# THE INFLUENCE OF THINK-PAIR-SHARE ON IMPROVING STUDENT LEARNING AND CRITICAL THINKING USING I-CLICKER TECHNOLOGY

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## Abstract

We aimed to assess the effectiveness of the cooperative learning technique Think-Pair-Share (TPS) in enhancing student learning and impacting critical thinking skills. A total of 110 animal science students in the domestic animal behavior course participated in a TPS exercise utilizing an I-Clicker audience response system. The exercise involved a 5-minute video demonstrating faulty associative learning techniques in animal training. Initially, students answered a single multiple-choice question (MCQ) to identify the training technique and submitted a written evaluation at the exercise's conclusion. MCQ was repeated after each 5-minute stage of the TPS exercise, and responses were recorded via I-Clicker. The impact of peer interaction on student competency was assessed through think-and-pair responses, while class discussion effects were evaluated from pair-to-share responses. Written responses were collected and compared with the previous year's students, who received the same material from the instructor without TPS implementation. Only 64% answered correctly post-"Think," increasing to 87% post-"Pair" ($P$<0.001) and reaching 99% post-"Share." Notably, 13% answered incorrectly twice after peer discussion, while 31% switched from incorrect to correct ($P$<0.001). About 96.4% successfully critiqued the training session, a significant improvement from 62% the previous year ($P$<0.001). In-class TPS interaction significantly enhanced student learning and critical thinking skills.

*Keywords:* cooperative learning, Think-Pair-Share (TPS), critical thinking, animal behavior, active learning

In contemporary education, the persistent challenge of students' inability to effectively solve problems has garnered considerable attention and remains a critical area requiring improvement (Candy & Crebert, 1991; Carnevale et al., 1990; Coplin, 2003; Espinoza, 1999; Evers et al., 1998; Stogdill, 1974). This predicament is particularly pertinent in the agricultural industry, where the need for adept problem-solving skills has been extensively documented (Andelt et al., 1997; Robinson, 2009; Robinson et al., 2007).

One contributing factor to students' struggles in problem-solving at the college level may stem from an instructional focus on delivering technical content, promoting passive learning, rather than considering how students learn best or prefer to receive information (Knight & Yorke, 2003; Greenberg & Martins, 2023). Consequently, it becomes imperative for college instructors to reassess and potentially alter their teaching styles to better align with the needs of their students (Fuhrmann & Grasha, 1983; Takeda et al., 2017). Cognitive transfer, crucial in learning, developing skills, and applying technical competencies, can be enhanced through such adjustments (Parr et al., 2008; Young et al., 2009).

The skill of problem-solving is inherently connected to understanding and applying science, technology, engineering, and mathematics (STEM). As these fields continue to garner attention in education, instructors are urged to adopt effective teaching methods (Fox & Hackerman, 2002). Recommendations include transitioning to more student-centered approaches to facilitate problem-solving and knowledge transfer across contexts (Schuck et al., 2003). In a rapidly changing world where innovation and problem-solving are imperative, becoming more student-centered is seen as essential for successful employment (Bransford, 2007; Takeda et al., 2017).

Building upon the recognized importance of active, cooperative learning strategies in enhancing students' problem-solving abilities, two such methodologies stand out: Think-Pair-Share (TPS) and Peer-Instruction. These approaches not only foster engagement but also play a pivotal role in shaping students' self-efficacy and competence in STEM skills within a college-level course (Martins et al., 2020).

Think-Pair-Share, as described by Butler et al. (2001), involves a collaborative learning exercise where students discuss a question in pairs and subsequently share their ideas with the larger class. This strategy, highlighted by McTighe and Lyman (1988), serves as an excellent tool for actively involving students in the lesson. The ensuing dialogue, encouraged through TPS, holds students more accountable for their learning and encourages a sense of ownership (Butler et al., 2001). By actively participating in the collaborative process, students not only refine their understanding of STEM concepts but also contribute to a dynamic learning environment.

As students engage in small-group discussions and pairs, the plausible outcome is an increased sense of confidence and competence in mastering the material. This impact is significant as it directly influences their overall self-efficacy — the belief in their ability to perform specific tasks (Bandura, 1977, 1993; Takeda et al., 2017). The concept of self-efficacy, as articulated by Bandura (1994), relies on students observing effective models and having the opportunity to replicate those models under guidance.

