

As one of the oldest natural sciences, physics investigates universal laws and the behavior of diverse phenomena, enabling learners to acquire both conceptual and procedural knowledge relevant to daily experiences. Understanding the contributions, challenges, and issues linked to innovations in physics also fosters a broader appreciation of the interconnections among science, technology, and society (Kumar, 1995). Despite its significance, however, physics instruction often presents challenges for both teachers and learners, which underscores the need for appropriate and effective teaching strategies.

One promising approach to overcoming these difficulties is the peer discussion method. By fostering learner interaction, peer discussion encourages students to confront and refine their understanding of scientific concepts. As Säljö (2012) emphasizes, such engagement allows learners to deepen their awareness of knowledge and skills through social exchange. Communication, whether through speaking, writing, or structured dialogue, becomes essential to learning, as it enables individuals to construct and transfer knowledge collectively (Olsson & Mattiasson, 2013).

Whereas traditional measures of student achievement often emphasized rote memorization, the demands of the information age place a premium on conceptual understanding (Huitt, 2007, as cited in Knight, 2015). Conceptual mastery is not only central to academic success but also critical for applying scientific knowledge to real-world contexts (Knight & Wood, 2005, as cited in Knight, 2015). To facilitate this, teachers must provide structured opportunities for peer discussion that allow students to exchange ideas, confront misconceptions, and refine their reasoning. These conversations also offer teachers valuable diagnostic feedback on learners' understanding (Crouch & Mazur, 2001, as cited in Knight, 2015).

Peer discussion thus serves multiple functions: it strengthens factual knowledge, promotes deeper conceptual understanding, and enhances students' ability to relate science to current events and everyday experiences (Singh, 2005). Moreover, collaborative learning environments extend students' capabilities beyond what they could achieve independently, benefiting learners of all ability levels and across different age groups. In this way, peer discussion emerges as a powerful pedagogical tool for enriching the teaching and learning of physics.

Application of Peer Discussion

Peer discussion can be implemented in diverse formats, with its effectiveness often depending on the specific variation employed. One widely recognized approach is peer instruction, described by Crouch and Mazur (2001, as cited in Flosason, 2011), in which students first respond to clicker questions individually and subsequently answer the same questions after reviewing their peers' initial responses and engaging in small-group discussions. The distinction between the studies of Crouch and Mazur and those of Smith et al. (2009, as cited in Flosason, 2011) lies in the structure of the questioning process. In the former, participants responded twice to each item under different conditions, whereas in the latter, students were immediately challenged to generalize their understanding by answering a related but novel question. Flosason (2011) further observed that students may derive particular benefits from discussions involving extended behavioral chains, as these promote deeper cognitive engagement.

Beyond its structural variations, peer discussion strengthens learning by broadening students' conceptual grasp of course content. Functionally, it provides opportunities for learners to reinforce and shape one another's responses, thereby facilitating generalized and even derived responding. This collaborative process reflects the principles of social constructivism, which views knowledge as actively constructed through interaction and negotiation (Duit & Treagust, 1998, as cited in Flosason, 2011). Moreover, peer discussion fosters higher levels of classroom participation. Even students who seldom contribute orally tend to engage by listening closely, reflecting on peers' reasoning, and posing questions, thereby enriching both individual and collective learning experiences.

Effectiveness of Peer Discussion in Teaching High School Physics: A Case Study

This research paper aims to examine the effectiveness of peer discussion as a teaching strategy in high school physics, with particular attention to its influence on student learning and performance. Specifically, it seeks to compare the academic outcomes of students who participate in peer discussions with those who do not, thereby identifying potential differences in their conceptual understanding and knowledge retention. By positioning peer discussion as a central component of the instructional process, the study endeavors to demonstrate its role in promoting active learning, enhancing critical thinking, and cultivating collaborative problem-solving skills among learners.

Methodology

A quantitative research method was employed to compare the physics achievement of students between two groups: control and experimental. In each selected school, one group was taught using the peer discussion method (experimental group), while the other was taught using conventional teaching methods (control group).

The study was conducted in Myitkyina Township, Kachin State, during the 2017–2018 academic year. Two sample schools BEHS (1) and BEHS (7), Myitkyina were randomly selected. From BEHS (1), 112 out of 121 Grade Nine students were included, while 77 out of 80 Grade Nine students from BEHS (7) participated.

