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The Effect of Team-Based Learning in a Neurorehabilitation Course within a Physical Therapist Assistant Academic Program

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Abstract- ***Physical Therapist Assistant (PTA) education is a demanding process, characterized by challenging coursework and high academic standards. Despite these efforts, PTA programs experience an attrition rate of nearly 20%, which imposes significant costs on students, programs, and institutions. The goal of this study was to assess whether learning outcomes in a neurorehabilitation course could be enhanced through the use of Team-Based Learning (TBL). This research utilized a quantitative, quasi-experimental, ex post facto design to evaluate the effectiveness of TBL. While TBL is known to foster self-efficacy, self-directed learning, and teamwork skills, its impact on student achievement of learning outcomes remains unclear.***

The primary research question of this study was whether students in a neurorehabilitation course taught using TBL would show improved learning outcomes on in-class examinations or on the National Physical Therapy Examination-Physical Therapist Assistant (NPTE-PTA), compared to students who received the same course in a traditional lecture-based format. To address this, two groups of students enrolled in the course during non-consecutive years were assessed for their learning outcomes. The analysis revealed no significant differences in examination scores or NPTE-PTA Neuromuscular and Neurological Systems scores between the two groups, even when controlling for pre-course Grade Point Average (GPA).

The findings suggest that TBL is at least as effective as lecture-based instruction in achieving student learning outcomes in the neurorehabilitation course. Further research is needed to explore the optimal timing of TBL implementation within PTA programs and to determine whether the non-academic benefits of TBL, such as improved teamwork and self-efficacy, justify its inclusion in PTA education.

Keywords: Active Learning, PTA, TBL, Effectiveness, Quantitative, Lecture, Teaching and Learning.

1. Introduction

Physical therapist assistant (PTA) education is a demanding and rigorous process designed to train entry-level generalist practitioners who work under the supervision of physical therapists. PTA programs often have selective admissions criteria aimed at enrolling capable students; however, graduation rates across these programs vary widely, ranging from 41.7% to 100%, with an average graduation rate of approximately 81% (American Physical Therapy Association, 2015). A significant factor contributing to this variation is attrition, which is commonly driven by academic challenges (Desmarais, Woble-Valenski, & Oestmann, 2011). Given the time, effort, and financial investment required for PTA programs, high dropout rates are costly for students, programs, and institutions alike.

Typically, PTA programs last for two full years and consist of a combination of general education, technical coursework, and clinical education. The curriculum is comprehensive, requiring mastery of fifty-one interventions, tests, and measures, as outlined in the Standards and Required Elements for Accreditation of Physical Therapist Assistant Education Programs by the Commission on Accreditation in Physical Therapy Education (CAPTE, 2016). This demanding curriculum includes general education courses in written communication and biological, physical, behavioral, and social sciences. Among the many subjects covered, courses related to the neurosciences—such as neurorehabilitation—are often considered some of the most challenging (Anwar, Shaikh, Sajid, Cahusac, Alarifi, & Al-Shedoukhy,

2015). The apprehension that many students feel toward these courses is often referred to as "neurophobia," a phenomenon that has been observed to persist beyond the classroom and into professional practice (Anwar et al., 2015; Maslakpak, Parizad, & Zareie, 2015).

The challenges in teaching and learning neuroscience have been well-documented. Flanagan, Walsh, and Tubridy (2007) noted that medical students and doctors often struggle with neurological problems due to perceptions that neurology is complex, diagnostic, and poorly taught. They argued that the traditional lecture method, which is commonly used for teaching complex material, results in information overload, leading students to disengage and develop anxiety, frustration, and disinterest in the subject. According to Maranhao-Filho (2014), this often leads to students' inability to integrate basic science and clinical information cohesively. Without a solid understanding of neurological principles, students may struggle to apply these concepts in clinical practice after graduation (Flanagan et al., 2007).

