Beyond the Numbers: A Case Study of Student Interaction and Peer Scaffolding in STAD Cooperative Learning for Statistics

40

Beyond the Numbers: A Case Study of Student Interaction and Peer Scaffolding in STAD Cooperative Learning for Statistics

Shafriaty Kepa[1*], Hamza Tabien[1] Andi Kaharuddin[2]
[1]Department of Mathematics Education, Universitas Banda Naira, Indonesia
[2]Department of Mathematics Education, Universitas Lakidende Unaaha, Indonesia

*Correspondence: shafriatykepa2015@gmail.com

Abstract
Most research on the Student Teams Achievement Division (STAD) model focuses on quantitative metrics such as test scores and completion rates. However, this focus often overlooks the complex social dynamics and interpersonal processes that drive these improvements. This study employs a qualitative case study approach to investigate "how" and "why" STAD alters student engagement in a Grade VIII Statistics class at SMP Negeri 1 Anggaberi. Data were collected through participant observation, in-depth interviews, and audio recordings of group discussions over six weeks. The thematic analysis reveals three core findings: (1) The "Ice-Breaking" Phenomenon, where shared team goals successfully dismantle passive classroom culture; (2) Natural Peer Scaffolding, where high-achieving students spontaneously develop pedagogical strategies to explain statistical concepts (mean, median, mode) to struggling peers; and (3) Affective Transformation, characterized by a shift from individual anxiety to collective confidence. This study argues that the effectiveness of STAD lies not just in its structure, but in its ability to engineer a "zone of proximal development" through social interaction.

Keywords: *STAD; Peer Scaffolding; Statistics Education; Classroom Dynamics.*

1. Introduction

In the landscape of mathematics education, Statistics is often perceived by junior high school students as a dry, formula-heavy subject. The challenge in teaching statistics is rarely just about computation; it is about interpretation and reasoning. Preliminary observations at SMP Negeri 1 Anggaberi revealed a concerning pedagogical reality: the classroom was dominated by silence. When the teacher posed a question about data representation, students would lower their heads, avoiding eye contact to escape the "threat" of being called upon. This passivity is not merely a lack of knowledge, but a symptom of a learning culture that isolates students as individual performers.

Traditional teaching methods, which rely heavily on one-way instruction, often fail to break this isolation. Students with low mathematical ability feel alienated, while high-achieving students are rarely challenged to articulate their understanding. To address this, a shift towards social constructivist pedagogy is required. The Student Teams Achievement Division (STAD) model, developed by Slavin, offers a structural remedy by organizing students into heterogeneous teams where success is determined by the collective improvement of all members (Kaharuddin, dkk., 2023; Kaharuddin, dkk, 2025).

However, existing literature on STAD is heavily saturated with quantitative experimental studies. Researchers like Fauzi and Rahman (2021) and Aningsih et al. (2023) have robustly proven that STAD improves scores. Yet, these numbers tell us *that* it works, but not *how* it works. We know little

Beyond the Numbers: A Case Study of Student Interaction and Peer Scaffolding in STAD Cooperative Learning for Statistics

41

about the micro-interactions that occur when a student explains the concept of "Median" to a peer who is confused. We have limited insight into the emotional journey of a shy student who suddenly feels responsible for their team's score.

This study aims to fill that gap. Grounded in Vygotsky's theory of the *Zone of Proximal Development* (ZPD) and Social Interdependence Theory, this research adopts a qualitative lens. It seeks to capture the "lived experience" of students as they navigate the transition from individual learning to cooperative interdependence. The primary objective is to explore the dynamics of student interaction, the mechanisms of peer support, and the shifts in perception towards statistics during the implementation of STAD.

2. Method

2.1. Research Design

The study follows the Case Study protocol defined by Yin (2018), encompassing three distinct phases: **(1) Designing the Case**, where the boundaries of the 'Class VIII A ecosystem' were defined; **(2) Data Collection**, involving prolonged engagement through observation and interviews; and **(3) Analysis and Reporting**, using thematic synthesis. This linear yet iterative approach ensures that the focus remains on the depth of the phenomenon rather than cyclical intervention improvements common in Action Research
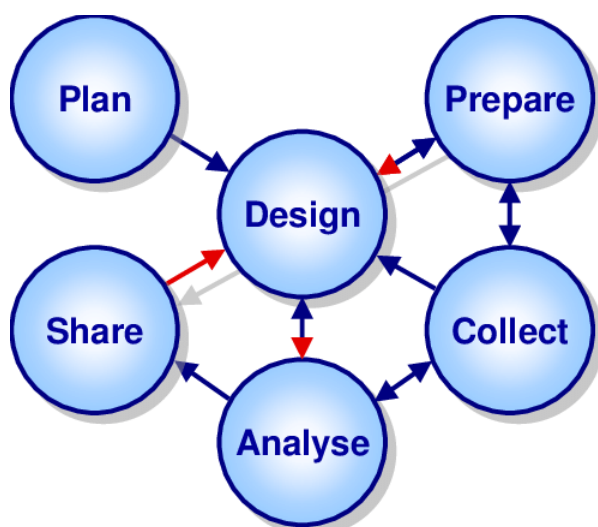