While enhancing self-efficacy is crucial for developing competence in specific skills, it is essential to acknowledge the potential misjudgment of one's capacity to perform tasks based on self-perceived abilities (Hoy & Spero, 2005). Therefore, a standardized measure, such as grades in a class, becomes warranted to objectively evaluate students' self-efficacy perceptions. Therefore, the objective of the study was to measure the effectiveness of a cooperative learning technique (Think-Pair-Share "TPS") in improving student learning and measuring the impact of this activity on students' critical thinking skills. By examining these active, cooperative learning strategies, the study aimed to contribute valuable insights into the effective enhancement of students' problem-solving abilities and self-efficacy. We hypothesized that students who participated in the TPS activity would have higher correct response rates and better critical thinking skills than those who participated in traditional instruction sessions.

## Methods

Before commencing the study, the instructor underwent a protocol revision process, and the Clemson University Institutional Review Board approved the revised protocol (#IRB2021-0068). Participation in the study was entirely voluntary, and students were given a survey to express their willingness to participate.

Domestic Animal Behavior (AVS 4100) is a fourteen-week course consisting of three 50-minute lectures per week and is offered in the Fall semester every year by the Department of Animal and Veterinary Sciences at Clemson University. The think-pair-share exercise was performed at the end of week 8 on the assessment of associative learning techniques in animal training during the Fall semester of 2023 (110 students), while traditional instruction were conducted in the Fall of 2022 (110 students). The same instructor delivered the same educational content in both semesters.

At the beginning of a typical class period, students within the TPS and traditional groups were shown a 5-minute video recording of an animal training session utilizing a faulty associative learning technique.

Students were asked to work individually for 5 minutes to answer a single multiple-choice question (MCQ) to identify the implemented associative learning technique. Students submitted their responses via I-Clicker, and answers were downloaded and stored as "Think" responses. After this stage, each student possessed 1 response, “Think” under his/her name.

Next, students in the TPS group only were instructed to discuss the question and their responses with a neighboring classmate for 5 minutes, and students were then asked to resubmit their responses for the same question via I-Clicker. Responses submitted after peer discussion were recorded as "Pair" responses and were stored per student, after this stage, each student possessed2 responses, “Think" and "Pair," under his/her name.

Once all the responses were received and stored, the instructor led a class discussion for 10 minutes, in which the responses from the previous stage were presented to the class. Certain students were selected to share their answers to the questions and explain the underlying rationale, however, the instructor did not share/highlight the correct answers. Finally, students were asked to submit their response to the same question for the third time, "Share," after the class discussion took place. Similarly, student responses were submitted via I-Clicker and stored per student. After this stage, each student possessed 3 responses, "Think," "Pair," and "Share," under his/her name.

Finally, students within both groups, "TPS and Traditional," were asked to submit a written response to an open-ended question in which they needed to justify their response to the MCQ. Student-written responses were collected and graded by the instructor, and their justification was considered either adequate or inadequate.

Statistical analyses were performed using R software (version 4.3.2) with the "stats" package (R Core Team, 2013). Descriptive statistics were calculated using the "psych" package, data were presented as mean (percentage), and $P \leq 0.05$ was considered significant.

Student responses to the MCQ question were graded as "correct or wrong", and then compared across the stages of TPS. Student written responses were graded as "Adequate or Inadequate" and compared across teaching methods (traditional or TPS) using McNemar's Chi-squared test with continuity correction, while package "ggstatsplot" was used to prepare the figures (Patil, 2021).

## Results

The enrollment figures for the course remained consistent over the two-year period, with a comparable distribution of students across academic levels and genders (Table 1).

**Table 1.**

*Classification of student level and gender in AVS 4100 "Domestic Animal Behavior" during 2022 and 2023.*

| Year | Level | Gender | n |
|---|---|---|---|
| Fall 2022 (Traditional) | Junior | M | 1 |
| | | F | 19 |
| | Senior | M | 4 |
| | | F | 86 |
| Fall 2023 (TPS) | Junior | M | 0 |
| | | F | 19 |
| | Senior | M | 5 |
| | | F | 86 |

In 2022, under traditional instruction, the total student count was 110 (Table 1), comprising of 20 juniors and 90 seniors. In contrast, the implementation of TPS in 2023 resulted in 19 junior students and 91 seniors. Across both years, the total number of female students was 105, with 19 junior and 86 senior students annually. Meanwhile, the male student population totaled 5 each year, with one junior and four seniors in 2022 and five seniors in 2023 (Table 1).

Examining student responses to the Think and Pair stages of TPS through McNemar's Chi-squared test demonstrated a notably significant distinction (McNemar's chi-squared = 14.593, df = 1, $p$ = 0.001; Figure 1).