A nonequivalent control group design was utilized. Both groups were randomly assigned and administered a pretest at the start of the study to measure baseline knowledge on the topic “Reflection of Light” from the

Grade Nine physics textbook. The test items were validated by experienced physics teachers, and necessary revisions were made based on their feedback.

Following the pretest, the experimental groups were taught using peer discussion, while the control groups received instruction through conventional methods. The treatment lasted for four weeks, with both groups receiving 45 minutes of instruction per day, four days a week, amounting to 3 hours and 45 minutes of instruction weekly. Lesson plans for both peer discussion and conventional methods were prepared in advance, along with supporting materials such as charts, handouts, and real objects.

At the end of the treatment period, a posttest was administered on 27 November 2017. The test lasted 1 hour and 30 minutes, carried a total of 50 marks, and included completion items, true/false questions, short-answer items, and long-answer questions, all based on the same content area as the pretest.

Pretest scores revealed no significant difference between the groups, confirming equivalence in their basic physics knowledge before the intervention. Posttest scores were analyzed using an independent samples t-test to determine the difference in achievement between the two groups.

The procedures of the treatment for the experimental groups are as follows, as suggested by Harvey (2013):

Step 1: Grouping

Step 2: Giving a brief lecture

Step 3: Posing a conceptual question

Step 4: Discussion between peers

Step 5: Presenting the answer

Step 6: Evaluating

Step 7: Providing feedback

The timetable for the treatment period is presented in Table 1.

Table 1

Time table for treatment period

Period / Day	1	2	3	4	5	6	7
Monday		HS2 CG	HS2 EG		HS1 EG	HS1 CG	
Tuesday		HS2 EG		HS2 CG		HS1 EG	HS1 CG
Wednesday		HS2 CG	HS2 EG		HS1 EG		HS1 CG
Thursday		HS2 CG		HS2 EG	HS1 EG	HS1 CG	
Friday		HS2 CG	HS2 EG		HS1 EG	HS1 CG	

Note: HS1 = BEHS (1), Myitkyina; HS2 = BEHS (7), Myitkyina; EG = Experimental group; CG = Control group

Findings

Table 2

Results of the pretest and posttest

School	Group	N	M	SD	MD	t	df	Sig. (2-tailed)
				Pretest				
HS 1	Experimental	60	27.35	3.55	0.16	0.24	110	0.811
	Control	52	27.19	3.40				
HS 2	Experimental	40	26.45	3.54	0.18	0.21	75	0.832
	Control	37	26.27	3.86				
				Posttest				
HS 1	Experimental	60	44.83	3.96	23.06	19.24	110	.000*
	Control	52	21.77	7.82				
HS 2	Experimental	40	30.28	8.99	17.71	9.26	75	.000*
	Control	37	12.57	7.67				
Total	Experimental	100	39.01	9.62	21.07	15.52	187	.000*
	Control	89	17.94	8.96				

Note: *p<.001

Table 2 presents the pretest scores of students from both the experimental and control groups. The analysis revealed no significant difference in achievement between the groups prior to the treatment, indicating that both sets of students began with the same initial level of ability. However, results from the posttest demonstrated a clear difference in performance. In HS1, the experimental group obtained a mean score of 44.83, compared to 21.77 for the control group. Similarly, in HS2, the experimental group achieved a mean score of 30.28, while the control group scored only 12.57.

These findings show that the experimental groups consistently outperformed the control groups in overall physics achievement. The results therefore indicate a statistically significant difference in favor of students who received instruction through peer discussion. This suggests that integrating peer discussion into physics instruction can enhance understanding, promote retention of concepts, and improve academic performance compared to conventional teaching methods.

Table 3 shows the results based on the level of questions. For remembering-level questions, the mean scores of the experimental and control groups were 14.12 and 7.40 in HS1, and 10.75 and 5.95 in HS2, respectively. In both schools, the experimental groups scored significantly higher than the control groups, indicating that peer discussion facilitated stronger recall of factual knowledge. For understanding-level questions, the mean scores of the experimental and control groups were 6.43 and 4.88 in HS1, and 5.28 and 3.41 in HS2. Once again, the experimental groups outperformed the control groups in both schools, suggesting that peer discussion enhanced not only factual recall but also conceptual understanding. These findings reinforce the conclusion that peer discussion is effective in improving students’ performance at both the remembering and understanding levels of cognition.