Fig 1. Research Design

2.2. Participants and Setting

The research was conducted at SMP Negeri 1 Anggaberi during the 2024/2025 academic year. The participants were 23 students of Class VIII A.

To obtain in-depth data, the researcher used **purposive sampling** to select 6 "Key Informants" for interviews: two high achievers (Students A & B), two average achievers (Students C & D), and two low achievers (Students E & F). This selection ensured a diversity of perspectives regarding the cooperative process.

2.3. Data Collection Techniques

The researcher acted as the primary instrument (*human instrument*), supported by:

1. Participant Observation: The researcher was present in the classroom for all six meetings, taking detailed *field notes* on body language, tone of voice, and group configurations.
2. In-Depth Interviews: Semi-structured interviews were conducted after the 3rd and 6th meetings to probe students' feelings about their teammates and the material.
3. Audio Documentation: Group discussions were recorded to capture the verbatim dialogue of peer tutoring sessions.

2.4. Data Analysis

Data were analyzed using the interactive model by Miles, Huberman, and Saldana (2014):

- *Data Condensation:* Selecting relevant transcripts related to interaction and understanding.
- *Data Display:* Organizing findings into narrative themes and dialogue excerpts.
- *Conclusion Drawing:* Synthesizing themes to answer the research problem. Trustworthiness was established through **methodological triangulation** (comparing observations with interviews) and **member checking** (asking students to verify the interpretation of their statements).

3. Results and Discussion

The thematic analysis of the data revealed three overarching themes that describe the qualitative transformation within the classroom.

3.1. Theme 1: Breaking the Silence — The Transition from Passive to Participatory

At the onset of the study (Meeting 1), the classroom atmosphere was characterized by "awkward compliance." When students were assigned to their

Beyond the Numbers: A Case Study of Student Interaction and Peer Scaffolding in STAD Cooperative Learning for Statistics

42

STAD teams, resistance was palpable. Field notes from Day 1 describe the scene:

> "The groups have been formed, but they are not 'teams' yet. In Group 3, Student R (Male) sits physically turned away from Student T (Female). They are working on the worksheet individually. The room is quiet, save for the sound of the teacher's footsteps." (Field Note, October 14, 2024).

This behavior aligns with the "First-Order Barriers" mentioned by Ertmer (1999), where students are hindered not by ability, but by a culture of individualism. However, the turning point occurred in Meeting 3, during the "Team Recognition" phase. When the teacher announced that the "Super Team" status depended on the improvement of the lowest-scoring member, the dynamic shifted instantly.

Narrative of Change: In Group 2, a student named "Dina" (pseudonym), who usually never spoke, was suddenly approached by "Rian," a high achiever.

- **Rian:** "Din, kamu sudah paham cara cari Modus data kelompok?" (Din, do you understand how to find the Mode for grouped data?)
- **Dina:** (Shaking head) "Belum." (Not yet.)
- **Rian:** "Kalau kamu nggak paham, nanti kuis nilai kita jatuh. Sini aku ajarin. Lihat tabel ini..." (If you don't understand, our quiz score will drop. Let me teach you. Look at this table...)

This interaction marks the transition from *passive coexistence* to *active interdependence*. The external motivator (Team Score) successfully forced a breach in the social barrier. In the interview, Dina reflected on this moment:

> "Biasanya malu bertanya sama Guru. Tapi karena Rian butuh nilai saya naik, dia maksa ajarin. Lama-lama jadi biasa ngobrol." ("Usually I'm too shy to ask the teacher. But because Rian needed my score to go up, he forced himself to teach me. Eventually, talking became normal.")

This confirms the theory that cooperative learning structures can override social anxiety by creating a shared destiny.

3.2. Theme 2: The Mechanics of Natural Peer Scaffolding

The most significant qualitative finding was the emergence of natural scaffolding strategies employed by students. Unlike teachers who often use academic language, peers used vernacular and analogies that resonated with their friends.