Initially, 61 students (64%) provided correct answers independently, while 35 students (35%) presented incorrect responses (Figure 1). Following collaborative discussions during the Pair stage, the number of correct responses surged to 96 students (87%), showing a statistically significant improvement ($p$=0.001; Figure 1). Specifically, 21 students changed their answers from incorrect to correct, indicating significant progress ($p$=0.001). Conversely, 14 students consistently submitted incorrect answers across both stages of TPS (Figure 1). Additionally, the impact of Pair versus group discussions on student responses revealed significant disparities (McNemar's chi-squared = 63.377, df = 1, $p$-value = 0.001; Figure 2).

Following a group discussion in the Share stage of TPS, a substantial majority of students, 109 (99%), provided correct answers (Figure 2). Among them, 13 students exhibited a positive shift, rectifying their responses from incorrect to correct after the in-class discussion. Notably, only one student consistently submitted incorrect answers in both stages, emphasizing the efficacy of group discussions in enhancing student comprehension ($p$=0.001; Figure 2).

Furthermore, examining the effect of TPS activity on important students' ability to actively analyze class material and provide robust justification of their responses compared to traditional instruction revealed significant differences (McNemar's chi-squared = 58.99, df = 1, $p$-value = 0.002; Figure 3).

**Figure 1**

*Analysis of the student responses to the "Think," and "Pair" stages of TPS.*

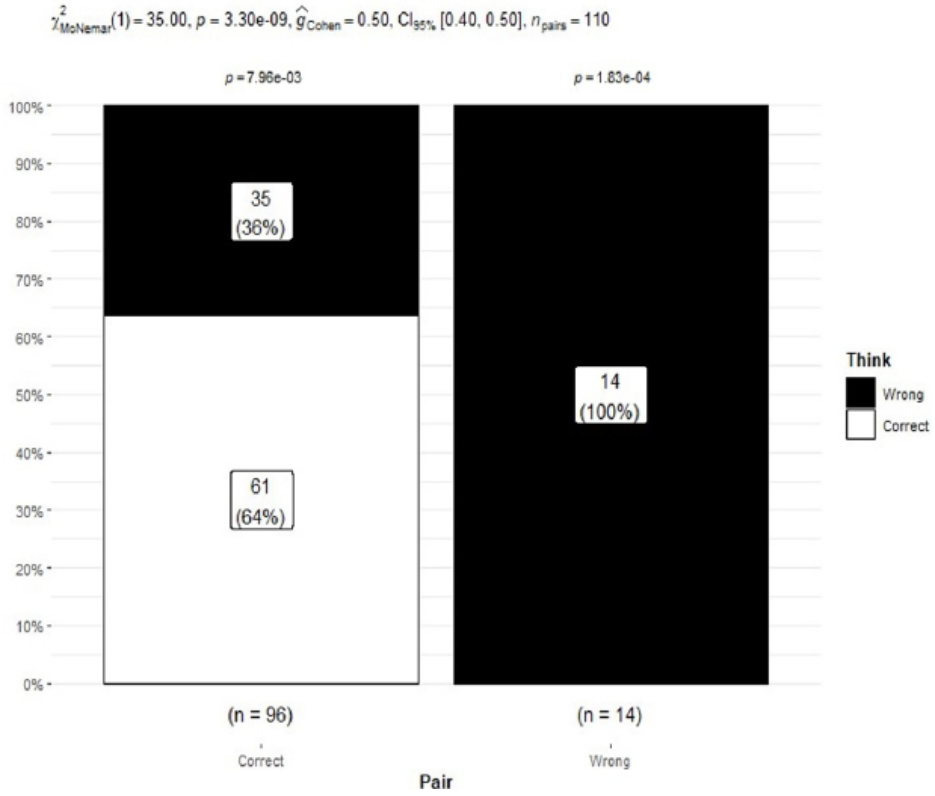


**Figure 2**

*Analysis of the student responses to the "Pair," and "Share" stages of TPS.*

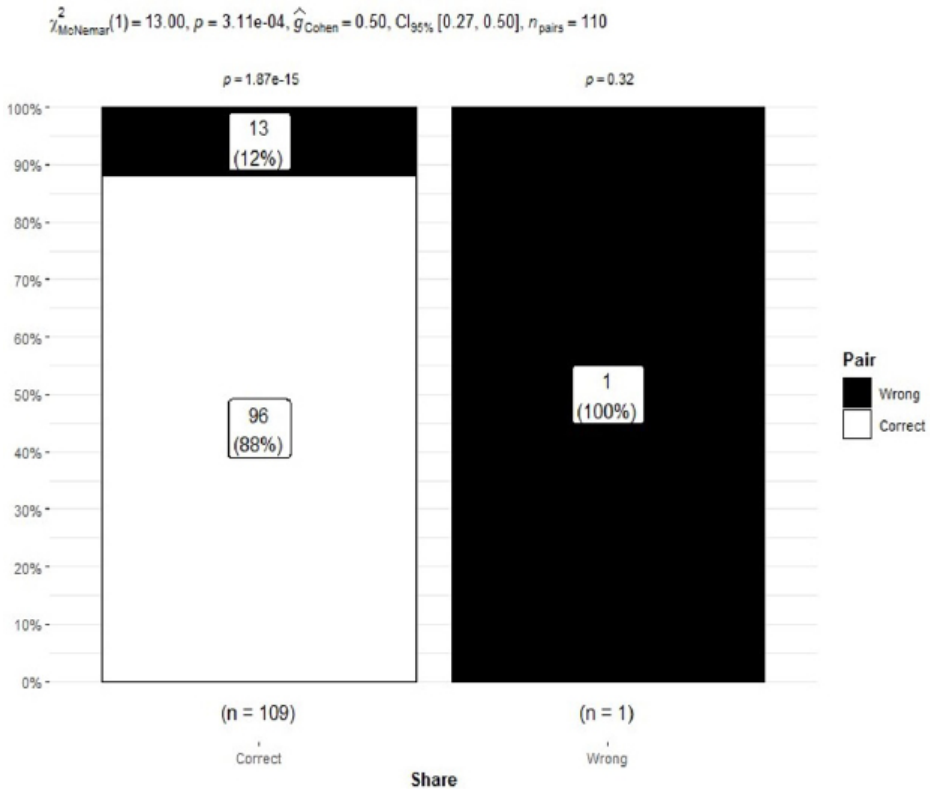
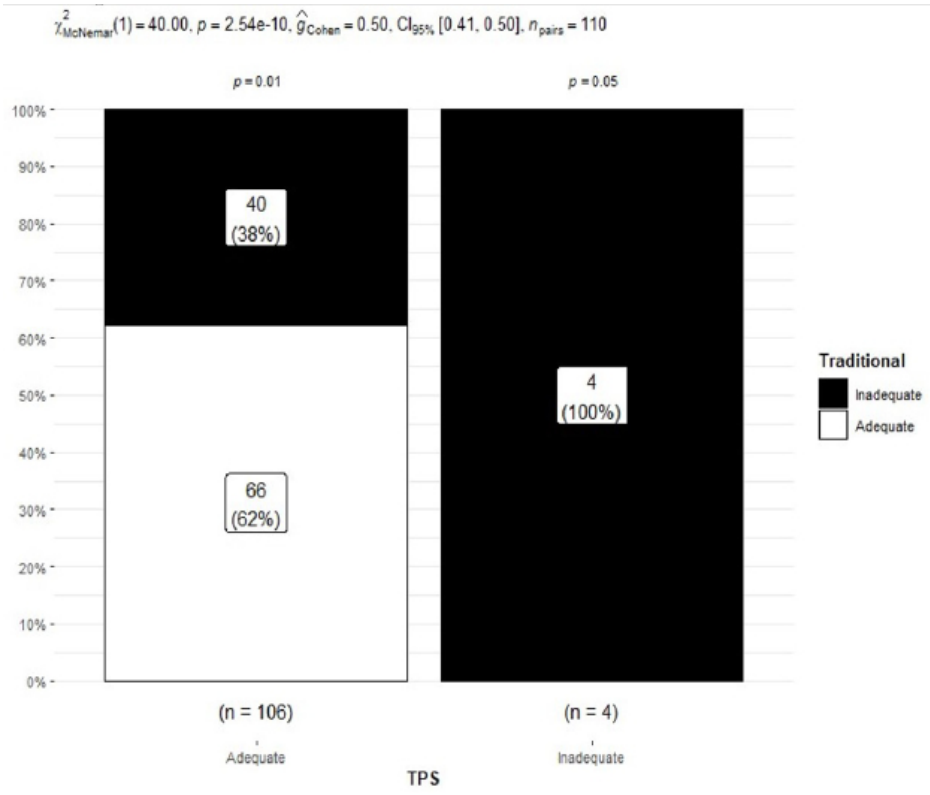



**Figure 3**

*Analysis of the studen-written responses to the "TPS," versus "Traditional."*



After TPS, a total of 106 (96.4%) students submitted adequate justification for their correct answers to the MCQ, compared to 66 (62%) students in the traditional instruction ($p$=0.001; Figure 3).