A survey conducted among medical students and doctors revealed that neurology was perceived as one of the most difficult subjects, with respondents reporting low confidence in their ability to assess patients with neurological issues. The same survey found that students felt they had received insufficient teaching in neurology and had limited exposure to neurological patients (Flanagan et al., 2007; Zinchuk, Flanagan, Tubridy, Miller, & McCullough, 2010). Youssef (2009) further emphasized that medical students identified neurology as their most challenging subject and argued that better teaching strategies, more clinical exposure, and extended study time were necessary to improve neurology education.

In response to these challenges, medical schools have made several changes to how neurology is taught. Humbert and Chang (2014), Maranhao-Filho (2014), and McColgan et al. (2013) highlighted the shift toward integrating neurological sciences into interdisciplinary courses and moving away from traditional lecture-based methods toward more interactive, small-group, problem-based learning formats. The Academy of Neurological Physical Therapy has echoed these recommendations for physical therapy programs, advocating for similar curricular changes to improve the teaching of neurology in physical therapist education (Academy of Neurologic Physical Therapy, 2015).

Traditional lecture-based teaching, however, often fails to foster the active engagement required for mastering complex material. According to Maslakpak, Parizad, and Zareie (2015), when a large amount of material is delivered through lectures alone, students tend to disengage, resorting to rote memorization rather than deeper learning. This passive learning environment leads to poor concentration, weak knowledge retention, and difficulties recalling critical concepts. As McColgan et al. (2013) pointed out, neurorehabilitation principles are essential to the effective treatment of patients, not only for physical therapist assistants but also for other healthcare professionals. These principles must be taught using more engaging and interactive methods.

Active learning, which promotes student engagement through various in-class activities, has been shown to enhance both information retention and student involvement. Prince (2004) defined active learning as activities introduced into traditional lecture formats to stimulate student engagement. Research by Hake (1998) demonstrated that students in active learning environments scored approximately twice as high on conceptual understanding tests compared to those in lecture-based courses. Active learning models, such as problem-based learning (PBL), flipped classrooms, skill laboratories, and simulations, have all been used in physical therapy education to varying degrees (Zaidi & Nasir, 2014). Among these, PBL is particularly well-regarded for its cooperative and collaborative structure, where students work together to generate solutions and hypotheses, share knowledge, and make decisions. However, PBL requires significant resources, as it demands one facilitator for every group of ten students (Burgess, Ayton, & Mellis, 2016).

To address the challenges of PBL, Team-Based Learning (TBL) was developed by Larry Michaelsen (Michaelsen, Bauman Knight, & Fink, 2004). TBL shares many strengths with PBL, such as cooperative learning, but is less resource-intensive. Once teams are formed, a single instructor can manage large groups effectively (Michaelsen, Davidson, & Howell, 2014). While TBL has been studied in various disciplines, including medical education, research on its use in physical therapy education remains limited, particularly in the context of neurorehabilitation. For example, Tan et al. (2011) compared the effectiveness of TBL versus passive learning in medical students studying neurology topics such as neurological localization and neurological emergencies. However, no studies have yet explored the use of TBL for teaching neurorehabilitation to physical therapist assistant students.

Establishing the efficacy of TBL in improving student learning outcomes has been challenging due to variations in study designs. Many studies have compared only a few units of a course, rather than an entire course taught using TBL, against traditional lecture-based instruction (Altintas, Altintas, & Caglar, 2014). Few studies have employed random assignment of students to TBL or traditional courses (Koles, Nelson, Stolfi, Parmelee, & Destephen, 2005; Thomas & Bowen, 2011). Moreover, most studies have measured outcomes like student satisfaction, faculty satisfaction, and student engagement, rather than directly assessing learning outcomes through in-class examinations (Currey, Oldland, Considine, Glanville, & Story, 2015; Ku, Tseng, & Akarasriworn, 2013).