Case Vignette: The "Mean" Debate in Group 4
During a task to calculate the Mean of a dataset containing an outlier, a conflict arose in Group 4. The audio recording captures a pivotal moment of cognitive conflict and resolution:

Student X (Low Ability)
> "Just add them all and divide by 10. The answer is 85."

Student Y (High Ability)
> "Wait, look at this number '20'. It's way smaller than the others. If we just average it, the score looks too low."

Student X
> "So what? The formula says $\sum x/n$."

Student Y
> "Imagine this is our pocket money. If we all have 100 thousand, but Budi only has 2 thousand, is it fair to say our 'average' is rich? No, right? That's why we need to be careful with the outlier."

In this dialogue, Student Y is not just giving an answer; they are engaging in **conceptual teaching**. They used an analogy (pocket money) to explain the concept of sensitivity to outliers in Statistics. This is a clear manifestation of Vygotsky's ZPD; Student X could not grasp the abstract concept of "outlier sensitivity" alone, but grasped it immediately through the "pocket money" analogy provided by a more capable peer.

This finding contrasts with conventional teaching where the teacher might simply define "outlier"[6]. In STAD, the students become the primary agents of knowledge transmission. The observation data showed that 70% of the questions asked during group work were directed at peers, not the teacher.

3.3. Theme 3: Affective Shift – Redefining Statistics

The third theme explores the emotional trajectory of the students. Interviews revealed a significant reduction in "Math Anxiety." Before the intervention, Statistics was viewed as a solitary

Beyond the Numbers: A Case Study of Student Interaction and Peer Scaffolding in STAD Cooperative Learning for Statistics

43

burden. By Week 6, it was viewed as a collective puzzle.

Interview Excerpt (Student F - Low Achiever):

"Dulu kalau lihat soal cerita statistika, rasanya mau nyerah. Pusing lihat angkanya. Sekarang, pas baca soal, saya langsung ingat suara teman sekelompok saya debat soal itu. Jadi berasa ada temannya pas ngerjain kuis." ("Before, looking at statistics word problems made me want to give up. The numbers were dizzying. Now, when I read a question, I immediately remember the voice of my teammate arguing about it. I feel like I have company even when doing the quiz.")

Vignette: Confronting the 'Free Rider'.

The transition to interdependence was not seamless. In Week 2, an observation in Group 1 captured a conflict regarding Student K, who appeared disengaged. *Student M (Team Leader):* 'K, why is your paper blank? We need the mean value for the second dataset.' *Student K:* 'I don't get it. You do it.' *Student M:* 'No. If the teacher calls you for the random check and you can't answer, our team points drop. I will read the numbers, you write and calculate. Come on.' This dialogue illustrates that peer pressure in STAD acts as a mechanism for accountability. The social cost of letting the team down outweighed the student's desire to remain passive.

This statement is profound. It suggests that the **social interaction** became an internal cognitive resource. The "voice of the teammate" became the inner voice of the student during individual assessments. This supports the notion that cooperative learning does not just improve skills, but fundamentally alters the student's relationship with the subject matter.

The findings of this study provide a qualitative explanation for the quantitative success seen in other studies (e.g., Aningsih et al., 2023). The improvement in scores is likely a byproduct of the intense *verbalization* of mathematical thinking. When students explain concepts to each other (as seen in Theme 2), they engage in **metacognitive processing**—they have to organize their thoughts to make them understandable to others. This deepens the explainer's understanding while aiding the receiver.

Furthermore, the "Team Recognition" component of STAD acts as a powerful catalyst for social cohesion. It converts the classroom from a

collection of competitors into a network of collaborators. However, it is worth noting that this process was not without friction. In the early weeks, some groups struggled with "free riders" (students who did not contribute). The teacher's role in monitoring and emphasizing *individual accountability* (via quizzes) was crucial to resolving these conflicts.

These findings offer a critical qualitative counterpoint to existing quantitative literature. While studies like Fauzi and Rahman (2021) demonstrate *that* STAD improves scores, this research illuminates *how* it happens: through the translation of academic concepts into student vernacular (Theme 2) and the conversion of individual anxiety into shared responsibility (Theme 3). This suggests that the 'black box' of cooperative learning success is fueled by emotional safety and linguistic accessibility, factors often invisible in test-score analysis.