## Discussion

In this study, we examined the effectiveness of a cooperative learning technique (Think-Pair-Share, "TPS"), a pedagogical method that improves not only the student learning and critical thinking skills but also promotes student participation in class and increases student interaction with each other and with the instructor. The findings from this study affirm a substantial improvement in student responses subsequent to peer discussions. Specifically, over 87% of students provided correct answers, contrasting with the 64% accuracy observed before engaging in peer discussions. Furthermore, the correctness ratio witnessed a significant rise to 99% subsequent to group discussions. The minimal involvement of the instructor in these discussions is noteworthy, as students predominantly led and conducted the discourse.

In the current study, active discussions between students resulted in 21 students changing their submission from incorrect to correct after peer discussion, while 13 more students exhibited a positive shift, rectifying their responses after the in-class discussion. Within these discussions, students shared their final responses and delved into the underlying concepts, affording them a more active role in the learning process. This active engagement contributes to an improvement in overall material comprehension (Biggs, 1999; Martins et al., 2020). In the academic domain, learners' intellectual and substantive growth is, in part, facilitated by their adoption of an active, rather than passive, role in the educational process. Nurturing a constructive attitude towards learning further cultivates higher-order thinking skills, thereby significantly contributing to enhanced cognitive development (Cavanagh, 2011; Gokhale, 1995; Shimazoe & Aldrich, 2010; Wyk, 2012).

The results obtained in the current study align with previous research indicating that peer instruction and collaborative learning contribute to enhanced student performance and scores (Cortright et al., 2003; Muir &Tracy, 1999; Rao et al., 2002; Rao & DiCarlo, 2000; Russo & Warren, 1999). These studies consistently highlight a marked improvement in students' correct answer submissions when knowledge is shared through cooperative learning compared to individual efforts. This suggests that peer instruction fosters meaningful learning by providing an educational experience that facilitates the transfer of knowledge to diverse contexts (Byrnes, 1996). This alignment with the ultimate goal of learning, as articulated by the National Research Council (Bransford et al., 2000), underscores the efficacy of peer instruction in promoting a deeper and more transferable understanding of the material. Furthermore, it is important to note that these discussions necessitate more time compared to traditional instruction. However, the additional time that students invest in critically analyzing the materials and sharing their perspectives proves highly beneficial in enhancing their level of understanding. This observation aligns with Mazur's conclusion (Mazur, 1997) that the extra time students spend in analysis and discussion significantly improves their overall level of comprehension, requiring relatively little effort and no additional capital investment.

Additionally, it has been reported that peer and group discussions may contribute to an increase in student attention (Cortright et al., 2003; Martins et al., 2020; Greenberg & Martins, 2023). Research within a lecture-based academic setting indicates that students demonstrate a lack of attentiveness approximately 40% of the time (Pollio, 1984). The diminishing levels of student attention during prolonged lectures imply a decline in engagement with each successive minute. Furthermore, sustained lectures primarily cater to auditory learners, fostering a tendency for the acquisition of factual information at lower cognitive levels. Moreover, the sustained lecturing approach operates on the assumption that all students assimilate information uniformly and at a consistent pace (Johnson et al., 1991). Therefore, the integration of peer instruction and active learning activities emerges as a strategy to enhance student attention and engagement in the learning process. In the present study, approximately 96% of students who received Think-Pair-Share (TPS) instruction demonstrated the capability to provide robust justifications for their correct answers, contrasting with only 62% of students who underwent traditional instruction. These findings, coupled with the preceding outcomes, affirm the hypothesis that peer interaction and active in-class discussions contribute to improved student learning, enhanced material comprehension, and a more successful collaborative approach to analyzing findings and solving problems.

The utilization of peer instruction and group discussions to address and resolve problems emerges as a successful technique that maximizes the collective learning of the entire group, as concluded by Johnson et al. (1999, 2006). Furthermore, discussions within groups, whether composed of two students or larger cohorts, enhanced students' ability to thoroughly analyze their responses and construct robust justifications. This, in turn, improved their proficiency in data analysis skills, as reported by Ebert-May et al. (1997).

## Summary

The study underscores the significance of implementing cooperative learning, specifically the Think-Pair-Share (TPS) technique, in educational settings. The observed improvements in student responses following peer and group discussions highlight the potential for enhancing both individual and collective learning outcomes. The findings emphasize the importance of active student engagement and peer interaction, suggesting that fostering such collaborative approaches can contribute to increased comprehension, critical thinking skills, and successful problem-solving. These insights advocate for the integration of cooperative learning strategies to optimize overall student learning experiences in educational settings.

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