Purpose of the Study

The purpose of this study was to evaluate the effectiveness of Team-Based Learning (TBL) in improving learning outcomes in a neurorehabilitation course compared to traditional, lecture-based learning. The study was conducted with second-year PTA students enrolled in a two-year PTA program at a small, proprietary college in Middle Tennessee. The learning outcomes were measured through in-course examination scores and scores on the Neuromuscular and Neurological System sections of the National Physical Therapy Examination – Physical Therapist Assistant (NPTE-PTA) taken by students after graduation.

Problem Statement

While several studies have explored the benefits of TBL in terms of student satisfaction, faculty satisfaction, and engagement (Altintas et al., 2014; Burgess et al., 2016; Clark, Nguyen, Bray, & Levine, 2008), there remains a gap in research regarding its direct impact on student learning outcomes. Most existing studies have focused on short-term, in-course outcomes, with few assessing retention of learned material after course completion (Bleske et al., 2014; Fatmi et al., 2013; Maslakpak et al., 2015). This study compares the learning outcomes of two groups of students, one taught using traditional lecture-based methods and the other using TBL, to assess whether TBL can lead to improved learning outcomes in neurorehabilitation education for physical therapist assistants.

Literature Review

Active learning has been shown to be more effective than traditional, lecture-based instruction in fostering student self-regulation and deeper engagement with course material. Ruckert et al. (2014) found that active learning techniques were particularly successful in promoting self-regulated learning among students, compared to the more passive experience offered by traditional lecture formats. Similarly, Sungur and Tekkaya (2006) observed that students engaged in problem-based learning (PBL) showed significantly higher levels of intrinsic motivation, critical thinking, metacognitive self-regulation, and peer learning when compared to their counterparts receiving lecture-based instruction. These results are consistent with findings by Sangestani and Khatiban (2013), who noted that adding PBL to traditional lectures improved students' ability to apply theory to clinical practice, boosted their learning motivation, and increased classroom engagement.

PBL, when compared to traditional lectures, has consistently been associated with higher academic achievement, improved attitudes toward peers, enhanced self-esteem, increased self-direction, and better role-taking abilities. Moreover, it promotes a sense of responsibility for one's own learning, which is crucial for fostering life-long learning skills (Griffith, 1990). These outcomes are in alignment with Chickering and Gamson's (1987) principles, which emphasize the importance of active learning in higher education. Active learning encourages students to engage both individually and collaboratively with course material, enabling them to construct learning through experience, whereas traditional lectures typically lack opportunities for such interaction and engagement (Jones, 2010, as cited in Mennenga, 2010).

Active Learning Strategies vs. Passive Learning Strategies for Improved Outcomes in Healthcare Education

In healthcare education, the use of active learning strategies, as opposed to passive lecture formats, has been shown to improve learning outcomes. Traditional lecture remains the most widely used teaching method in medical education. While lectures are efficient in delivering up-to-date information to large groups, they are often criticized for their passive nature, which may hinder the development of critical thinking skills and clinical decision-making abilities (Altintas et al., 2014). Research has demonstrated that the time students spend listening passively to lectures correlates negatively with the development of critical thinking skills, and that retention of information from passive learning environments is typically poor (Altintas et al., 2014).

Active learning, by contrast, encourages deeper engagement with the material through student interaction and peer discussion, both of which have been shown to enhance understanding and retention (Janssen, Kirschner, Erkens, Kirschner, & Paas, 2010). Active learning is defined as any instructional method that involves students in meaningful learning activities that require them to think critically about their participation (Prince, 2004). Studies by Johnson, Johnson, and Smith (2014) confirmed that active learning correlates with improved academic performance, enhanced interpersonal interactions, increased self-esteem, and a greater sense of social support among students. Additionally, Springer, Stanne, and Donovan (1999) found that active learning significantly improved academic retention.