4. Conclusion

This qualitative case study illuminates the "black box" of the STAD learning model. It concludes that the effectiveness of STAD in teaching Statistics at SMP Negeri 1 Anggaberi is driven by three key qualitative mechanisms:

1. Social Safety: The small-group structure provides a safe harbor for students to express confusion without fear of public judgment.
2. Cognitive Accessibility: Peer scaffolding renders abstract statistical concepts more accessible through the use of student-level language and analogies.
3. Shared Responsibility: The interdependence created by the scoring system motivates high achievers to become mentors, fostering a classroom culture of care and collaboration.

For educators, this study implies that implementing STAD requires more than just following steps; it requires active **social engineering**. Practical interventions include: **(1) Strategic Grouping**, where teachers pair students not just by grade capability but by social compatibility to reduce friction; and **(2) Scripted Communication**, such as enforcing the 'Ask Three Before Me' rule, which compels students to exhaust peer resources before seeking teacher aid. Teachers must essentially design the social architecture of the classroom to force positive interdependence

Beyond the Numbers: A Case Study of Student Interaction and Peer Scaffolding in STAD Cooperative Learning for Statistics

44

References

Andriani, N., Hidayat, R., & Suryani, T. (2024). Innovative learning models for improving student motivation in mathematics. *Journal of Mathematics Education Research*, 15(3), 4598–4610.

Aningsih, D., Pratiwi, N., & Santoso, B. (2023). The effectiveness of STAD in improving elementary students' mathematics achievement. *Journal of Educational Practice*, 12(4), 3602–3615.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications.

Durrotunisa, L., Septian, D., & Mulyani, A. (2020). Cooperative learning strategies and student responsibility in mathematics classrooms. *Indonesian Journal of Mathematics Education*, 8(2), 104–110.

Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology R&D*, 47(4), 47-61.

Fauzi, A., & Rahman, H. (2021). Implementation of STAD model in junior high school mathematics: Its impact on students' achievement. *International Journal of Learning, Teaching and Educational Research*, 20(3), 10–18.

Fernandez-Batanero, J. M., Montenegro-Rueda, M., Fernandez-Cerero, J., & Garcia-Martinez, I. (2022). Digital competences for teacher professional development. Systematic review. *European Journal of Teacher Education*, 45(4), 513–531.

Gillies, R. M. (2023). Promoting academic talk in schools through cooperative learning. *Pedagogies: An International Journal*, *18*(1), 105-120.

Hidayat, M. (2023). Effective instructional design and its contribution to student achievement. *Journal of Pedagogy and Learning*, 9(1), 40–49.

Hidayat, R., & Suryani, T. (2021). STAD model in developing active learning environments. *Cakrawala Pendidikan*, 40(1), 45–52.

Jumrawarsi, R., & Suhaili, S. (2020). Teachers' role as facilitators in cooperative learning. *Jurnal Pendidikan dan Pembelajaran*, 7(2), 50–58.

Kaharuddin, A., Arsyad, N., & Asdar, M. P. (2023). Media Hologram 3D dalam Pembelajaran Geometri untuk meningkatkan keterampilan proses sains. Pustaka Learning.

Kaharuddin, A., García, J. G., Magfirah, I., & Yulismayanti, Y. (2025). Validating a TPCK-S Instrument for Hologram-Based Mathematics Teaching. Indonesian Journal on Learning and Advanced Education (IJOLAE). Kaharuddin, S. P., Kahar, M. J., Ernawati, S. P., Ismiyati, N., Umar, S. P., Murniati, S. P., ... & Susilo, G. (2025). MENGUASAI RISET PENDIDIKAN: Implementasi Best Practice dalam Metodologi Dasar. CV. EUREKA MEDIA AKSARA.

Koehler, M., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge (TPACK). *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70.

M. L., & Ing, M. (2024). Student dialogue and engagement in mathematics classrooms: Unpacking the black box of peer interaction. *Journal of the Learning Sciences*, *33*(2), 210-235.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook*. Sage Publications.

Nurhidayati, D., & Pratama, S. (2022). Reducing student learning anxiety through cooperative learning strategies. *Journal of Mathematics Education Innovation*, 6(2), 55–63.

Nurjanah, R., & Fauzi, I. (2022). Structured cooperative learning in mathematics education. *Jurnal Riset Pendidikan Matematika*, 9(2), 110–118.

Slavin, R. E. (1995). *Cooperative learning: Theory, research, and practice*. Allyn and Bacon.

Tran, V. D. (2019). The Effects of Cooperative Learning on the Academic Achievement and Knowledge Retention. *International Journal of Higher Education*, 3(2), 131-140.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods*. Sage Publications.

Zakaria, E., Chin, L. C., & Daud, Y. (2010). The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. *Journal of Social Sciences*, 6(2), 272-275.