Table 3

Distribution of the results based on level of questions

School	Group	N	M	SD	MD	t	df	Sig. (2-tailed)
				Remembering				
HS 1	Experimental Control	60 52	14.12 7.40	1.04 2.83	6.71	16.18	110	.000*
HS 2	Experimental Control	40 37	10.75 5.95	2.69 3.39	4.80	6.92	75	.000*
Total	Experimental Control	100 89	12.77 6.80	2.50 3.14	5.97	14.35	187	.000*
				Understanding				
HS 1	Experimental Control	60 52	6.43 4.88	1.06 1.87	1.55	5.29	110	.000*
HS 2	Experimental Control	40 37	5.28 3.41	1.89 1.98	1.87	4.24	75	.000*
Total	Experimental Control	100 89	5.97 4.27	1.55 2.04	1.70	6.39	187	.000*
				Applying				
HS1	Experimental Control	60 52	20.43 6.21	3.15 4.65	14.22	18.64	110	.000*
HS2	Experimental Control	40 37	10.40 1.70	5.73 2.84	8.70	8.54	75	.000*
Total	Experimental Control	100 89	16.42 4.34	6.58 4.57	12.08	14.80	187	.000*
				Analyzing				
HS1	Experimental Control	60 52	3.85 3.27	0.36 1.32	0.58	3.09	110	.003*
HS2	Experimental Control	40 37	3.78 1.51	0.42 1.74	2.26	7.69	75	.000**
Total	Experimental Control	100 89	3.82 2.54	0.39 1.73	1.28	6.83	187	.000**

Note: **p<.001, *p<.01

For applying-level questions, the mean scores were 20.43 and 6.21 in HS1, and 10.40 and 1.70 in HS2, with the experimental groups demonstrating a clear advantage. Similarly, for analyzing-level questions, the mean scores were 3.85 and 3.27 in HS1, and 3.78 and 1.51 in HS2. In both schools, the experimental groups consistently outperformed the control groups.

These results confirm a significant difference in the achievement of students who engaged in peer discussion compared with those who did not. Grade Nine students taught through peer discussion exhibited markedly higher achievement than those instructed through conventional methods, an outcome attributed to increased student participation and engagement. Consistent with the findings of Harvey (2013), students who participated in peer discussions in physical science classes acquired deeper conceptual understanding than their counterparts who were taught traditionally.

At the remembering level, students in peer discussion groups demonstrated stronger retention of information and achieved higher scores than those taught conventionally. For understanding-level questions, students who engaged in peer discussions also outperformed those who did not. This aligns with Alexopoulou and Driver (1996), who reported that discussion significantly enhanced students' physics reasoning, and with Smith et al. (2009, as cited in Flosason, 2011), who showed that group discussion enabled learners to independently construct conceptual understanding and provide correct responses.

At the applying level, peer discussion groups again showed superior performance. Crouch et al. (2004) found that peer discussion enhanced both conceptual reasoning and qualitative problem-solving skills. In this study, high school students engaged in peer discussion exhibited improved ability to transfer learning to new contexts, solve problems, and demonstrate critical and creative thinking. These outcomes were also associated with gains in self-esteem and self-efficacy. For the analyzing level, peer discussion groups displayed a stronger grasp of physics concepts and principles compared with control groups. This finding is consistent with Johnson and Johnson (1987, as cited in Curtis, 2013), who emphasized that collaborative learning promotes analytical reasoning and problem-solving skills.

Overall, the findings corroborate the conclusions of Muise (2015), affirming that peer discussion not only yields higher academic achievement compared to conventional methods but also fosters essential 21st-century competencies such as communication, creativity, and higher-order thinking skills in physics learning.

Recommendation

Teachers are encouraged to adopt innovative teaching methods to create engaging and enjoyable learning environments where students can develop creativity and critical thinking. To ensure an effective teaching–learning process, teachers play a crucial role in selecting and applying appropriate instructional strategies, with peer discussion emerging as a viable alternative to traditional methods. For successful implementation, however, class sizes should be kept manageable, as overcrowded classrooms can limit meaningful interaction and diminish the effectiveness of peer discussion. Reducing the number of students per class fosters deeper participation and more productive exchanges among learners.

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