Cooperative learning, a key component of active learning, involves students working in small groups toward a common learning goal. According to Eng (2009), cooperative learning is based on eight principles: students in cooperative settings learn more effectively, learn to listen to others, share ideas, and construct new understanding. Eng further suggested that students should be grouped heterogeneously to encourage diverse perspectives, and emphasized that cooperative learning promotes individual accountability and team success. The positive outcomes of cooperative learning are also highlighted by Breneiser, Monetti, and Adams (2012), who identified its core characteristics: small groups with a common goal, interdependence, mutual assistance among group members, and individual and group accountability.

Team-Based Learning (TBL) in Healthcare Education

Team-Based Learning (TBL) is a cooperative and collaborative learning method that has gained traction in healthcare education, particularly in medical and allied health fields. TBL was first implemented in a health professions course at Baylor College of Medicine in 2001 (Haidet et al., 2014), and has since been adopted by multiple medical, nursing, pharmacology, and dental schools, as well as in physical therapy education. Despite its growing popularity, studies evaluating the effectiveness of TBL in improving learning outcomes in healthcare education have yielded inconsistent results. These inconsistencies are often attributed to differences in instructional design, methodologies, and how outcomes are measured (Fatmi et al., 2013). Fatmi et al. (2013) found that only a small fraction of the

studies they reviewed adhered to the original TBL methodology as described by Michaelsen et al. (2004).

Team-Based Learning in Physical Therapy Education

In physical therapy education, TBL has been less widely studied. A notable exception is a study by Livingston, Lundy, and Harrington (2014), who implemented TBL in a gross anatomy course within a three-year physical therapy curriculum. Their study found that students in the TBL group reported significantly higher levels of satisfaction with the course compared to a previous cohort that received traditional instruction. However, research on the impact of TBL on learning outcomes in neurorehabilitation and other specialized areas of physical therapy remains limited.

The application of TBL in physical therapy education faces challenges, particularly due to variations in how TBL is implemented across studies. For instance, many studies have compared only a small segment of a course or used inconsistent methods to assess learning outcomes (Altintas, Altintas, & Caglar, 2014). Moreover, few studies have assessed the retention of material beyond the conclusion of the course, which is crucial for understanding the long-term impact of TBL on knowledge retention and clinical application (Burgess, McGregor, & Mellis, 2014; Tan et al., 2011).

Methodology and Study Design

This study adopts a quantitative, quasi-experimental design to compare the effectiveness of TBL with traditional lecture-based instruction on student learning outcomes. The research specifically examines the impact of TBL in a neurorehabilitation course for second-year PTA students at a small, proprietary college in Middle Tennessee. The outcomes are measured through in-course examination scores and post-graduation performance on the National Physical Therapy Examination – Physical Therapist Assistant (NPTE-PTA). The study aims to address the gap in research concerning the use of TBL in neurorehabilitation courses and its potential to improve learning outcomes for physical therapist assistant students.

Results and Discussion

The statistical analysis of the participants' performance in the Team-Based Learning (TBL) and lecture-based courses is presented below. The results from the analysis of covariance (ANCOVA) for each exam are detailed in Tables 1, 2, 3, and 4. These tables summarize the comparison of exam scores between the two instructional groups, controlling for pre-course GPA. The interpretation of these results is provided to give meaning to the quantitative data.

Table 1: ANCOVA Results for Exam 1

Independent Variables	df	MSE	F	p	Partial Eta Square
Instruction	1, 29	397.890	3.852	0.059	0.117
GPA	1, 29	652.258	6.314	0.018	0.179
Instruction * GPA	1, 29	329.200	3.187	0.085	0.099

The ANCOVA results for Exam 1 suggest that there is no significant difference in scores between the students taught with lecture-based instruction and those taught with TBL, when controlling for GPA. The strength of the relationship between the instructional method and Exam 1 scores, as indicated by the partial η^2, was weak, accounting for only 9.9% of the variance in the scores.

Table 2: ANCOVA Results for Exam 2

Independent Variables	df	MSE	F	p	Partial Eta Square
Instruction	1, 29	550.987	9.329	0.005	0.243
GPA	1, 29	643.452	10.894	0.003	0.273
Instruction * GPA	1, 29	499.417	8.456	0.007	0.226

The ANCOVA for Exam 2 revealed a significant difference between the two groups. The TBL group (M = 80.762) outperformed the lecture group (M = 75.040) on Exam 2, with the independent variable explaining 22.6% of the variance in scores. This result suggests that the TBL group had higher learning outcomes compared to the lecture group after controlling for pre-course GPA.

Table 3: ANCOVA Results for Exam 3

Independent Variables	df	MSE	F	p	Partial Eta Square
Instruction	1, 29	2.066	0.066	0.799	0.002
GPA	1, 29	289.611	9.290	0.005	0.243
Instruction * GPA	1, 29	0.103	0.003	0.954	0.000

For Exam 3, the ANCOVA results were non-significant, indicating no difference between the TBL and lecture groups in their performance. The strength of the relationship between the instructional method and Exam 3 scores was negligible, as assessed by a partial η^2 of 0.0%, meaning that the instructional method had no impact on Exam 3 scores after controlling for GPA.

Table 4: ANCOVA Results for Exam 4

Independent Variables	df	MSE	F	p	Partial Eta Square
Instruction	1, 29	165.749	4.136	0.051	0.125
GPA	1, 29	680.342	16.978	0.000	0.369
Instruction * GPA	1, 29	102.401	2.555	0.121	0.081

For Exam 4, the ANCOVA showed a weak relationship between instructional method and exam scores, with the TBL group scoring slightly higher (M = 85.512) compared to the lecture group (M = 74.981), but this difference was not statistically significant (p = 0.121). The partial η^2 value of 0.081 suggests that the instructional method accounted for only 8.1% of the variance in Exam 4 scores.

To evaluate whether there were differences in NPTE-PTA Neuromuscular and Neurological System scores between the two instructional groups, an Independent Samples t-test was performed. The analysis revealed no statistically significant difference in NPTE-PTA Neuromuscular and Neurological System scores between the lecture group (M = 686.9) and the TBL group (M = 659.6), with a t-value of 1.315 and a p-value of 0.198.

Discussion

This study aimed to compare the effectiveness of Team-Based Learning (TBL) and traditional lecture-based instruction in a neurorehabilitation course for physical therapist assistant students. The results showed that there was no significant difference in learning outcomes between the two instructional methods when controlling for pre-course GPA. However, the TBL group did outperform the lecture group in Exam 2, suggesting that TBL may be more effective in certain types of assessments.

The findings of this study are consistent with previous research, which has shown mixed results regarding the effectiveness of TBL in improving learning outcomes. While some studies have found that TBL leads to improved academic achievement (Carmichael, 2009; Conway, Johnson, & Ripley, 2010), others have found no significant differences between TBL and traditional instruction (Koles et al., 2005; Mennenga, 2010). The lack of significant differences between the two groups in Exams 1, 3, and 4, as well as in NPTE-PTA scores, suggests that TBL may not be more effective than traditional instruction for all types of assessments or for all students.

This study's use of a small, homogenous sample limits the generalizability of the findings. Future studies should include larger, more diverse student groups, and randomize participants into the TBL and lecture-based groups to minimize potential confounding factors. Furthermore, incorporating qualitative data, such as student feedback on their learning experiences, would provide valuable insights into the non-academic benefits of TBL, such as improved team collaboration, self-directed learning, and engagement.

Recommendations

Given the small sample size and homogeneity of the student population in this study, future research should include a larger and more diverse sample of students from different racial and gender backgrounds. Random assignment of students to either the TBL or lecture group would help mitigate potential bias in the results. Additionally, it may be beneficial to conduct this study in a larger class setting, as TBL was originally designed for larger groups and may yield more apparent results when applied in such a context.

Future studies should also incorporate mixed-methods designs that include both quantitative assessments of learning outcomes and qualitative data on student experiences. This would provide a more comprehensive evaluation of the impact of TBL, taking into account factors like student satisfaction, motivation, and the development of collaborative skills.

Conclusion

The aim of this study was to compare the effectiveness of Team-Based Learning (TBL) with traditional lecture-based instruction in a neurorehabilitation course for physical therapist assistant (PTA) students. This research focused on measuring student learning outcomes through in-course examination scores and subsequent performance on the National Physical Therapy Examination-Physical Therapist Assistant (NPTE-PTA) Neuromuscular and Neurological System sections. The results of the study indicated that, overall, there were no significant differences between the two groups in terms of academic achievement, with both the TBL and lecture groups performing similarly across the majority of assessments.

In particular, while the TBL group showed a slight advantage in the performance on Exam 2, the differences were not substantial enough to suggest that TBL led to consistently higher learning outcomes across all examinations. The non-significant differences in Exams 1, 3, and 4, as well as the NPTE-PTA Neuromuscular and Neurological System scores, point to the fact that, while TBL may offer benefits for certain types of assessments, these benefits did not translate into superior long-term learning outcomes in this specific setting.

These findings are in line with previous research that has examined TBL in various educational contexts, including medical, nursing, and allied health programs. While some studies have shown positive results, such as increased student satisfaction, improved teamwork, and higher levels of engagement (Carmichael, 2009; Conway, Johnson, & Ripley, 2010), others have found that TBL does not always outperform traditional teaching methods in terms of student achievement (Koles et al., 2005; Mennenga, 2010). The mixed results across different studies may be attributed to several factors, including

variations in the implementation of TBL, the type of content being taught, and the nature of the assessments used.

The lack of a significant difference between the TBL and lecture groups in this study suggests that TBL may be at least as effective as traditional lecture-based instruction for teaching neurorehabilitation in PTA programs. This finding aligns with other studies where TBL was found to be comparable to lecture in terms of learning outcomes (Mennenga, 2010; Weiner, Plass, & Marzfhadidet, 2009). Thus, while TBL may offer advantages in terms of student engagement, teamwork, and the development of self-directed learning skills, it does not necessarily result in significantly higher academic achievement when compared to traditional lecture methods.

It is important to note that this study had several limitations that should be addressed in future research. One significant limitation was the small sample size and the homogeneity of the student groups, which may have influenced the generalizability of the findings. The majority of students were female (79%) and Caucasian (88%), which limits the ability to draw conclusions about the effectiveness of TBL across diverse demographic groups. Additionally, while the study controlled for pre-course GPA, other potential confounding factors, such as prior experience with active learning methods or variations in teaching effectiveness, could have influenced the results.

Future research should aim to include a larger, more diverse sample of students from various backgrounds and PTA programs. Random assignment of students to the TBL or lecture groups would help minimize selection bias and improve the reliability of the results. Moreover, studies should explore the impact of TBL on other non-academic outcomes, such as student motivation, teamwork skills, and long-term retention of knowledge, which were not directly addressed in this study. Additionally, the implementation of a mixed-methods approach, combining quantitative analysis of learning outcomes with qualitative data from student feedback, would provide a more comprehensive understanding of the benefits and limitations of TBL.

In conclusion, while this study found no significant difference in learning outcomes between TBL and traditional lecture-based instruction in a neurorehabilitation course for PTA students, TBL remains a promising educational strategy. The findings suggest that TBL could be a valuable instructional method to incorporate into PTA curricula, particularly when aiming to foster skills such as teamwork, self-directed learning, and peer collaboration. However, further research is needed to determine the most effective contexts for implementing TBL, the specific benefits it offers in comparison to other teaching strategies, and its impact on a broader range of learning outcomes. Given the growing demand for innovative, student-centered teaching approaches in healthcare education, TBL may provide an effective way to engage students more actively while promoting the development of essential skills that are crucial for professional success.

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